Abhandlung

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Life on Pálava Hills in the Urnfield period through the perspective of a metal-detecting survey

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Zusammenfassung: Pálava ist ein Komplex markanter Kalksteinhügel in Südmähren mit umfangreichen Spuren prähistorischer Aktivitäten. Diese Studie präsentiert die Ergebnisse einer langfristigen Metalldetektor-Untersuchung der Pálava-Hügel und ihrer Umgebung. Sie konzentriert sich auf Funde aus der Bronzezeit, insbesondere aus der Urnenfelderzeit mit 673 aus dem Oberboden geborgenen Artefakten. Die Studie überwacht die funktionale Zusammensetzung der Gegenstände innerhalb des Datensatzes sowie die räumliche Verteilung einzelner Artefakte. Die Daten aus den Untersuchungen ermöglichen Vergleiche zwischen den umschlossenen Stätten auf den Hügeln Stolová hora, Kotel und Děvín und den offenen Satellitensiedlungen im Hinterland. Die Ergebnisse werden auch für Vergleiche mit anderen bronzezeitlichen Fundorten in Mähren verwendet, die mit derselben Methode untersucht wurden. Die Studie beinhaltet auch eine metallographische Analyse von 177 Objekten. Die Ergebnisse zeichnen das Bild einer intensiv genutzten Höhenburg auf Stolová hora, die in der Urnenfelderzeit als Zentrum einer breiteren Agglomeration und zeitweise wahrscheinlich auch der gesamten Region diente.

Schlüsselworte: Pálava, Urnenfelderzeit, Metalldetektor-Untersuchung, Höhenburg, Bronzezeit

Abstract: Pálava is a complex of prominent limestone hills in South Moravia, with extensive traces of prehistoric activities. This study presents the results of a long-term metal-detecting survey of the Pálava Hills and their surroundings. It focuses on findings dated to the Bronze Age and especially to the Urnfield period with 673 from the topsoil recovered artefacts. The study monitors the functional composition of the items within the dataset, as well as the spatial distribution of individual artefacts. The data from the surveys allow comparisons between the enclosed sites at the Stolová hora, Kotel, and Děvín hills, and the open satellite settlements in the hinterland. The results are also used for a comparison with other Moravian Bronze Age sites that have been surveyed with the same method. The study also includes a metallographic analysis of 177 objects. The results create a picture of an intensively used hillfort at Stolová hora, which in the Urnfield period represented a centrepiece of a broader agglomeration, and at some point, also probably of the whole region.

Keywords: Pálava, Urnfield period, metal-detecting survey, hillfort, Bronze Age

Abstrakt: Pálava je soustava výrazných vápencových kopců na jižní Moravě s bohatými doklady pravěkého osídlení. Tato studie prezentuje výsledky dlouholetého detektorového průzkumu Pálavských kopců a jejich okolí. Zaměřuje se na nálezy z doby bronzové a zejména z doby popelnicových polí, kterých bylo z povrchové vrstvy vyzvednuto na 673. Studie sleduje zastoupení funkčních kategorií v rámci datového souboru a dále prostorovou distribuci jednotlivých nálezů. Data z průzkumů umožňují srovnání mezi ohrazenými areály na Stolové hoře, Kotli a Děvíně a satelitními otevřenými sídlišti v jejich zázemí. Výsledky jsou srovnány s dalšími moravskými lokalitami doby bronzové, které byly prozkoumány stejnou metodou. Součástí studie je i metalografická analýza 177 předmětů. Výsledky průzkumů vytvářejí obraz intenzivně využívaného ohrazeného hradiště na Stolové hoře, které v době popelnicových polí představovalo centrum širší aglomerace a v určitém období nejspíše i celého regionu.

Klíčová slova: Pálava, popelnicová pole, detektorová prospekce, hradiště, doba bronzová

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1 Introduction

The Pavlov Hills make up one of the most characteristic geomorphological features of southern Moravia. The three most dominant limestone summits (Děvín, Kotel, and Stolová hora) are located above the confluence of three major Moravian rivers, and very likely played an important role in the landscape of prehistoric societies. This is not only evidenced by the prominent silhouette visible from a distance of tens of kilometers, but also by the existence of enclosed sites on all of the three summits, as well as by the significant wealth of archaeological findings. The earliest documented finds were recorded in the early 19th century in the Klentnice cadaster, which lies directly below the slopes of the Bronze Age hillfort on Stolová hora. After the discovery of the hoard in 1950 near Stolová Hora, the area received intensive attention from the professional archaeologist Jiří Říhovský[1]. He carried out two seasons of systematic excavation at the hillfort itself[2], and a rescue excavation of the burial site at the northern edge of the village[3]. Subsequently, he focused on surveying other Pálava hills and their immediate hinterland[4].

With the rise in metal detecting as a leisure activity in the Czech Republic at the beginning of the new millennium, professional archaeologists began receiving information that the Pálava sites were facing enormous interest from treasure hunters[5]. This situation motivated the staff of the Regional Museum in Mikulov to start their own metal-detecting surveys in 2008. In the following years, these surveys were carried out in co-operation with the Brno City Museum, and subsequently developed into long-term survey activities with the involvement of amateur collaborators. Between 2008 and 2022, a series of 20 mostly one-day survey events took place in Pálava, including metal detecting surveys, as well as tracing wall and enclosure relics. A geomagnetic survey of Stolová hora was also conducted[6]. During this time, over 770 metal artefacts were recovered, dating from the late Eneolithic period to modern times. A number of partial results have already been published[7]. The study is aimed at presenting the results of the surveys related to the Bronze Age, and especially the Urnfield period.

1.1 Pálava's natural conditions

Pálava, or the Pavlov Hills, located in southern Moravia near Mikulov, is a system of distinctive limestone klippes that form a line of seven hills, stretching for approximately 10 km in the north-south axis, including Děvičky, Děvín, Kotel, Stolová hora, Turold, Svatý Kopeček, and Šibeničník. On the top of the second, third, and fourth hill, prehistoric hillforts were built. The tallest, and most prominent, of the hills is Děvín (549 m above sea level), with an elevation of almost 400 m above the surrounding lowlands. The hillfort on Stolová hora was introduced in literature by J. Říhovský as 'Tabulová hora', which is nowadays understood as an archaic name in relation to the much more commonly used name 'Stolová hora'. In this paper, 'Stolová hora' is understood as a geographical name, while 'Tabulová hora' is used for the archaeological site of the hillfort that includes not only the acropolis on the top of the hill, but also two adjacent suburbs. The surrounding landscape is generally a fertile lowland along the Dyje River, which was intensively used for settlement purposes throughout prehistory. Two other major Moravian rivers – Svratka and Jihlava – flow into Dyje, in the close vicinity of Pálava Hills. Between 1975 and 1988, Nové Mlýny dam was built on this section of the river (Fig. 1).

Geologically, the Pavlov Hills are part of the West Carpathian flysch zone. The limestone klippe towers above the surrounding relatively thin and flat flysch bedrock. The north-western slopes of the Děvín and Kotel hills form areas of massive slope deformations and landslides, consisting of a mixture of soil and loose limestone, while the south-eastern side is made up of Pleistocene loess layers. The south-western and southern slopes of Stolová hora are composed of calcareous clays. The bed of the Dyje River north of the hills is naturally formed by fluvial sediments, and is lined with Pleistocene gravel terraces. The situation is similar on the southern edge of the Pálava, where the original and abandoned Dyje riverbed runs. On the eastern side, the Pavlov Hills are bordered by the Milovice Upland[8].

As a result of the ruggedness of the Pavlov Hills and the Milovice Upland, there are significant local mesoclimatic and microclimatic fluctuations. Limestone outcrops accumulate heat on sunny days, and the hills tend to hold low cloud cover on rainy days. Paleoclimatologically, the Bronze Age falls in the period after the end of the so-called "climatic optimum", i. e. a period characterized by a drier climate, climatic fluctuations, and the retreat of forests[9].

1 Říhovský 1950.
2 Říhovský 1955; 1958
3 Říhovský 1965a; 1970.
4 Říhovský 1957; 1965b.
5 Navrátil 2010; Vích 2009, 142.
6 Navrátil/Bíško/Tencer 2020.
7 Navrátil 2021a; Goláňová/Navrátil 2017; Holubová/Navrátil 2020.
8 Bíl *et al.* 2020.
9 Sádlo *et al.* 2008, 92.

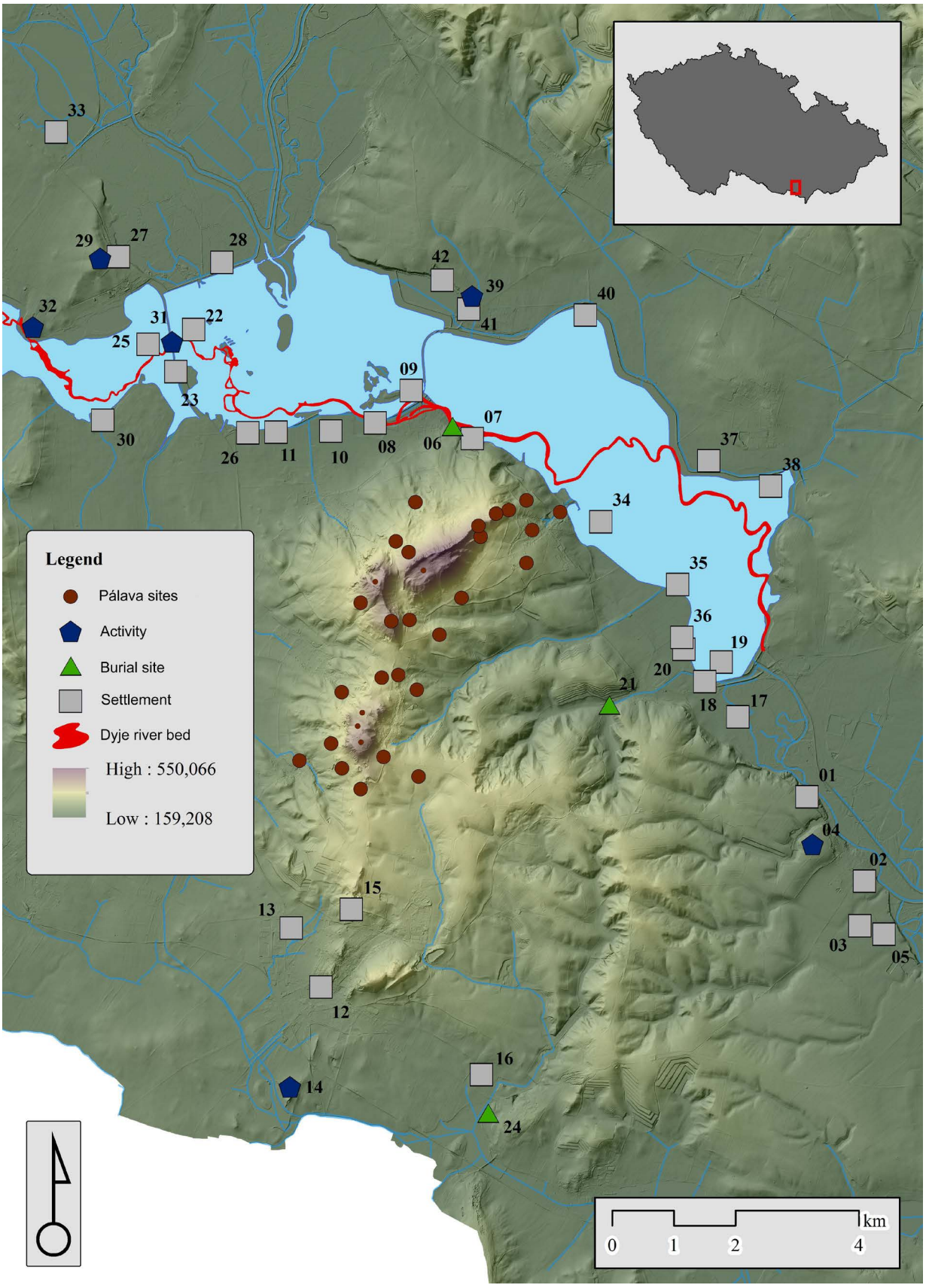

Fig. 1: Urnfield period sites in wider context of the Pálava Hills.

1.2 Definition of the study area, data collection method, and research objectives

The spatial borders of the study are based on the surveys carried out by J. Říhovský in the 1960s[10]. Basically, the studied area includes cadasters of the municipalities where the summits and slopes of hills with the hillforts are located – i. e. the cadasters of Bavory (BA), Dolní Věstonice (DV), Horní Věstonice (HV), Klentnice (KL), Pavlov (PA), and Perná (PE). The borderline of the Pálava Protected Landscape Area is used as an auxiliary for the purpose of the study. This is, of course, an arbitrary delimitation. However, when applied, it more than sufficiently covers the area monitored by the survey activities within the project (Fig. 2). Also, it filters out a number of settlements that were located in the lowland along the Dyje floodplain.

Data collection was conducted mainly in the form of a metal-detecting survey. The methodology has evolved over the years. The early surveys between 2008 and 2010 were mainly focused on documenting the archaeological situation disturbance level on Stolová hora caused by treasure hunters[11]. The events involved employees of the Mikulov Museum and their closest collaborators, numbering just a few individuals. Since 2013, the surveys have taken the shape of one-day events, organized with the help of volunteer metal-detector users. The aim of the events was to collect archaeological artefacts from the topsoil, in order to monitor prehistoric activities, and also to secure the artefacts from further illegal raids. An average of 10 collaborators and an archaeologist participated in each event. At the 2022 events, the number rose to 30 collaborators. Between 2013 and 2022, a total of 15 organized metal-detecting surveys were conducted.

Due to the short-term nature of the individual events, the size and ruggedness of the studied area, as well as the lack of logistical support, the method of free movement of detectorists in the defined polygon was chosen. Such a polygon represented one site. Although this method does not allow for absolute quantification of the artefacts resting in a defined area, it does allow a substantially large area to be sampled. Moreover, the surveys confirmed the obvious fact that in the whole area of Pálava, and especially at the hillforts Tabulová hora, Kotel, and Děvín, the archaeological situation has been significantly disturbed by intensive illegal metal-detecting activities. In spite of the unfavorable situation, we believe in the meaningfulness of the surveys and analysis of the obtained data. Although a similar situation nowadays concerns practically all archaeological sites from the metallic periods, they still bear significant information potential for archaeologists[12].

Considering the aspects described above, the aim of the surveys was to obtain as much data as possible, from as large an area as possible, and thereby to create a 'bigger picture' of the prehistoric activities on the Pavlov Hills and in their immediate hinterland. The depth of the holes made within the surveys exceptionally exceeded 15 cm. We can therefore assume that the vast majority of the artefacts represent lost or otherwise unintentionally deposited objects of daily use that have been archaeologised in the cultural layer. Individual artefacts were geo-located, using a portable GPS station.

From a chronological perspective, the study focuses on the Bronze Age, the Urnfield period in particular, to which the majority of the artefacts can be dated. All of the artefacts have been deposited in the Regional Museum in Mikulov.

1.3 The Data set

The dataset consists of two main components – artefacts and sites. During his surveys in early 1960s, J. Říhovský identified 18 sites – 14 settlements and 4 hillfort sites (two within the Perná – Kotel site) dating to the Urnfield period or the Bronze Age in general[13]. In our study, we have extended this number to a total of 33 sites. The additional sites were identified during rescue excavations or survey activities after 1965. The sites can be divided into four categories. The first category is *hillforts* – enclosed settlements on the top of the hills of Stolová hora, Kotel, and Děvín (Fig. 3). In total, there are 5 of these sites, as the Tabulová hora hillfort consists of three individual sites – an acropolis and two suburbs. The second category is the *settlements* – sites located below or on the slopes of the hillforts, which can be assumed to have formed satellite settlements with a closer relationship to the hillforts. There are sufficient pottery pieces and metal artefacts from these sites (at least five pieces from either type, or at least ten pieces of pottery) to suggest sustained settlement activity. A total of 10 such sites have been identified. The third category is *activity* – this marks sites on which isolated finds were found, and it is not possible to clearly determine whether they represent isolated lost artefacts, the remains of settle-

10 Říhovský 1965b.

11 Navrátil 2008; 2010.

12 Komoróczy *et al.* 2019; Goláňová *et al.* 2020; Profantová 2017; Profantová *et al.* 2020.

13 Říhovský 1965b.

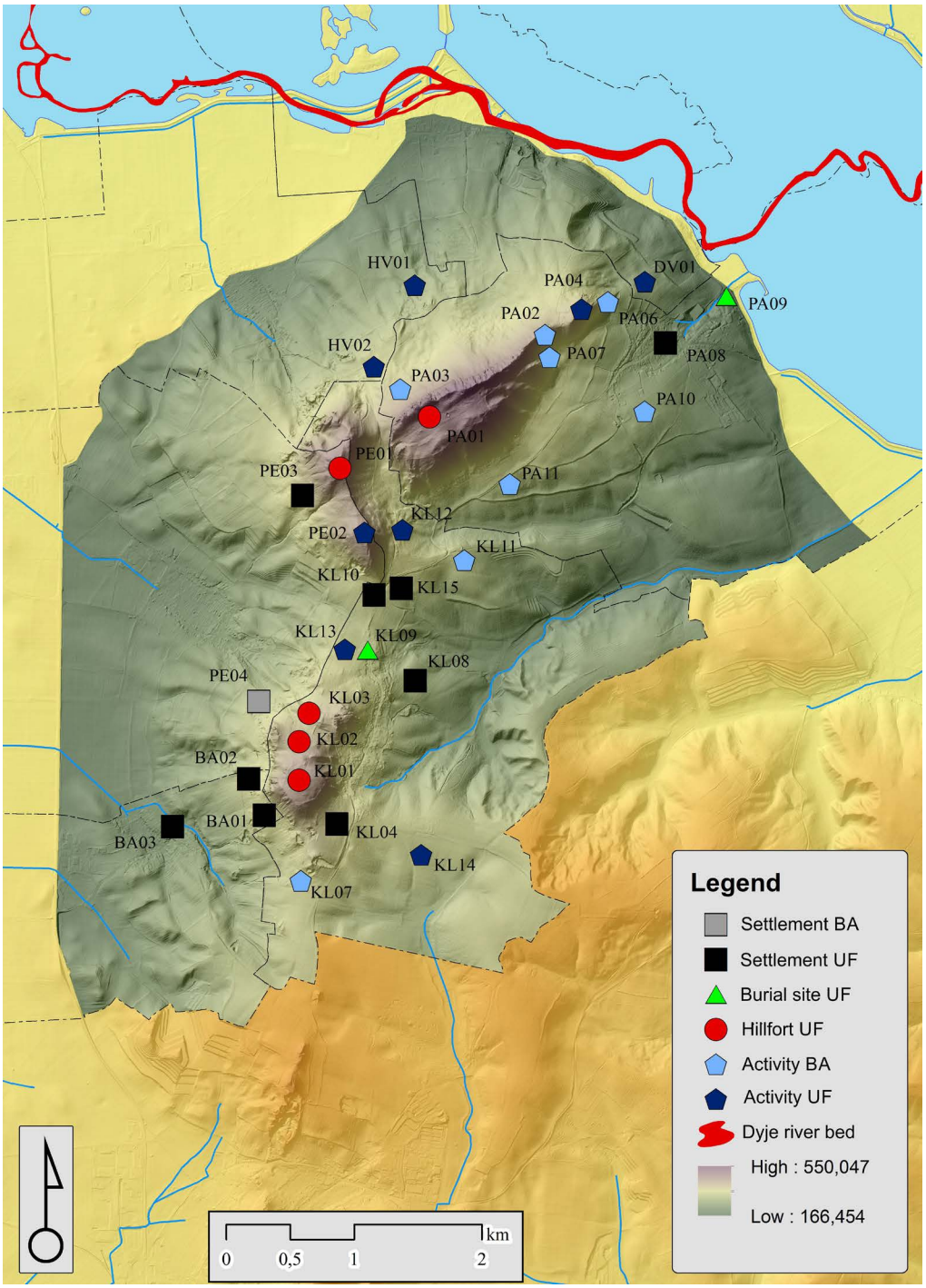

Fig. 2: Map of the area of interest with identified sites marked (BA – Bronze Age; UF – Urnfield). BA01: Bavory – Pod Pálavou 1; BA02: Bavory – Pod Pálavou 2; BA03: Bavory – Intravilán obce; DV01: Dolní Věstonice – Pod Děvičkami; HV01: Horní Věstonice – U lesa; HV02: Horní Věstonice – Pod Děvínem; HV03: Horní Věstonice – Pod Martinkou; KL01: Klentnice – Tabulová hora – akropole; KL02: Klentnice – Tabulová hora – I. předhradí; KL02: Klentnice – Tabulová hora – II. předhradí; KL04: Klentnice – Nad hřbitovem; KL07: Klentnice – Bavorsko; KL08: Klentncie – Pod hotelem; KL09: Klentnice – Severní konec obce; KL10: Klentnice – U lomu; KL11: Klentnice – Mezi vinohrady 1; KL12: Klentnice – Soutěska 1; KL13: Klentnice – Za kovárnou; KL14: Klentncie – Prostřední hony; KL15: Klentnice – Mezi vinohrady 2; PA01: Pavlov – Děvín 1; PA02: Pavlov – Děvín 2; PA03: Pavlov – Soutěska 2; PA04: Pavlov – Děvičky; PA05: Pavlov – JV okraj obce; PA06: Pavlov – SZ okraj obce; PA07: Pavlov – Pod Pálavou; PA08: Pavlov – Intravilán obce; PA09: Pavlov – SV okraj obce; PA10: Pavlov – J okraj obce; PA11: Pavlov – Nová Hora; PE01: Perná – Kotel 1; PE02: Perná – Kotel 2; PE03: Perná – Kotelná; PE04: Perná – U Mikuláška; PE05: Perná – Pod lomem.

ment, or other activity. There are 16 such sites in the data set. The last category is *burial sites* – there are two of these in the study – the well-known burial site at the northern end of Klentnice, excavated by J. Říhovský, and two graves from Pavlov in the northeastern part of the village. All of the sites are further distinguished according to the reliability of the typochronological determination, into those that can be unambiguously assigned to the Urnfield period and those for which this is probable but not certain (Fig. 2). Sites with finds from the Early and Middle Bronze Age and the Hallstatt period have already been published in detail elsewhere[14].

A total of 770 identifiable metal artefacts from the Bronze Age to the early modern period were recovered during the surveys on Pálava. Of the total, 673 can be classified as Bronze Age artefacts. Regarding chronology, fragments of plano-convex (PC) ingots and amorphous droplets may appear problematic. While the fragments of the PC ingots are typologically well-dated from the beginning of the Middle Bronze Age to the end of the Urnfield Period[15], amorphous droplets cannot be typochronologically determined. However, their association with Bronze Age settlements is typical, as is the association with PC ingot fragments[16]. Occasionally, they are also documented in hoards and on sites of later periods[17]. A total of 76 % of the PC ingots in our data set were found on Tabulová hora, where no later prehistoric settlement activities than the Bronze Age ones have been documented. In contrast, only 6 droplets in total come from sites where Iron Age finds are present, i. e. Pavlov – Děvín (PA01), Pavlov – Pod Pálavou (PA07), Perná – Kotel (PE01-02), Klentnice – Soutěska 1 (KL12). Metallographic analysis of 28 droplets confirms typical values for Bronze Age raw material (see chapter 5.2). It is therefore highly probable that the vast majority of the amorphous droplets belong to the Bronze Age. Three hoards, consisting mostly of cast rings, were found on Tabulová hora during the survey. For the sake of data management, they are treated as three individual entries in the database (i. e. KL01_050: 224 pieces; KL02_057: 54 pieces; KL02_120: 21 pieces). In absolute numbers, the assemblage therefore contains 972 Bronze Age metal artefacts, weighing a total of 9957 g. The metal finds come from 24 out of 33 sites. A total of 22 % of the data set was not found during organized surveys, but came from collections of local detectorists who decided to co-operate with the archaeologists, and whose methods of information recording showed a solid quality and a high level of reliability. These items were included in the study because they represent a quantitatively and qualitatively significant segment of the data that adds immeasurably to the information potential of the entire collection. All recorded finds were handed over to the Regional Museum in Mikulov.

2 Representation of functional categories

The metal artefacts in our dataset are categorized by function. The most abundant category (42 %) is *raw material,* in various forms of *PC ingots*, *amorphous droplets*, or *casting waste* from the casting process. The remaining artefacts are categorized into *ornaments* (pins, bracelets, torcs), *tools* (axes, sickles, knives, chisels, razors, awls), *weapons* (spearheads, daggers, arrowheads), *appliqués* (rings, caps, studs, buttons), *harness* components (nobs), *hoards*, and *unidentifiable* artefacts. *Appliqués* are understood to be functional or decorative objects that were part of composite artefacts – typically, cast rings as parts of leather belts/straps, or sew-on eyelet caps as decorative appliqués[18].

Tools make up the second most numerous category (18 %), followed by *appliqués* (13 %). *Weapons* (9 %) and *ornaments* (9 %) occur in similar numbers. It can be assumed that the rate of occurrence of artefacts in the surface layers indirectly reflects the rate of their use in the social context. It is of course necessary to take into account the archaeologization filter that all of the archaeological artefacts have gone through. Today, unfortunately, we must count illegal metal-detecting surveys among these filters. On the other hand, the development of the use of metal detectors in archaeology has also resulted in an increasing number of datasets collected by this method that can be confronted. For the purpose of comparison with the Pálava assemblage, the following Urnfield period datasets from Moravia seem the most suitable: the survey of three open settlements at Ivanovice na Hané near Vyškov[19], the survey of the Kladky hillfort near Moravská Třebová[20], and the survey of an open settlement at Sedlec near Vysoké Mýto[21]. All of the above-mentioned datasets were obtained by a similar method. As a representative of the Pálava assemblage, only the artefacts from Tabulová hora were chosen for the comparison, so that only one type of site – namely a hillfort – is

14 Holubová/Navrátil 2020; Navrátil 2021a.
15 Lutz/Krutter/Pernicka 2019, 365; Chvojka/Jiráň/Metlička 2017, 163.
16 Parma 2017, 64–94.
17 Golec/Kos 2020; Vích *et al.* 2020.
18 Navrátil 2021b, 104–106.
19 Parma 2017.
20 Vích 2012.
21 Vích 2016.

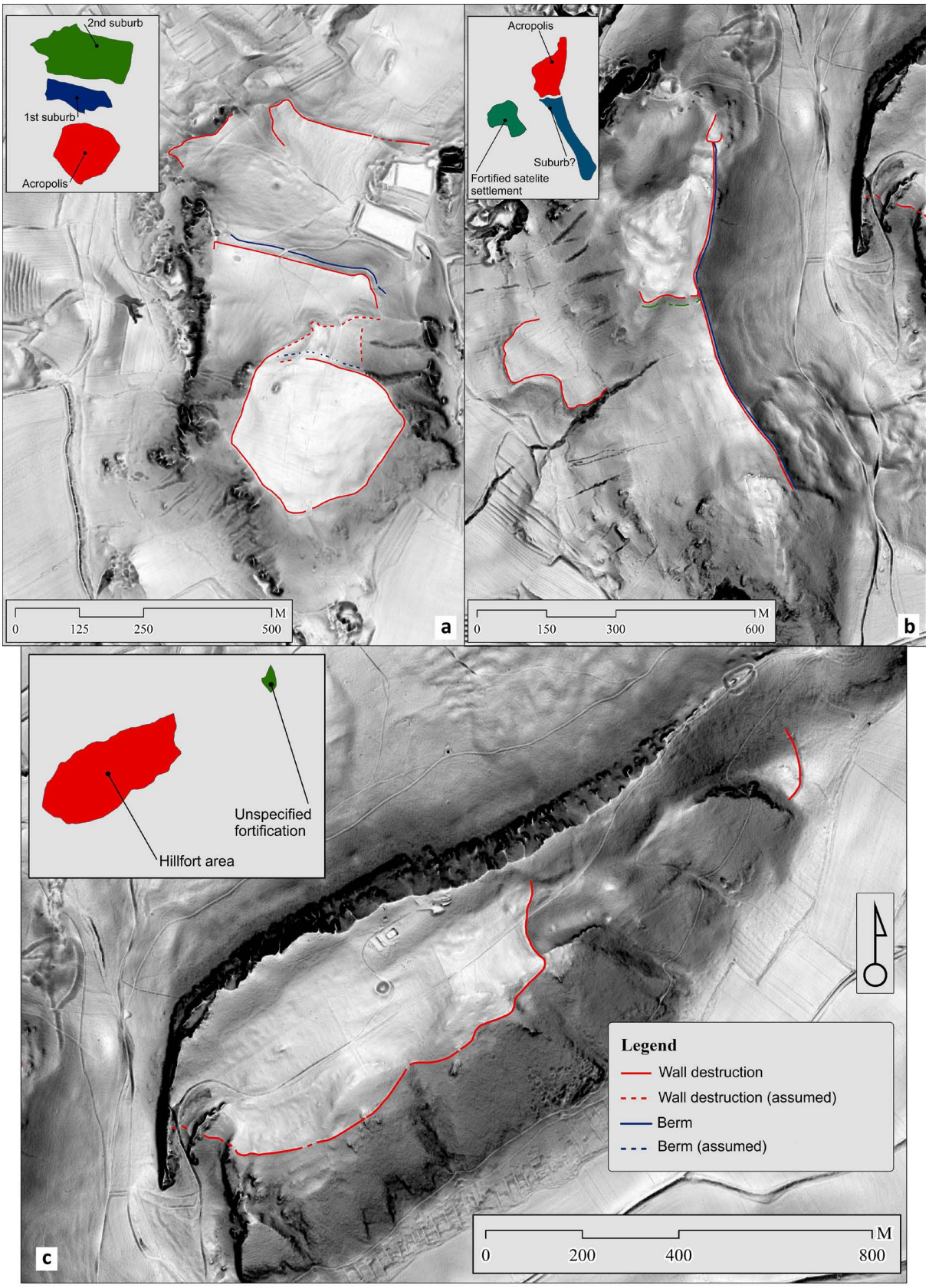

Fig. 3: Hillforts Klentnice – Tabulová hora (a), Perná – Kotel (b), and Pavlov – Děvín (c) with the relicts of fortification marked. Only on Tabulová hora acropolis (KL01) is the dating of the fortification to the Urnfield period confirmed by the excavation.

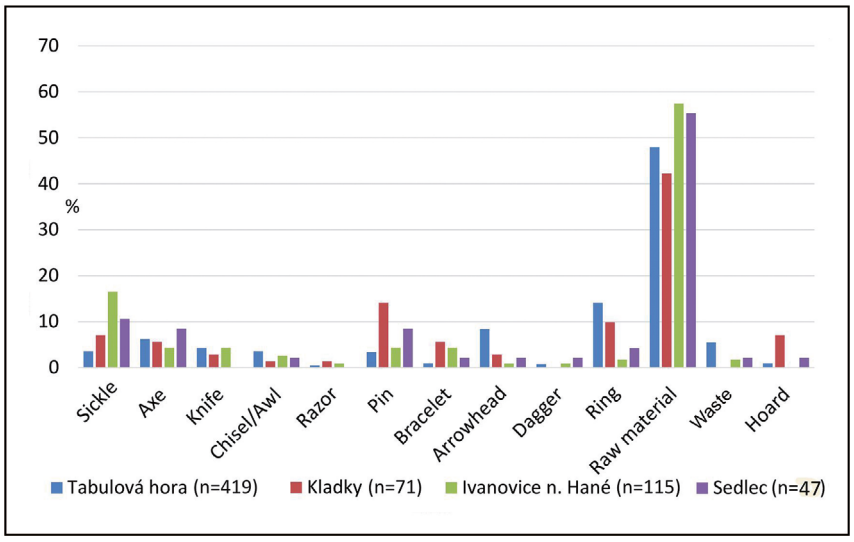

Fig. 4: Comparison of percentage representation of item types in assemblages collected by means of metal detectors on four different Urnfield sites.

represented. The percentages of artefact categories from each set were plotted on a bar graph (Fig. 4). Only those artefact categories that occurred in at least three of the four sets were included in the graph. It is worth noting that in contrast to Tabulová Hora, at the sites at Ivanovice na Hané, Sedlec, and especially the Kladky hillfort, relatively low to minimal treasure hunting activity was recorded. The comparison may therefore also point to differences between the archaeological potential of intensively and less actively looted sites.

Looking at the comparison, the most striking is the occurrence of raw material in the form of PC ingot fragments and amorphous droplets. These represent 42–57 % of the total assemblage at all sites, and therefore represent a clear trend across Bronze Age site types. The open settlement sites appear to have a slightly higher representation of raw material, compared to the hillforts. Waste from the metallurgical production of bronze objects is most abundant at Tabulová Hora (5 %), and also occurs to a lesser extent at Ivanovice and Sedlec. In contrast, it is absent at Kladky. The data may therefore indicate a relatively intensive metallurgical activity on Tabulová hora, and at the same time, its more limited occurrence in the common lowland settlements. The representation of tools such as axes, knives, chisels/awls, and razors is relatively similar across the sites. A difference is represented by the occurrence of sickles at the open lowland settlements of Ivanovice na Hané (16.5 %) and Sedlec (10.6 %), compared to the hillforts on Tabulová hora (3.5 %) and Kladky (7 %), which may indicate a lower degree of involvement of hillforts in agricultural production. There is a striking difference in the occurrence of pins between Tabulová hora (3.3 %) and Kladky (14 %), which can be explained by the level of illegal activities. Pins, unlike tool fragments and pieces of raw material, are attractive finds for looters. The relatively low representation of bracelets and hoards at Tabulová Hora can be interpreted in the same way. What makes this site stand out, on the other hand, is the rate of occurrence of arrowheads (8.3 %). This phenomenon can perhaps be related to a specific historical event (see Chapter 4.2.3). The last striking element of the comparison is the significantly higher incidence of cast rings at the hillforts (Tabulová hora 14 %, not counting the 285 rings from the three hoards; Kladky 9 %), relative to the open settlements (Ivanovice na Hané 1.7 %; Sedlec 4.2 %), which can perhaps point towards an increased mass production of rings at the hillforts.

3 Chronological modelling of activities on Pálava

3.1 Activities on Pálava from metallic prehistory to the medieval period

If we assume that the quantity of finds recovered from the cultural layer are remains of settlement or settlement-related activities, we can use our data to model the intensity of activities on individual Pálava sites from the early metallic period to modern times. We assume that the higher the density of artefacts in a cultural layer, the more intensive or longer the use of the layer was.

In terms of quantity, the artefacts are very unevenly represented at the individual sites. Almost 72 % of the finds come from the Tabulová Hora hillfort. Due to the methodology, the intensity of activities on particular sites cannot be expressed simply by the number of artefacts found there,

as not all sites received the same level of attention. It is necessary to take into account the length of the survey. For this reason, we can only use data that was collected during organized, and therefore measurable, surveys to model the intensity of site use. Organized surveys were carried out at 10 of the 33 sites recorded, and comprise 76 % of the items in the dataset. A total of 899 hours were spent on organized surveys. From the ratio of the number of artefacts to the hours spent on each site, we obtain the intensity of finds in the form of the average number of artefacts retrieved per hour (Fig. 5a). The value therefore reflects the 'density' of artefacts in the topsoil and, indirectly, the intensity/duration of site use. For the sake of comparison, the resulting values are consistent with those obtained by similar surveys at sites near Ivanovice na Hané (Fig. 5b).

By comparing the occurrence of artefacts from different chronological periods, we can model the intensity of the Pálava sites' use over time (Fig. 6a). The results show that by far the most intensive activities took place in the Bronze Age, especially in the Tabulová hora suburbs (KL02 and KL03), followed by the fortified settlement at Kotelná (PE03). The acropolis on Tabulová hora (KL01) and the hillfort on Kotel (PE01) show a similar level of use, while the open settlements at the foot of Tabulová hora Nad hřbitovem (KL04) and Pod Pálavou 1 (BA01) show a slightly lower level of activity. It should be noted that the acropolis of Tabulová hora (KL01) has seen by far the most intensive illegal treasure-hunting activities, and therefore the missing artefacts are very likely caught in the data.

In order to conveniently monitor the intensity of activities in other periods, it is necessary to adjust the number of finds per hour in the graph by displaying it on a logarithmic scale to overcome the disproportionate number of finds (Fig. 6b). On the adjusted graph, we can see that apart from the intensive Bronze Age activities, there were also isolated finds from the Roman period on Tabulová hora (KL01-03). The slightly higher intensity of barbaric activities is also visible on the site Nad Hřbitovem (KL04). The graph also shows that there are no finds from the Hallstatt or the La Tène periods on Tabulová hora, while they concentrate on the Děvín hillfort (PA01) and in the adjacent Soutěska site (KL12). Here, the intensity of activities reaches practically the same values as in the Bronze Age. These results might cast doubts on the existing dating of the fortification at Děvín (PA01), which was assumed to be erected in the Bronze Age, however, it hasn't been confirmed by test trenches so far[22]. The medieval finds from the foothills of Tabulová hora (KL03) and in Soutěska (KL12) are related to the existence of the three local medieval castles and their hinterland[23].

Sites	Hours Sum	Artefacts Sum	Artefact/Hour
BA01 Pod Pálavou 1	13	4	0,31
KL01 Akropole	232	93	0,40
KL02 I. předhradí	170	215	1,26
KL03 II. předhradí	135	114	0,84
KL04 Nad Hřbitovem	64	18	0,28
KL12 Soutěska 1	18	3	0,17
PA01 Děvín	86	15	0,17
PA07 Pod Pálavou	45	4	0,09
PE01 Kotel	78	31	0,40
PE03 Kotelná	18	11	0,61
Sum	859	**508**	**0,59**

a

Sites	Hours Sum	Artefacts Sum	Artefact/Hour
Inavovice n. H. 3	108	25	0,23
Ivanovice n. H. 6	119	42	0,35
Ivanovice n. H. 7	148	58	0,39
Sum	**375**	**125**	**0,33**

b

Fig. 5: Tables summarizing hours spent and artefacts found within organized surveys on Pavlov Hills during the period 2008 to 2022 (a) and Ivanovice na Hané sites (b) – after Parma 2017.

3.2 Bronze Age activities at the Tabulová hora hillfort

To analyze the intensity of activities on the Pálava in the Bronze Age in more chronological detail, we lack enough chronologically sensitive data. Our assemblage consists mostly of fragments of PC ingots and tools of daily use, which can often be dated only roughly to the Urnfield period. However, it seems viable to attempt to model the chronological development of the Tabulová hora hillfort, since almost 72 % of the entire assemblage (483 items) comes from its three hillfort parts (KL01-03). Among these items, we find more chronologically sensitive objects such as pins, bracelets, and similar items in sufficient numbers. It is possible to use 37 chronology-sensitive artefacts for chronology modelling. These include 25 pins, 2 axes, 2 sickles, 2 daggers, 2 knives, 1 battle axe/mace, 2 bracelets, and one hoard. The assemblage was supplemented by 15 well-dated finds, published earlier.

22 Salaš 1987, Abb. 1.

23 Kreuzer 1969; 1971; Měřínský/Unger 1972.

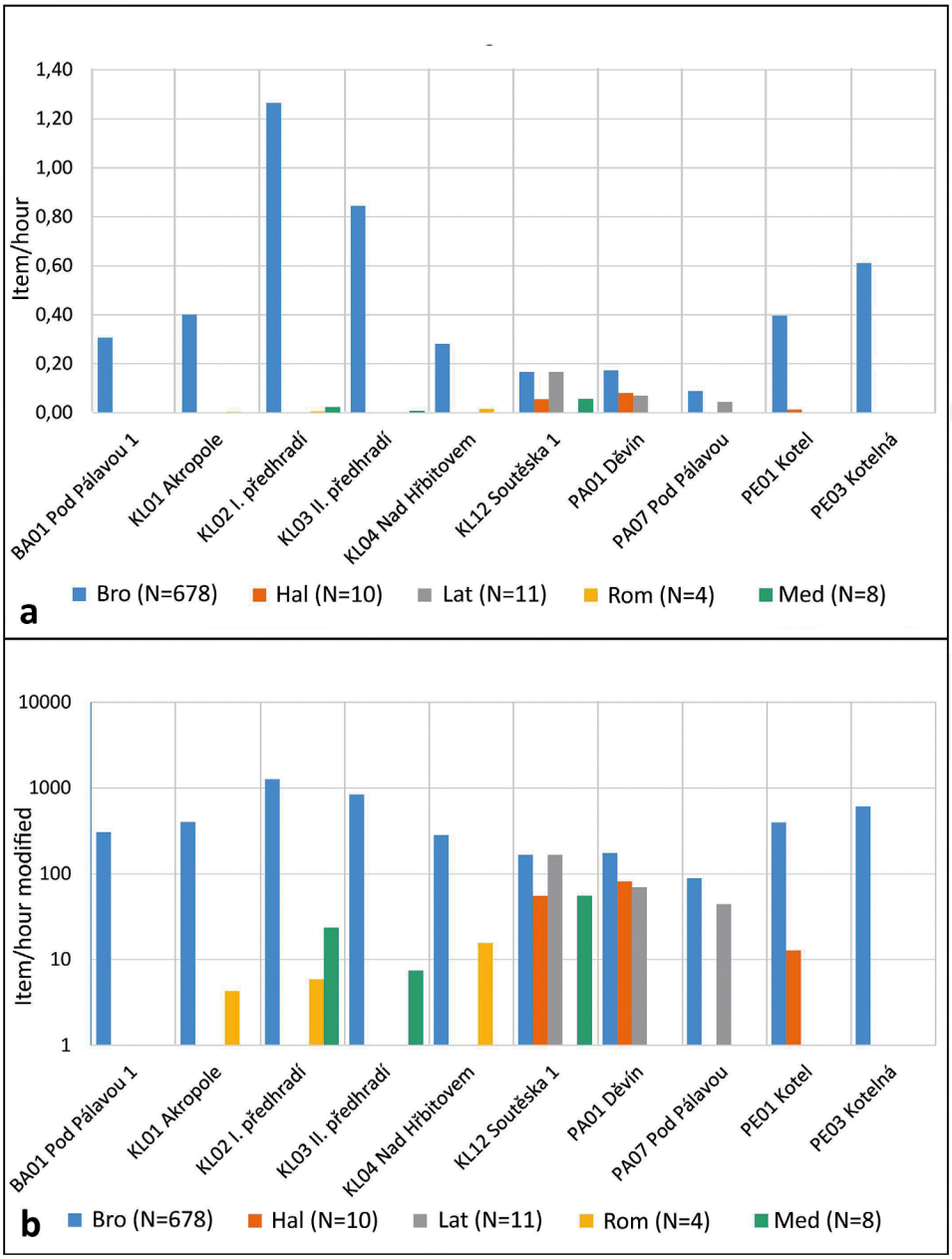

Fig. 6: a – Comparison of the item per hour ratio on sites with organized surveys and chronological periods. b – Modified item per hour ratio by multiplying by 1000 and presented on a logarithmic scale. Bro – Bronze Age; Hal – Hallstatt Period; Lat – La Tène Period; Rom – Roman Period; Med – Medieval Period.

The modelling was performed by using a seriation where one point was assigned to each of Reinecke's phases (Br A2 to Ha B3[24]) for each artefact with the occurrence in the particular phase. The summarized values for individual phases depicted in the line graph can be seen as the relative probability of site use in each phase (Fig. 7). Parallel with the items, a set of graves from the Klentnice burial site (KL09) is plotted (Fig. 7a)[25]. We assume that, at least in the Urnfield period, the burial site was mainly used by the community residing on Tabulova Hora. Therefore, the intensity of use of the Klentnice burial site reflects to some extent the intensity of use of the hillfort and its surroundings. A total of 51 burials enter the model – 1 burial from the Early Bronze Age, 7 from the Middle Bronze Age, and 43 from the Urnfield

24 Salaš 2005, 132–154.

25 Říhovský 1965a; Navrátil 2021a.

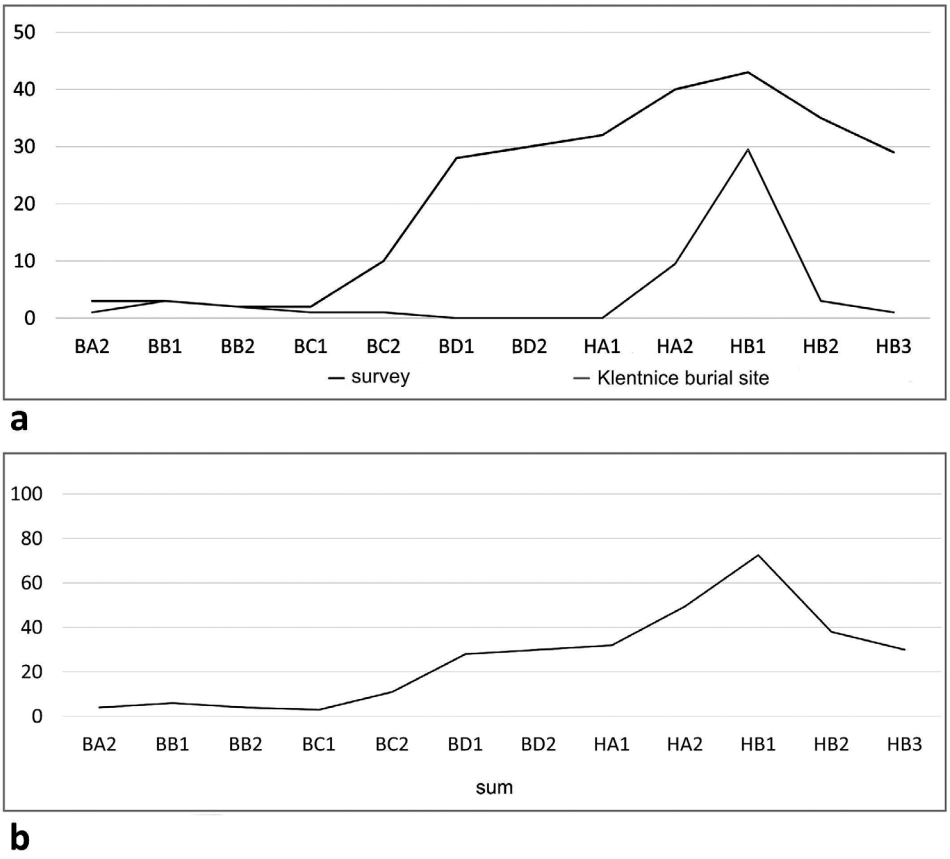

Fig. 7: Chronology model of use of the Tabulová hora hillfort in the Bronze Age on the line graph.

period. A total of 19 burials dated to the Ha A2/Ha B1 intermediate phase assign equal probability to the Ha A2 and Ha B1 phases in the model.

The results of the modelling show that the Tabulová hora hillfort was used to some extent in the Early Bronze Age. This is evidenced by findings such as a triangular dagger (Fig. 8c,1), a Borotice-type bracelet (Fig. 8c,2), and a pin with a spherical perforated head (Fig. 8c,4). One inhumation grave at the Klentnice burial site is also dated to this phase, and is assigned to the Věteřov group[26]. Seven inhumation burials are attributed to the Tumulus culture, of which only grave II can be dated specifically into the Br B1, while the rest of the burials are only generally dated to the Middle Bronze Age[27]. Among the objects from the surveys, the early tumulus phase is represented by a dagger with an oval-shaped base (Fig. 8d,2). The probability of the occurrence of artefacts then increases at the end of the Middle Bronze Age, in the transitional stage Br D1, and culminates in the phase Ha B1. The transitional Tumulus-Velatice and the early Velatice phases are completely absent from the burial site, then the intensity of occurrence increases sharply in phases Ha A2 and Ha B1 (Fig. 7a).

After summarizing the results of metal artefacts from Tabulová hora and from the Klentnice burial site, we see that the probability of the activities intensity on Tabulová hora kept at a similarly low level from the Early Bronze Age to the early Velatice period, then increased dramatically in the Ha A2 and Ha B1 phases, followed by a decline again (Fig. 8b). The model indicates that Tabulová hora was used to varying degrees throughout the whole Bronze Age, but the hillfort clearly experienced its heyday in the Ha A2, and especially in the Ha B1 phases. Early and Middle Bronze Age activities are only sporadically manifested in the finds, and cannot yet be unreservedly associated with the residential use of the hillfort, or the existence of the fortification. The boom at the end of the Middle and the beginning of the Late Phase of the Urnfield period is followed by a gradual decline. By the beginning of the Hallstatt period, the site was completely abandoned, although the burial site continued to be used[28]. Findings from the surveys and recent rescue excavations in the area indicate that during the Hallstatt

26 Stuchlíková 1990.
27 Navrátil 2021a, 52.
28 Říhovský 1970.

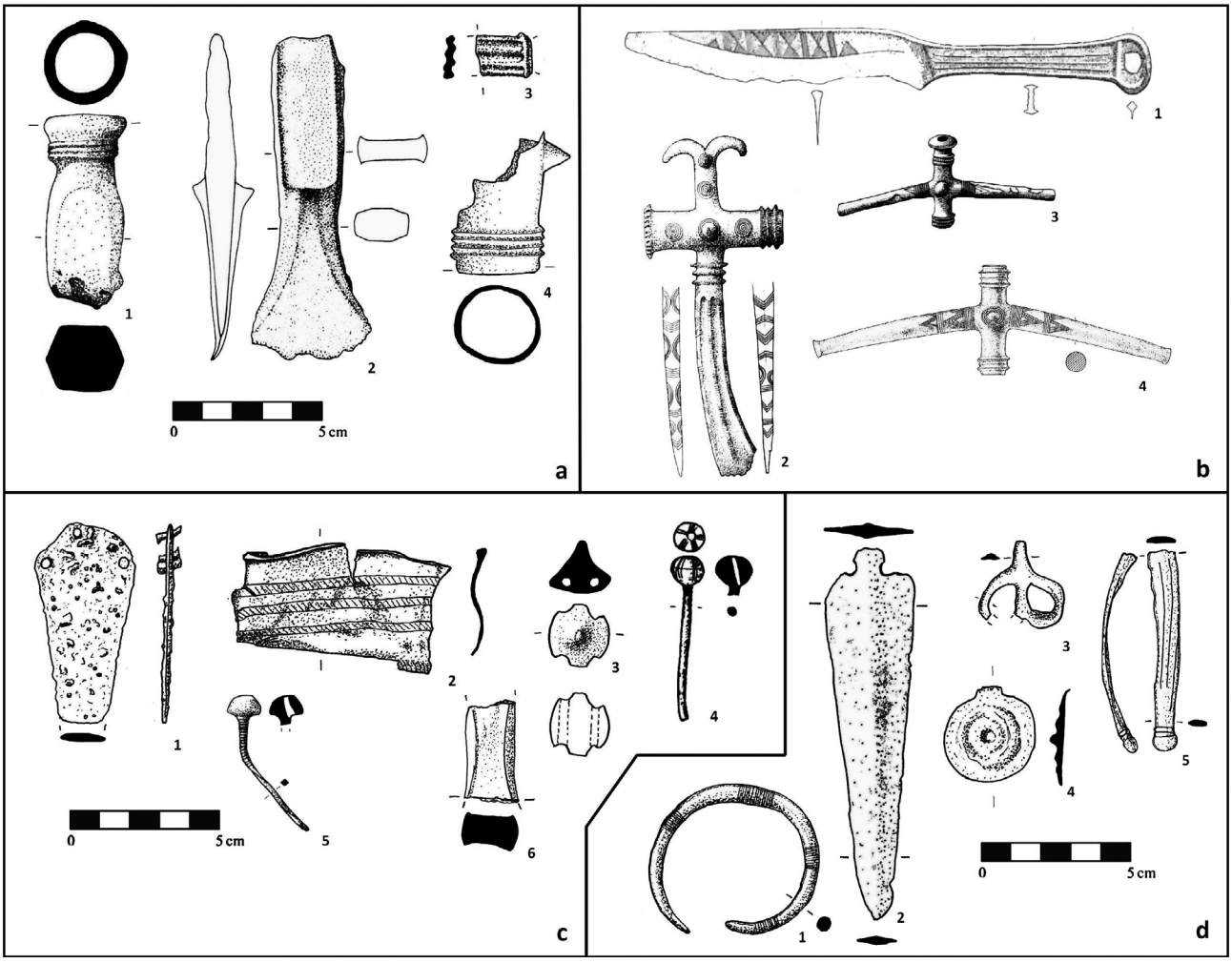

Fig. 8: Selection of various artefacts. a – potential non-local artefacts. b – analogies to non-local artefacts. c – Early Bronze Age artefacts. d – Middle Bronze Age artefacts.

period, local communities became more attracted to the Děvín hillfort and its surroundings[29].

The resulting pattern of activities on Tabulová hora can be compared with the use of other Urnfield hillforts (Fig. 9). Bronze Age hillforts of comparable size or larger (about 20 ha or more) from southern Moravia were selected for the comparison table. The time periods of their use were modelled by following the available information from the published research. The resulting picture indicates that at least some of the researched sites experienced their heyday in different phases of both the entire Bronze Age and the Urnfield period. If we assume that similarly sized hillforts played a similar role in the organizational structure of Urnfield society (with the exception of the Blučina – Cezavy site, where despite intensive use at the beginning of the Urnfield period, the settlement character of the site and the fortification is absent), the different periods of flourishing may suggest social and geopolitical dynamics in the development of the region. For instance, a large fortified site on the western edge of the Central Danube Ecumene Réna near Ivančice is evidenced to have been used in the early, and perhaps at the beginning of the middle, Urnfield phase[30]. In the Ha A2 and Ha B1 phases, when the Tabulová hora hillfort experienced its greatest flowering, Réna seems to have been abandoned. Similarly, during the decline of Tabulová hora, the intensity of activities at the Brno-Obřany – Hradisko hillfort, which lies on the northern edge of the Ecumene, is on the rise[31].

29 Holubová/Navrátil 2020.

30 Salaš 2018, 136–137.

31 Podborský 1994, 209–211.

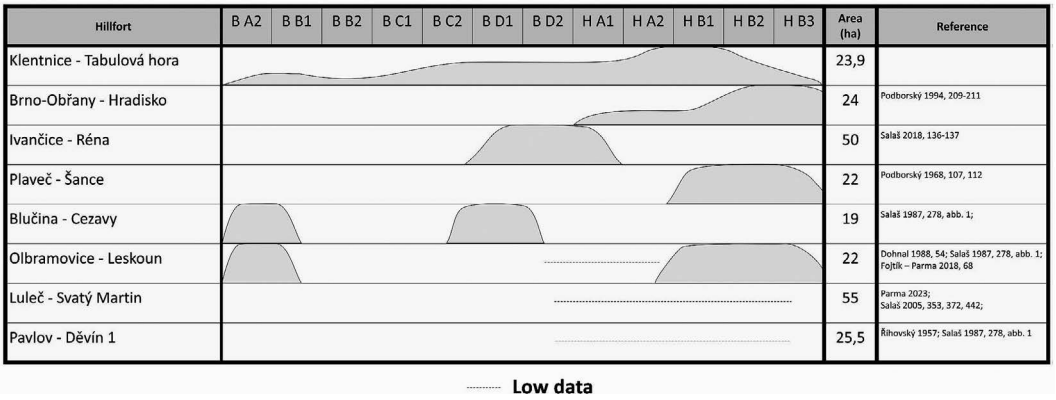

Fig. 9: Comparison of chronological use of hillforts (over 20 ha) in the South Moravia region.

4 Spatial distribution of the artefacts

An important part of our dataset is the spatial information for individual finds, which allows us to process them using a Geographic Information System (GIS). For a variety of technical and logistical reasons, 58 (9 %) of the 673 objects in the dataset lack coordinates, and are located only to the site. These are mostly raw material fragments obtained during early surveys, or from the collections of amateur collaborators. Specifically, 44 items – mostly PC ingots, droplets, and a few rings – from the Tabulová hora hillfort (KL01-03), 6 items from the Klentnice – Nad hřbitovem site (KL04), 3 items from Pavlov – Děvín (PA1) and a few individual items from various sites. Of course, these objects cannot be used in spatial analyses.

4.1 Sites

At the level of sites, the spatial concentration of finds confirms the existence of a number of settlements discovered during the surveys by J. Říhovský in the 1960s[32]. In particular, these are the sites Bavory – Pod Pálavou 1 (BA01), Bavory – Pod Pálavou 2 (BA02), Perná – Kotelná (PE03), where relics of fortification were also newly discovered, Perná – U Mikuláška (PE04), Klentnice – Nad hřbitovem (KL04), Klentnice – U lomu (KL10), and Klentnice – Mezi vinohrady (KL11). In addition, a number of new sites were identified, in particular Klentnice – Za kovárnou (KL13), or Klentnice – Prostřední hony (KL14). The survey clearly confirmed the existence of two large suburbs of Tabulová hora (KL02-03; Fig. 3a), which were not known to the archaeological public until 2020[33]. Furthermore, the surveys clarified the use of the hitherto unexplored hillfort Perná – Kotel (PE01-02), where almost all finds are concentrated at only one of the two summits, around which previously unknown enclosure with a relic of an entrance has been newly identified (Fig. 3b). Similarly, an until recently unknown enclosure with an entrance and a concentration of finds was discovered at Pavlov – Pod Pálavou (PE07), suggesting the possible existence of a forward entrance to the Děvín hillfort (Fig. 3c). However, the chronologically heterogeneous set of finds does not yet allow us to determine the dating of the fortification.

4.2 Artefacts

At the artefact level, spatial data allows the tracking of potential spatial structures in the distribution of the categories or types of artefacts. As mentioned above, almost 72 % of all finds come from the three sites comprising the Tabulová hora hillfort (KL01-03). This indicates not only the focus of survey activity on this site, but also the objectively high density of finds in the topsoil, compared to surrounding sites, reflecting the higher level of intensity of use of the site in the Bronze Age (see chapter 3.1).

4.2.1 Raw material

The most striking component of the assemblage is the raw material in the form of PC ingot fragments, droplets, and casting waste, as it makes up 42 % of all of the objects

32 Říhovský 1965b, Tab. 6.

33 Navrátil/Bíško/Tencer 2020.

found. Raw material is absent from 8 of the 25 sites with metal finds. However, these are sites with a non-representative number of finds not exceeding 5 pieces. Looking at the proportion at each site, we do not observe any dramatic differences. If we filter out sites with fewer than 10 pieces of raw material, we are left with a set of 10 sites where the representation is most often between 32 % and 48 %. The two outliers are satellite settlements with 25 % and 61 % (Fig. 11b). Therefore, we do not see any major difference between the occurrence of raw material at hillforts and adjacent settlements. In terms of spatial distribution, no distinct pattern emerges in the case of PC ingots and droplets (Fig. 10c; 12a). Both types of artefacts are common in all of the settlements with a documented metallic component. A total of 7 sites contain either PC ingots or droplets. Again, in all cases these are sites with a non-representative number of finds (max. 5). Similarly, high levels of entropy in the spatial distribution of raw material can be observed at other Urnfield period sites[34].

A different situation is presented by waste from the casting process (Fig. 12a). It was found only at the Tabulová hora hillfort (KL01-03) and the adjacent satellite settlement, Klentnice – Nad hřbitovem (KL04). The situation may indicate that casting was taking place at the Tabulová hora and in the immediate vicinity. On the other hand, the distribution of waste does not indicate any concentration that could identify a specific area where the casting activities might have occurred. This is not an uncommon phenomenon at enclosed Bronze Age sites[35].

4.2.2 Tools, pins, and appliqués

Looking at the distribution of the *tool* category, we can observe several interesting things. Sickle fragments, similarly to raw material, are represented at 14 of the 25 sites with metal finds (Fig. 12b). Therefore, they are represented at the majority of sites across types. However, the proportional occurrence is significantly lower than that of raw material. This is visible especially at the Tabulová hora suburbs (KL02-03), where the most quantitatively representative samples were collected. This may indicate the previously mentioned negative association of sickle fragments with hillforts.

Interestingly, axe fragments are found in relatively large numbers on Tabulová hora and on the settlements in its immediate vicinity, while they are almost absent in the vicinity of the Kotel and Děvín hillforts (Fig. 12b). An exception is a flanged axe fragment at Perná – Kotel 2 (PE02_001) and a complete socket axe found probably on Děvín[36]. Both items were found outside the systematic surveys, and therefore are not presented on the distribution map as they lack GPS information.

The distribution of small rod chisels seems to be more structured (Fig. 12.b). In general, they occur similarly to the axes on the suburbs of Tabulová hora (with a distinct concentration on the 1st suburb KL02) and on the adjacent satellite settlements. The most striking is the relatively isolated concentration of chisels in the Perná – Kotel 1 hillfort (PE01). Rod chisels cannot be directly associated with metallurgical production, as the tools have a wide range of use[37], but it is possible to associate them with craft production. Their distribution may indicate a concentration of craft production on and around Tabulová hora, and at the Kotel hillfort.

Notable is the concentration of 10 knife fragments in the 1st suburb of Tabulová hora (KL02) out of 24 pieces in the whole assemblage (Fig. 12b). The remaining fragments, however, are also found on a number of other sites, and therefore do not appear to have any structural limitation to their occurrence.

Pins and cast rings have a very similar distribution. They are mainly concentrated in large numbers in the suburbs of Tabulová hora (KL02-03), and occur as individual pieces at other sites (Fig. 12c). In the case of pins, the situation reflects mainly the density of finds on Tabulová hora, as proportionally the percentage of pins is not significantly higher than at sites with fewer finds (Fig. 11a). At the open sites at Ivanovice na Hané and Sedlec, the proportion of pins is even higher (Fig. 4). A notably lower number of pins in contrast to the 1st and 2nd suburbs of Tabulová hora (KL02-03) occurs on the acropolis (KL01). This situation can be explained by the already mentioned high degree of damage caused by illegal metal-detecting activities aimed mainly at attractive objects.

In the case of cast rings, the situation is different in that the percentage at both Tabulová hora and the Kladky hillfort is significantly higher than that of the lowland or satellite settlements (Fig. 4), suggesting the already mentioned stronger link of ring use or production to the hillforts.

34 Parma 2017, Figs. 4.21, 4.23.

35 Găvan 2020, 466–467; Ilon 1996, 183; Jockenhövel 1982, 264.

36 Říhovský 1992, no. 830.

37 Nessel 2010.

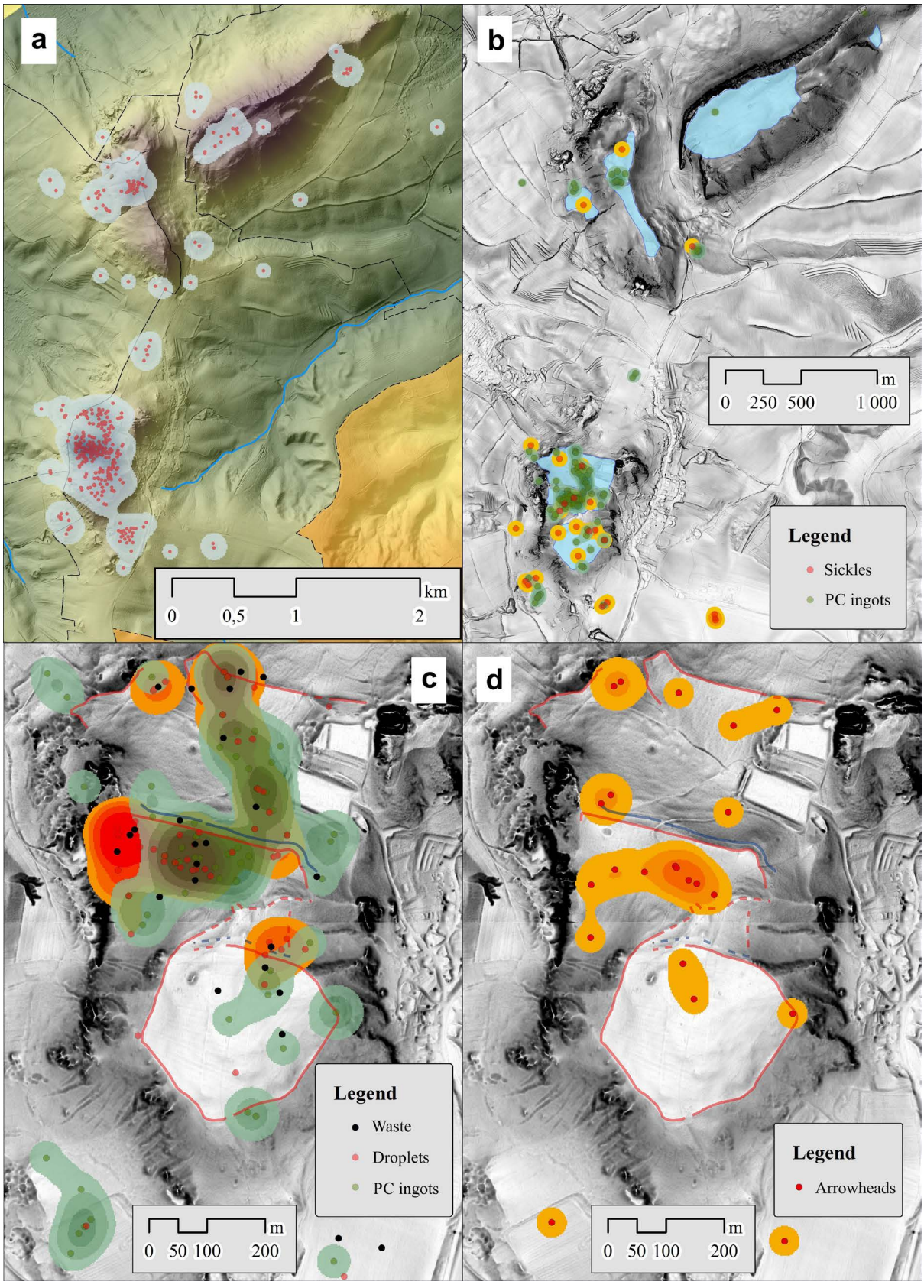

Fig. 10: Spatial analysis of artefact distribution on Pálava Hills. a – all artefacts. b – sickles and PC ingots in the whole area. c – raw material on Tabulová hora. d – arrowheads on Tabulová hora.

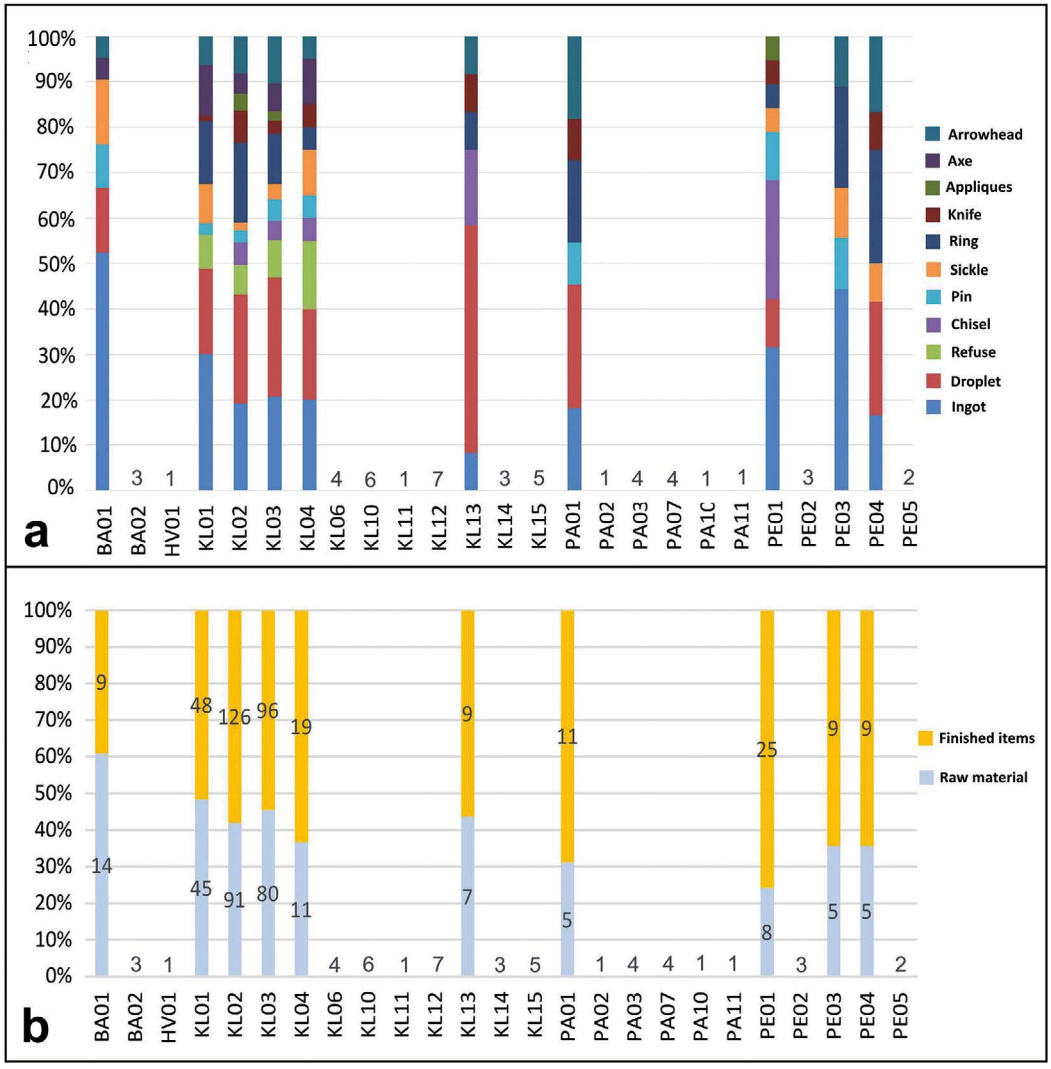

Fig. 11: Percentage ratio of item types on Pálava sites with 10 or more artefacts.

4.2.3 Weapons

A distinctive spatial structuring is represented by the weapon category, especially arrowheads (Fig. 12d). Interestingly, no spearhead has been found so far at Tabulová hora, while 6 pieces have been recovered from adjacent settlements. The largest concentration of three spearheads comes from the Klentnice – Nad hřbitovem settlement (KL04) and one fragment from Děvín (PA01). Only 6 pieces of dagger fragments could be identified. In contrast, 45 arrowheads were recovered, 35 of which came from Tabulová hora. Moreover, when looking at the distribution of the arrowheads, the connection of the finds to the fortification of the 1st and 2nd suburbs becomes quite clear (Fig. 10d). A group of five arrowheads was found along the line of the northern wall of the 2nd suburb. Another group of at least eight pieces was found in an irregular line in the slope behind the rampart of the 1st suburb. Three more arrowheads were located on the slope below this rampart. The distribution of the arrowheads strongly suggests the remains of a wartime event involving firing arrows at the defenders on both ramparts. It is worth noting that firing arrows at the 1st suburb ramparts was only possible when the 2nd suburb had already been taken, which would indicate its capture. For the context, it is in order mentioning the discovery of articulated parts of at least two human skeletons, uncovered during the 1952 excavations in a ditch on the south side of the acropolis, chronologically related to the hillfort's fortifications[38]. Archaeological evidence of particular Bronze Age wartime events is relatively rare, however, they do exist. Examples include the potential traces of a siege of

38 Říhovský 1955, Fig. 11.

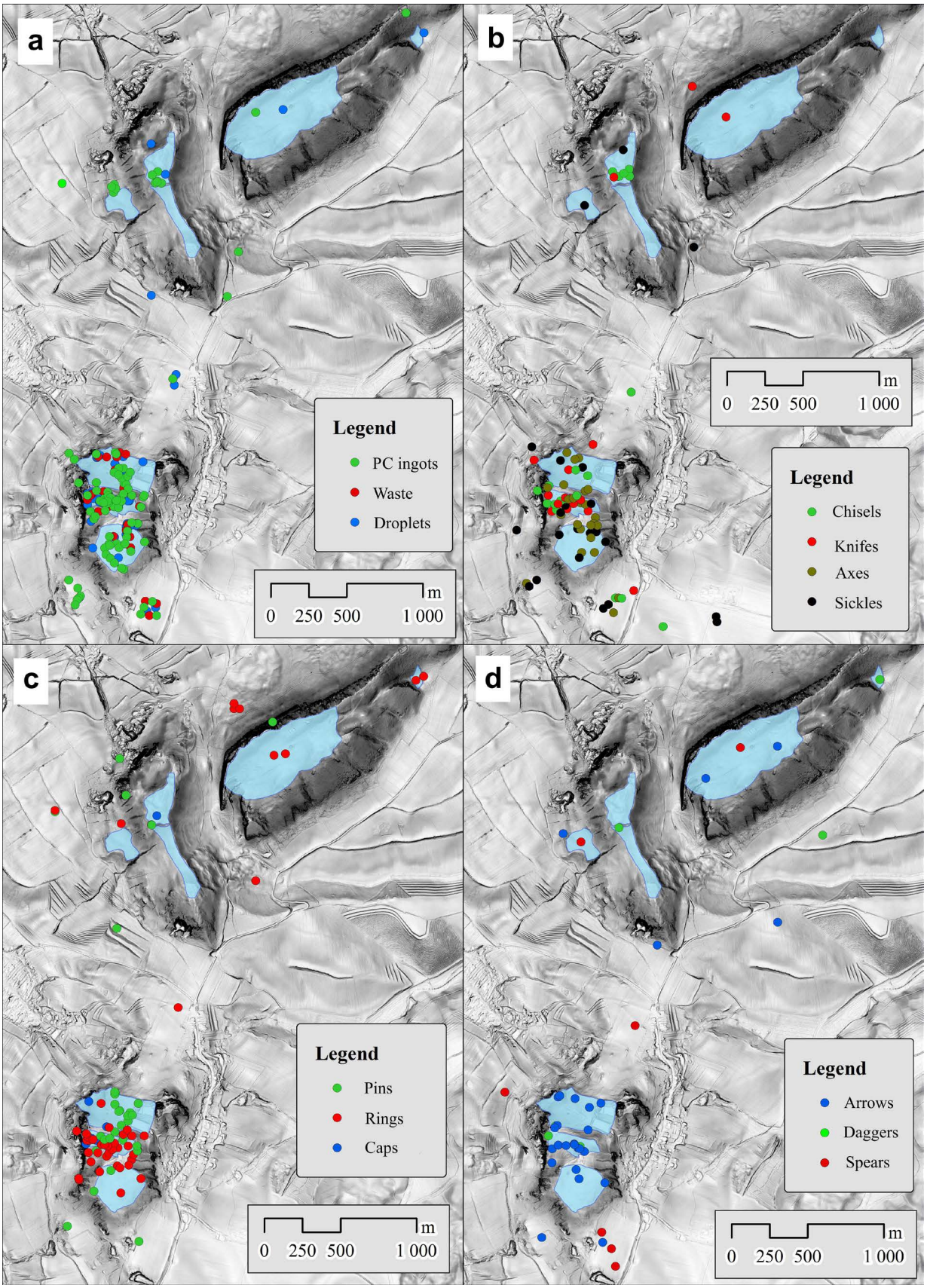

Fig. 12: Spatial distribution of item categories. a – raw material. b – tools. c – appliqués. d – weapons.

the fortified site of Sântana in Romania, and the presumed battlefield at the well-known site of Tollense[39]. Similarly, a metal-detecting survey identified a violent military event at Early Medieval fortified site of Kal in north-east Bohemia[40].

5 Metallurgy aspects of the dataset

5.1 Raw material and traces of the casting process

The *raw material* category has by far the highest number of artefacts in the dataset. This is 284 items, which represents 42 % of the entire dataset. By raw material, we mean items that are not finished products. The category is further divided into three subcategories: PC *ingots*, amorphous *droplets*, and *waste* from the casting process.

PC *ingots* are the standardized form in which raw copper was transported and distributed within the bronze items production chain from the early stages of the Middle Bronze Age until the end of the Bronze Age[41]. The number of artefacts identifiable as PC ingots in the assemblage is 126, representing 18 % of the whole dataset, and 44 % of the raw material category. There is only one representative of a rod-shaped ingot from the Perná – Kotelná site (PE03_005). Rod-shaped ingots (Stabbarren in German) are commonly found in hoards, especially of the early Urnfield period, although their occurrence is significantly lower in comparison to PC ingots[42]. Moulds are also known from the settlement context[43]. All other items from the ingot subcategory belong to PC ingots (Gusskuchen in German). In our assemblage, these are generally small fragments, which is typical for artefacts found in the topsoil. PC ingots are generally casts into shallow moulds with a bowl-shaped or flat bottom, circular or oval in plan, with dimensions up to almost 30 cm, but most often around 15 cm[44]. There has been a long-standing debate about the process of making PC ingots. Ingots of a plano-convex profile were often considered to be fills from the bottom of furnaces as the end product of copper ore smelting[45]. However, this process has not yet been successfully replicated, and the results of experiments and the analyses of the profiles have led their authors to conclude that the ingots were cast into moulds – most likely into a simple bowl-shaped pit in the ground – using crucibles, or by guiding the melt from the bottom of the furnace. Some ingot profile analyses testify to a multi-step casting process[46]. In our assemblage, a fragment of a massive PC ingot from the site Klentnice – Soutěska 1 (KL12_004), shows a distinct, step-like profile, which is a typical result of the flow of cooling melt onto the edge of the already cooled surface of the ingot[47].

The average weight of the ingot fragment in our set is 46 g. If we filter out the outliers – namely the set of the five heaviest fragments found lying next to an illegal hole at the Klentnice – Soutěska 1 site (KL12_002-006), and which most likely come from a hoard[48], the average weight of the fragment falls to 31 g. The median weight of the ingot fragments from the Pálava assemblage is 18.5 g (18 g after filtering out the potential hoard from Soutěska 1), and is therefore less than 8 g higher than the median weight of the Ivanovice n. Hané assemblage which is 10.8 g[49].

Interestingly, similar to the settlement assemblage from Ivanovice and the hoard from Velké Bílovice, rim fragments account for approximately half (55.5 %) of all ingot fragments[50]. This phenomenon may perhaps point to the popularity of obtaining fragments for raw material circulation by breaking off the edges from the ingot body[51], while the central parts may have been preferred for the casting process.

There are only 4 complete ingots in our set. Without exception, these are *small ingots* up to a maximum size of 7 cm. Although, based on morphology, these smaller pieces are often understood as being raw material ingots, it is clear that they represent a distinct subgroup, in terms of creation. These pieces are sometimes referred to as ‘droplet ingots’ or ‘cake droplets’, and most often include smaller, slightly plano-convex or flat and non-porous pieces[52]. They were formed not primarily as ingots, but as a more or less intentional by-product/excess of the casting process by casting a small amount of melt aside. This would be consistent with the element composition, with 5 of the 7 analysed pieces containing between 3 and 12 % of tin (Fig. 14a). There are 13 such ingots in the Pálava assemblage, 9 of which are fragments (Fig. 13d). In comparison, 6 such pieces have been

39 Golgâtan/Sava 2012; Jantzen *et al.* 2014.
40 Profantová 2023.
41 Lutz/Krutter/Pernicka 2019, 365–366; Modl 2019, 394.
42 Salaš 2005, 129; Kytlicová 2007, 164; Mozsolics 1985, Taf. 145.
43 Ilon 1996, 176, Taf. 2:8; Mozsolics 1984, Taf. 12.
44 Salaš 2005, 127; Nessel 2019, 200.
45 Czajlik 1996, 166; Salaš 2005, 127.
46 Modl 2010; 2019; Nessel 2019, 189–191; Bachmann *et al.* 2003, 88.
47 Modl 2010, 130–132.
48 Navrátil 2021b, 250–251.
49 Parma 2017, Fig. 4.25.
50 Parma 2017, 87; Parma *et al.* 2021, Tab. 1.
51 Modl 2019, Fig. 11; Nessel 2014, 407.
52 Augustýnová/Fikrle/Kmošek 2021, 568; cf. Bachmann *et al.* 2003, 90–91.

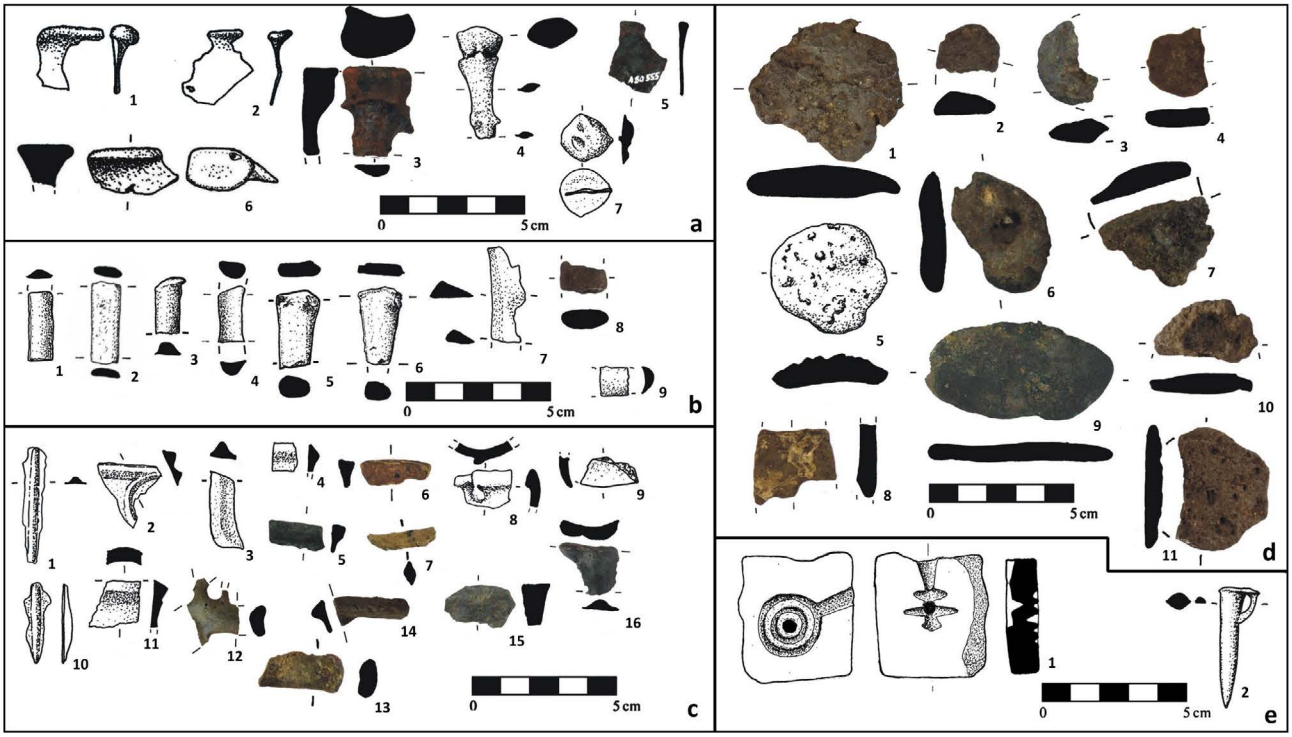

Fig. 13: Selection of artefacts from the surveys on Pálava. a – pouring cup sprues. b – channel and vent sprues. c – unidentified items from moulds. d – small ingots. e – casting tools.

identified in hoards from southern, western, and north-western Bohemia[53].

Amorphous *droplets* are drops of melt of various shapes, rarely exceeding the maximum dimension of 4 cm. They were most likely formed as a non-intentional by-product of the casting process by dripping pieces of melt during the handling of the crucible and mould. Their heterogeneous nature is consistent with the fact that 18 of the 38 samples analysed contained between 2 and 11 % tin. There are a total of 124 such droplets in our set, representing 18.5 % of the total set, and 44 % of the raw material category.

Amorphous droplets, together with ingots, make up over 37 % of the finds from Pálava metal-detecting survey. This is by far the highest number, compared to all of the other categories. The second most numerous category is tools, representing 18 % of the assemblage. In terms of individual artefact types, arrowheads are the second most numerous group, with 45 pieces (6.5 %). More or less the same picture is seen at other sites from the Urnfield period, where raw material not rarely exceeds 50 % of the assemblage (Fig. 4). Clearly, in terms of quantity, ingots and droplets played a very significant role in the everyday life in the Urnfield period.

The term *casting waste* refers to all items produced as integral by-products of the bronze casting process. This sub-category consists of 33 items, which is 5 % of the total assemblage, and 12 % of the raw material category. They can be divided into three groups. The first are the sprues, from the pouring cups of the moulds, of which we have 7 pieces documented (Fig. 13a). They have a characteristic shape in the form of a sprue channel with a funnel-shaped top, caused by the solidification of a larger quantity of melt at the top of the pouring cup. In one case, the shape indicates a sprue from a mould with a casting core (Fig. 13a,3)[54]. The second group is represented by sprues from the channels or vents, which are generally oval or plano-convex in profile, often with a mould line visible (Fig. 13b). The third group is represented by more or less unidentifiable pieces of bronze, which show that they have solidified in a mould, and therefore bear non-random shapes (Fig. 13c). In some cases, they are fragments of miscasts, in others they may be simple droplets, solidified on moulds or on other various items.

Until recently, this type of artefacts came mainly from hoards, while only a few pieces were known from settlement or grave contexts[55]. With the increase in systematic

53 Augustýnová/Fikrle/Kmošek 2021, Tab. 2.

54 cf. Nessel 2012, 147.

55 Ibid. 145; 2019, 270–271; Jockenhövel 1986, 213–214.

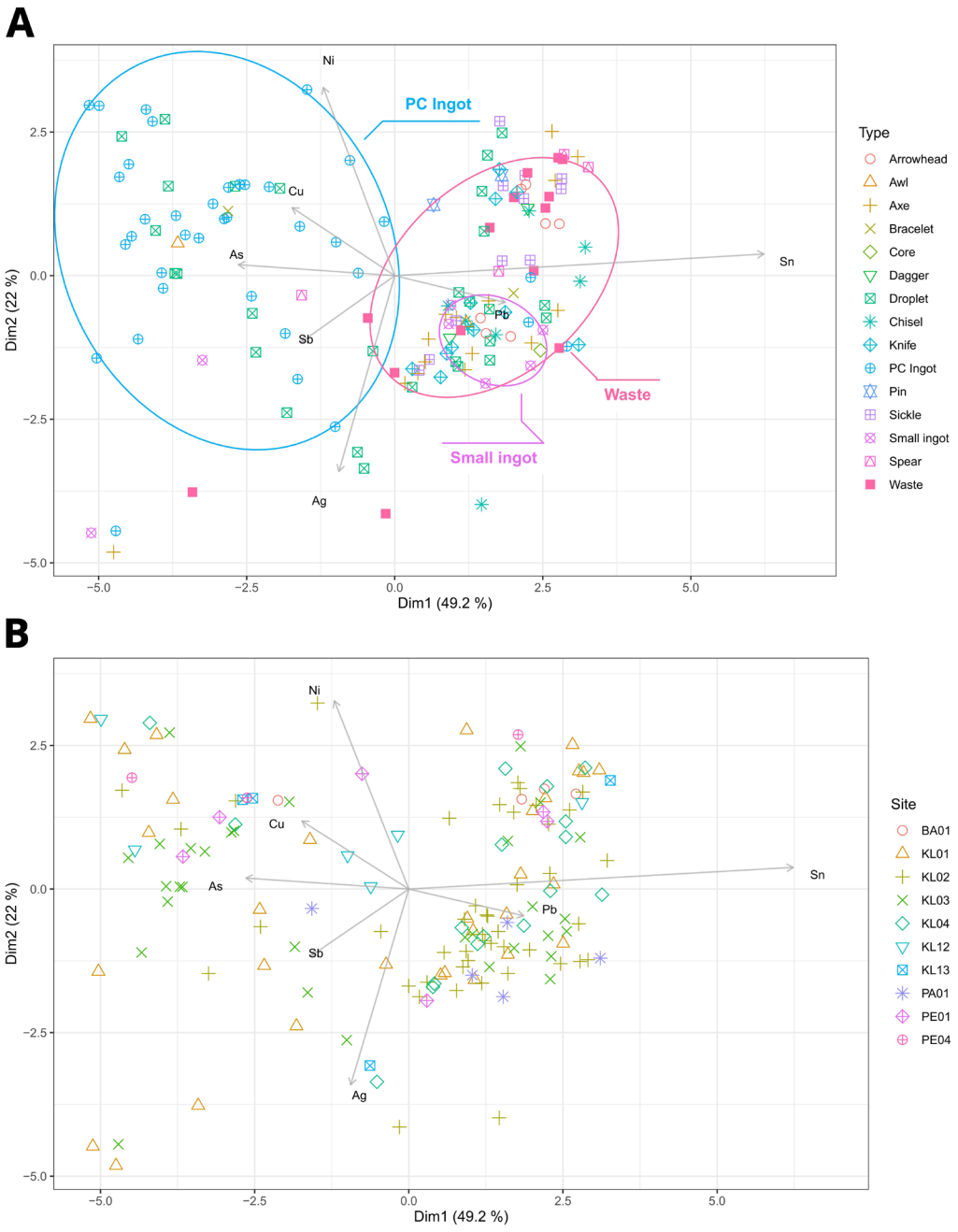

Fig. 14: Biplot of the Principal Component Analysis of the composition of the artefacts related to artefact type (a) and site (b).

metal-detecting surveys, casting waste became a relatively stable part of the finds assemblages from the topsoil of Bronze Age settlements. In general, the presence of the waste at the settlement, similarly to the presence of metallurgical tools and casting moulds, is considered indirect evidence of casting activity at the site. However, it is impossible to say whether the waste was generated directly on the site, or came to the site as part of the circulation of fragmented metal. If we accept the casting waste as one of the indications of casting activity, it indirectly confirms the assumption that bronze casting was also commonly carried out on open settlements, and therefore not only on hillforts or at specialized sites[56]. On the other hand, at Tabulová hora, casting waste constitutes 5 % of the whole assemblage, whereas on open settlements at Ivanovice na Hané and

56 Augustýnová 2017; Jockenhövel 1986; Salaš 1995; Găvan 2020, 463.

Sedlec it is only 2 and 1.5 % respectively. This may indirectly point to a relatively more intensive casting production at Tabulová hora, and probably at hillforts in general. By analogy, the hillfort at Brno-Obřany offers a concentration of evidence of metallurgy in form of 10 stone moulds, while one, or rarely two, pieces are known from open settlements in general[57]. However, this obviously cannot be taken as a rule, as we also know exceptional cases of large assemblages of moulds from open settlements[58]. Also, there is no casting waste recorded on above mentioned Kladky hillfort (Fig. 4).

Regarding moulds, we know only one piece from Pálava so far. It is a sandstone, double-sided mould for a disc-shaped pendant, and an unidentified object from Perná – Kotel (PE01), which is dated to the Middle Bronze Age (Fig. 13e,1)[59]. Another evidence of metallurgy is a casting core for socketed arrowheads from the 1st suburb of Tabulová hora (Fig. 13e,2). The core has a side eyelet, by means of which it was fixed in the mould, as we can see on the mould from Zlín-Malenovice[60].

5.2 Composition analysis of selected artefacts

Out of a total 673 artefacts gathered during the surveys, 229 were selected for the chemical composition analysis. Sampling was performed by drilling with a 1.2 mm diameter drill to ensure penetration of the corrosion layer, thereby obtaining a sample of pure metal in the form of metal fillings of shavings. Subsequently, this sample was analysed using the Rigaku NEX CG energy-dispersive X-ray fluorescence spectrometer (ED-XRF). This device is equipped with a 50W Pd anode. The primary beam passes through secondary targets in Cartesian geometry. The sample was poured loosely into a cuvette, and given the limited amount obtained due to the artefact size and the nature of the chosen sampling method, it was analysed in a rotary holder. This approach facilitated some homogenization of the signal, and compensated for the small sample quantity. Each analysis lasted 120 seconds.

The acquired data was first inspected, and samples contaminated with impurities and corrosion were excluded. The resulting dataset, containing 177 samples, underwent a CLR transformation using the Compositions library[61] in the statistical program R[62]. This transformation method is recommended for compositional data. This was followed by a Principal Component Analysis (Fig. 14). Another method of the data analysis was classification into types of copper alloys as per Bray *et al.*[63], and further refined by Arnoldussen *et al.*[64], which is presented in Fig. 15. A rate of Pb was also traced in alloy and item types.

In terms of alloys, the most represented are generally copper alloys containing Ni, especially Sb-As-Ag-Ni, with Pb most often in the range of 1–5 %. A very high range of Pb concentrations is noticeable, with the highest values occurring in Sb-As-Ag-Ni alloys, while the lowest values are found in the purer alloys containing only As, Ni, or Sb. The high occurrence of the alloy with all monitored elements present along with high rates of Pb might point to a higher rate of recycling. On the other hand, the high representation of Sb-As-Ni alloy with lower Pb range (mostly below 1 %) may suggest a trace of the preferred source of raw material.

The results generally show considerable variability in chemical composition, even between artefact categories. This is understandable, given the heterogeneous nature of the dataset collected from the surface layers, where it gathered over centuries.

PC ingots include all alloy categories except As-Ag, with Ni-containing variants and pure Cu being the most represented. In the case of Pb, the vast majority of values for PC ingots are below 0.1 %, with outliers over 1 %, and therefore obviously present a negative association with Pb and Sn (Fig. 14a).

As described above, *small ingots* present a specific type of ingots mostly containing a substantial amount of Sn and Pb. Though they do not represent a statistically significant assemblage (7 pieces), their alloy-type representation is close to axes, with a slightly lower Pb contents (below 1 %), compared to axes and other artefacts. Higher representation in Sb-As-Ag-Ni alloy might again point to an association with recycling.

Droplets are the second most frequent artefact type analyzed, where alloys containing Sb alone are noticeably more abundant, compared to ingots, while pure Ni and alloys with Ni admixture are less present. Droplets generally contain more Pb, with a median of around 1 %, and outliers of up to 5 %.

In the case of *waste*, considerable variability was also noted, though with a different proportion of groups, and the absence of As, As-Ag, Sb-As, and Sb-Ni alloys. This distin-

57 Salaš 1995, 570.
58 Erneé/Smejtek 1997.
59 Navrátil 2021, 63.
60 Říhovský 1996, 128.
61 van den Boogaart/Tolosana-Delgado/Bren 2023.
62 R Core Team 2021.
63 Bray *et al.* 2015.
64 Arnoldussen *et al.* 2022.

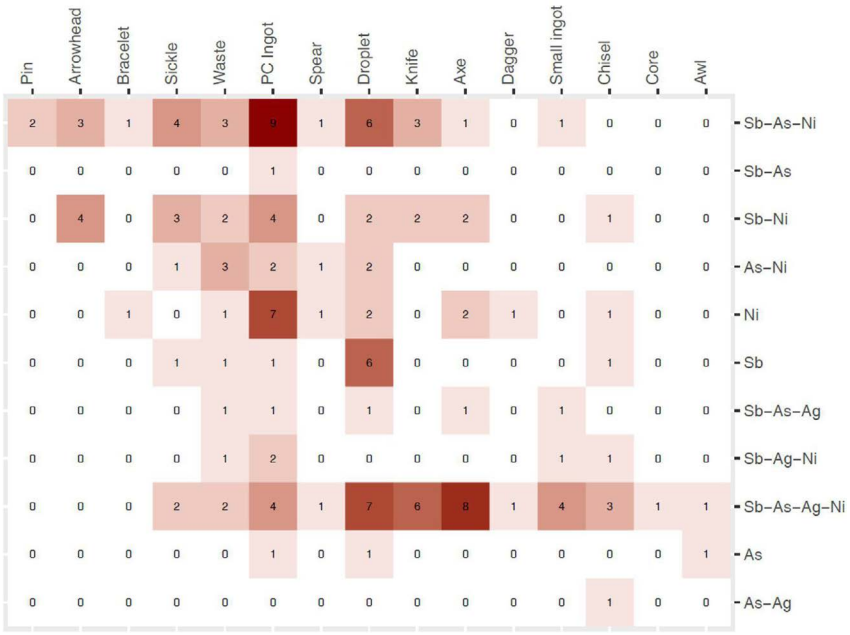

Fig. 15: Bertin matrix analysing identified copper alloys in relation to artefact type.

guishes most of the waste from the rest of the assemblage (Fig. 14a).

Knives, axes, and sickles also have variable compositions, but not nearly as much as the waste and ingots. The knives are fairly uniform, with an even representation of Sb-As-Ag-Ni and Sb-As-Ni. The axes are dominated by Sb-As-Ag-Ni, but other Ni-containing groups are also represented, similar to the ingots. In sickles, Sb-As-Ni predominates, but other Ni and Sb-containing alloys are also represented.

The casting core is composed of Sb-As-Ag-Ni alloy, and has an extremely high Pb content (over 6 %). Other statistically insignificantly represented artefacts, such as daggers, pins, spears, bracelets, and arrowheads, have Ni-containing alloys and, with the exception of bracelets (Pb around 0.1 %), Pb amounts to around 1 %.

The main feature of the analysed alloys is the high variability, where all alloy types defined by Bray *et al.*[65] are present. It indicates variability in raw material for bronze artefact production, though a preferred source, as well as recycling, is suggested. This might be anticipated on a site with an assumed central role and long-distance connections (see Chapter 6.3).

From the spatial perspective, there seems to be no structure present in the distribution of artefacts among sites according to chemical composition (Fig. 14b).

65 Bray *et al.* 2015.

6 Life on Pálava in the Bronze Age

6.1 Intensity of activities on the sites

As is well known, Pálava was used by people from the Paleolithic to the modern era. Seen from the perspective of metal artefacts found in the surface layer, human activities here reached their peak in the Bronze Age, especially in the Urnfield period. This assertion is supported not only by the quantity of artefacts recovered during the surveys, but also by the high number of sites in the area, as well as by the size of the local Bronze Age burial site.

If we assume that the density of artefacts in the cultural layer reflects the intensity of activities on the site, the Tabulová hora hillfort clearly emerges as a central site of busy life. An average of 0.83 artefacts per hour were found here (Fig. 5a). The lower intensity on the acropolis (KL01–0.4 artefacts/hour) compared to the suburbs (KL02 – 1.26 and KL03 – 0.84 artefacts/hour) can be explained by a higher level of illegal metal-detecting activity on the acropolis. Compared to these values, the density of artefacts in the satellite settlements is lower, and ranges from 0.28 to 0.61 artefacts/hour. This situation is in line with the density of artefacts at open sites in the Vyškov region (0.23 to 0.39 artefacts/hour – Fig. 5b). The Perná – Kotel (PE01) hillfort shows a similar density of finds, with 0.4 artefacts/hour. Interestingly, the largest enclosed site of Pavlov – Děvín (PA01) shows only 0.17 finds per hour, which is only slightly higher than the density of finds from the Hallstatt and La Tène periods on the site. This data places the centre of

social life in the Pálava region in the Bronze Age clearly at the Tabulová hora hillfort, while the intensity of activities at Kotel and Děvín did not exceed the values of common open settlements. The concentration of craft production in certain period of use can be assumed at Kotel, while the role of Děvín as the most prominent dominant feature of Pálava in the Bronze Age remains unclear.

Although Pálava was used throughout the Bronze Age, according to a model based on chronologically sensitive artefacts, the main flowering of the Tabulová hora hillfort, and probably also the surrounding sites, clearly happened in the Ha A2–Ha B1 phases (Fig. 7). This is consistent with the results of J. Říhovský's excavations, both at Tabulová hora and at the Klentnice burial site, where the largest number of graves belong to these phases[66]. The activities at the hillfort and the surrounding satellites gradually faded in Ha B2 and Ha B3, and by the very end of the Bronze Age these sites seem to have been abandoned. Whether this decline was in any way related to any potential warlike event/events represented by the accumulation of arrowheads along the ramparts, along with human remains in the fortification ditch, is impossible to say. The continuity of the burial site was not interrupted, and burying continued into the Hallstatt period. However, settlement activities shifted towards Děvín and its surroundings[67]. Tabulová hora was never used for the settlement purpose again.

6.2 Raw material as currency

Until the spread of metal-detecting, fragments of bronze objects were known mainly as an integral part of Bronze Age hoards. In the Central European region, this is mainly true in early and middle Urnfield period hoards, consisting predominantly of fragments[68]. Countless attempts have been made to interpret this phenomenon[69]. In recent years, a viable view has increasingly emerged – the fragments of bronze objects in the hoards represent not only material for re-cycling or votive offerings, but also a socially recognized bearer of value suitable for exchange[70]. How is this idea reflecting in the Pálava Hills dataset?

Firstly, it is worth noting that while the assemblages of objects in the Bronze Age hoards mostly represent a one-off selection based on socio-cultural preferences, the finds from the surface layers are lost objects reflecting the structures of long-term use of the site. We know from the unique discovery of a settlement at Must Farm (UK) that the equipment of Bronze Age households included both whole objects and damaged pieces collected for further use[71].

The number of fragments of finished objects at Pálava accounts for 31 % of the entire collection. It is of course problematic to distinguish between objects that were already part of the circulation of fragments and in which cases they were lost artefacts that were not yet part of the circulation – e. g. lost strap rings and appliqués from clothing, or chipped axe blades. A unique role in this respect is clearly played by the raw material, or rather the PC ingot fragments and amorphous droplets, which, excluding the 33 pieces of casting waste, make up almost 38 % of the whole assemblage. Unlike the finished objects, the ingots and droplets could not have played any other functional role than as raw material. Its high representation and wide spatial distribution is therefore very striking. Moreover, this is a significant trend that is observable at all of the surveyed sites, and therefore it is not a random distribution. It is clear that ingot fragments and amorphous droplets were an integral and very important part of the living society in the Urnfield period. The importance of the raw material is also evidenced by its often significant representation in hoards. This is evident, for example, in the more recently discovered Bohemian hoards, where the raw material in some cases reaches 50–70 % of the composition[72].

That ingots were a common part of personal equipment, and therefore most likely a form of currency, is indicated by a unique find from the Tollense site. The assemblage of objects found at one spot probably represented remains of a personal pouch that contained several fragments of ingots, in addition to small tools and other personal equipment[73].

In terms of spatial distribution, the fragments of finished products and raw material overlap, rather than exclude each other – except at the Kotelná site (PE03). This means that whether or not the finished artefact fragments were part of the raw material circulation, their archaeologization followed similar patterns to that of the raw material. This situation further supports the suggestion that small fragments of raw material were a common part of life and personal equipment in the Urnfield period, and therefore, given the nature of the raw material, must have represented a kind of currency, in the form of a commodity. For the sake of reference, the situation can be compared with the distri-

66 Říhovský 1955; 1965a.
67 Holubová/Navrátil 2020.
68 Kytlicová 2007, 174–178; Vachta 2016, 59–65.
69 Brandherm 2018, 46–48.
70 Pare 2000, 28; Bachmann *et al.* 2003, 89; Kavur/Kavur/Starac 2020, 421; Primas/Pernicka 1998, 56–57; Primas 1986, 37 ff.; Ialongo/Lago 2021.
71 Brandherm 2018, 48; Knight *et al.* 2019, Fig. 9.
72 Chvojka/Jiráň/Metlička 2017, 166.
73 Uhlig *et al.* 2019.

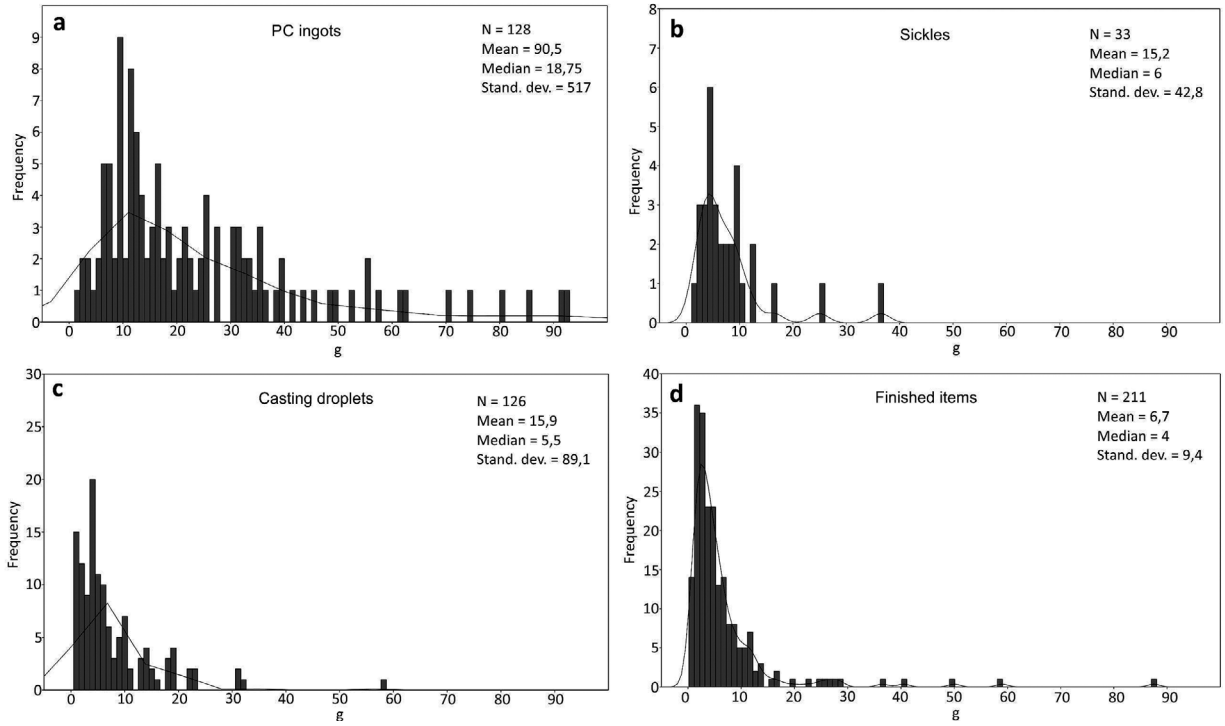

Fig. 16: Histogram of weight frequencies of particular item types.

bution of finds at a Roman-period settlement located not far from Pálava, at the Drnholec – Holenická pole site, where a metal-detecting survey was carried out using the same method as at Pálava[74]. Roman coins here similarly overlap with common lost items in the main epicentres of occurrence, and account for 37 % of all Roman-period finds.

In a recent study, its authors identified weight standards in approximate multiples of 10 g on fragments of finished objects (not raw material) from Italian and Central European hoards[75]. This did not show on the set of 211 fragments of finished objects from the topsoil layer at Pálava, as most fragments fall in the weight range between 3 and 6 g (Fig. 16d). Sickle fragments and amorphous droplets have a similar weight distribution (Fig. 16b–c). For the PC ingot fragments, most individuals range between 10–13 g, though the standard deviation is rather high (Fig. 16a). From a practical point of view, obtaining fragments with specific weight values by controlled breaking must have been very difficult, especially in case of smaller pieces[76].

Some archaeologists believe that it was mainly fragments of sickles that played the role of currency in the Bronze Age, as they are stably one of the most numerous types of objects in the 'scrap hoards'[77]. In the Pálava data, the sickle fragments differ greatly from the raw material, especially in their numbers, as sickles represent less than 5 % of the assemblage. Although the representation is slightly higher at the other surveyed Urnfield sites, it does not exceed 16 % (Fig. 4). It is clear, therefore, that sickle fragments were considerably less represented in circulation than ingot fragments and amorphous droplets, and therefore they clearly could have been neither the exclusive nor the preferred form of currency.

6.3 Long distance connections

Some of the artefacts found on Tabulová hora allow us to speculate about long-distance contacts or influence. Among these artefacts is a socket fragment of a double-armed mace or battle-axe (Fig. 8a,4). The design of the four ribs encircling the socket mouth is worth noting. Their distinct triangular profile is alien to local maces, while typical for artefacts of Nordic provenance, such as the mace from the Moravian hoard from Hulín (Fig. 8b,4)[78]. Similarly decorated weapon sockets from the Slovakian hoards of Rimavská Sobota and

74 Komoróczy *et al.* 2019, Figs. 24; 25.
75 Ialongo/Lago 2021.
76 Modl 2010, 147.
77 Primas 1987, 37 ff.
78 Říhovský 1992, 53.

Velký Blh are assumed to be local, however, with Nordic influence (Fig. 8b,2–3)[79]. A palstave found in the 1970s at Tabulová hora is also deemed to be Northern European type (Fig. 8a,2)[80]. Another artefact, identified as a direct Nordic import, is a socket hammer found at the acropolis of Tabulová hora (Fig. 8b,2)[81]. Long-distance contacts to the east may be indicated by a fragment of a full-handled knife handle with longitudinal ribs, which may belong to the Niederrussbach type knife, known in single specimen from Lower Austria. Alternatively, it could belong to a similar Strzegom type from Silesia and Greater Poland. Both of these types are seen in Central Europe as foreign elements of eastern origin[82]. These findings indicate that the hillfort on Tabulová hora might have played the role of a communication node on long-distance routes. This assumption is also supported by its location at the confluence of three major Moravian rivers (Fig. 17). Some of the finds described above (the mace and the axe) fall chronologically into the Middle Bronze Age or early Urnfield phase, suggesting that the site was an important place even before its supposed heyday at the turn of the late and final Bronze Age periods.

6.4 Urnfield elites on Pálava Hills?

There has been an ongoing debate in archaeology about the extent of the influence the elites had on the social, cultural, and economic life of Bronze Age societies. Opinions range from significant control over long-distance routes and commodity movements on the one side, to marginalizing their influence in favour of local interactions on the other side[83]. This discussion is also closely related to hillforts, as they are often seen as potential elites' residences.

At Urnfield period hillforts in Central Europe, proving the presence of elites is generally a very problematic task, as the range of artefacts and situations does not differ much from open settlements[84]. Even regarding grave goods, the differences in social stratigraphy are far less pronounced than, for example, in the subsequent Hallstatt period[85]. Nevertheless, the differences do exist and can be traced, in particular, in the presence of bronze vessels or swords, which are generally rare phenomena in Urnfield burials[86]. Two graves with bronze vessels are known from the Klentnice burial site (KL09). The first grave was discovered within the rescue excavation of the burial site in the 1950s by J. Říhovský. Grave No. 63 was bordered by an approximately 4 m wide stone circle and contained, in addition to a number of ceramic vessels, fragments of a flange-hilted sword with an antenna-shaped pommel, as well as fragments of a knife, a razor, and a bronze cup (Fig. 18a)[87]. The second burial was discovered by chance in 1996. It contained a collection of pottery, a knife, and a bronze cup (Fig. 18b)[88]. Both burials are dated to Ha B1, and their grave goods stand out among the other modestly equipped burials on the burial site. In terms of richness of the grave goods, these burials would rank among the poorer Urnfield elite graves, with a single bronze vessel. They do not reach the richness of burials with whole drinking sets, such as those from Milavče and Hostomice in Bohemia. However, such burials are extremely rare throughout Central Europe[89]. It is worth mentioning that of the entire Klentnice burial site, only a portion was excavated, and that there is likely a minority of burials known to us.

The social stratigraphy within Tabulová hora can be indicated by the division of the hillfort into an acropolis and two suburbs. Clear evidence of the presence of elites in a form of specific artefacts or architecture is however typically lacking. The assemblage appears homogeneous, and does not differ much from the assemblages collected at open settlements. It is questionable, however, to what extent the presence of elites at hillforts is visible in the archaeological record acquired by conventional methods. Unique prestige objects of the Bronze Age period that can be associated with the existence of elites are rarely uncovered within systematic research; on the contrary, they are often accidental or outright illegal finds (e. g. the well-known disc from Nebra). Similar kinds of finds might have happened on Tabulová hora. As mentioned earlier, Tabulová hora used to attract the intensive attention of illegal treasure hunters. It is assumed that many tens of hoards were looted from the site[90]. Among others[91], a set of golden 'diadems' was allegedly found there, of which we have a photograph at our disposal (Fig. 19). Unfortunately, the picture is the only trace of the items that we have, therefore the information cannot be verified. However, the assemblage and the location is

79 Novotná/Furman 2018, 85–86.
80 Říhovský 1971; 1992, 129.
81 Salaš 2014, 69–70.
82 Gedl 1984, 41–42; Říhovský 1972, 40–41.
83 Earle *et al.* 2015, 634; Nessel *et al.* 2018, 78–79; cf. Earle 1997; Kristiansen/Larsson 2005; Brück/Fontijn 2013; Harding 2015.
84 Jockenhövel 1982, 268; Smrž 1995, 74–75.
85 Harding 2015, 115.
86 Kytlicová 1988.
87 Říhovský 1956; 1965a.
88 Kos 1997.
89 Kytlicová 1988, 366–367.
90 Navrátil 2010; cf. Szabó 2013.
91 Stuchlík 2018.

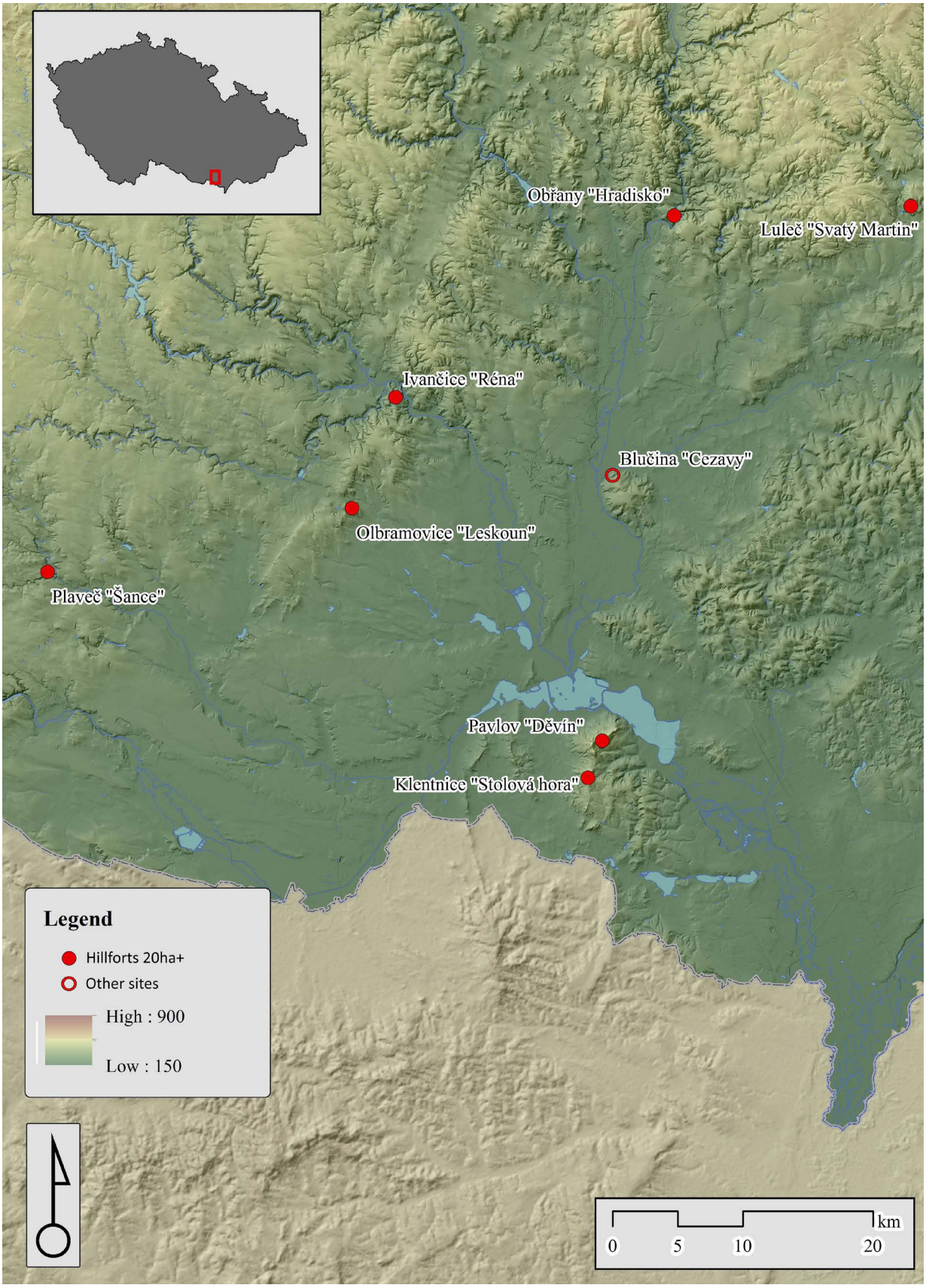

Fig. 17: Hillforts of over 20 ha in the South Moravia Region on a relief map.

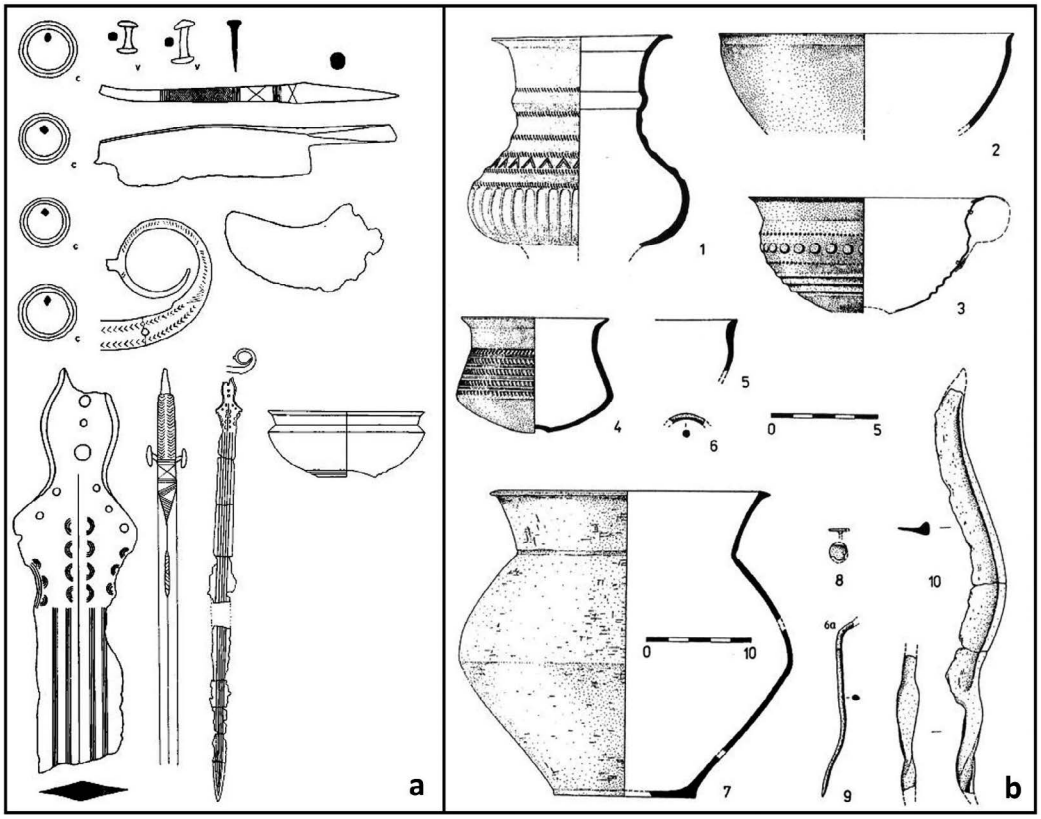

Fig. 18: Burials with bronze vessels from Klentince burial site. a – grave No. 63 excavated in 1952. According to Říhovský 1965a. b – burial excavated in 1996. After Kos 1997.

strikingly consistent with similar assemblages known from Central Europe. These sets usually consist of 1 to 3 pieces of similar 'diadems' – ornaments made of oval-shaped bronze/copper sheet, covered on one side with gold foil, decorated with typical stamped concentric circles. The objects are often perforated at the ends. Their interpretation ranges from diadems, to collars or dress accessories. In the assemblages, they are often accompanied by other gold and bronze objects. A number of these hoards also come from prominent hillfort sites of the Urnfield period. Among these is an illegal find via metal detector from Bullenheimer Berg, Bavaria[92], and an earlier discovered hoard from the western Hungarian site of Velem – St. Vid[93]. A set of three pieces received by the Berlin Museum is said to come from the Moravian-Lower Austrian Dyje region[94].

The data show that the Tabulová hora hillfort was a large fortified, built-up (Fig. 20), and busy place in the Urnfield period. The construction of the extensive fortification (over 2 km) certainly required a high degree of organization. The choice of the location itself is also striking. The hillfort was built on a prominent terrain feature, which is actually not really suitable for settlement purposes (significant microclimatic fluctuations), neither in terms of active spatial control (distance to the controlled routes), nor in terms of defence (too extensive fortifications to defend). This is evidenced by the fact that the site was never reoccupied. The dominant location, and likely also attractive geomorphological features in the form of prominent rock outcrops, appears to be a priority for the selection. These are also known from a number of other similarly situated large hillforts of the Urnfield period in Moravia such as Olbramovice – Leskoun, Štramberk – Kotouč or Buchlovice – Holý kopec. The building of large fortifications on dominant positions with distinctive geomorphological features appears to be a cultural and social trend in the Urnfield period Central Europe, likely associated with the elites' desire for self-presentation and the building of social exclusivity, rather than a purely pragmatic social response to external stimuli, such as violent threats[95]. The evidence of long-distance contacts and the potential evidence of high-prestige gold goods on

92 Gebhard 2003.
93 Ilon 2015.
94 Hänsel 2003.
95 cf. Harding 2006.

Fig. 19: A set of gold ornaments allegedly found at Tabulová hora hillfort. Photo: authors' archive.

Tabulová hora fit this picture. This said, we believe that at second glance, there are elites and their motivation visible behind the activities on Tabulová hora in the Urnfield period, though not immediately protruding from the archaeological record.

7 Conclusion

The main aim of this study was the evaluation of a series of metal-detecting surveys carried out between 2008 and 2022 on Pálava. The quantitative occurrence shows that the Pálava Hills were most intensively used during the Urnfield period. The centre point of activities was the hillfort of Tabulová hora, which was surrounded by a number of satellite settlements. Together, the sites formed a large central agglomeration that was part of the wider structure of the lowland settlements in the micro-region. Activity is also evident at the other two enclosed sites of Perná – Kotel and Pavlov – Děvín. However, the intensity of activity here does not significantly exceed that of the satellite settlements. Also, despite the fortification relics on these two sites are generally associated with the Urnfield activities, the dating hasn't been proved by excavation so far.

The peak of activity at Tabulová hora falls in the Ha A2 and Ha B1 phases, which can be interpreted as the period of the settlement's heyday. There is insufficient material to date the other sites in detail, though their existence may be associated with the Tabulová hora. The role of the enclosed sites of Kotel and Děvín is not clear, but it is clear that they did not have the central function similar to that of Tabulová hora. In the Hallstatt and La Tène periods, activities shifted to Kotel, Děvín, and their surroundings, but overall, they never reached the intensity of the Urnfield period. Tabulová hora was abandoned and no longer inhabited at this time, and most of the satellite settlements disappeared along with it.

The metal finds are dominated by fragments of PC ingots, amorphous droplets, and casting waste, which together make up 42 % of the whole assemblage. Their spatial distribution overlaps with that of the other object types, and has therefore been archaeologized according to similar patterns. An identical situation is known from other Moravian Bronze Age sites examined by metal-detecting surveys. The most appropriate interpretation seems to be that the raw material fragments (along with the finished items fragments?) were used as a currency, and carried around as a common part of personal belongings.

A distinctive spatial structure can be observed in the distribution of arrowheads. They are conspicuously distributed along the line of the fortifications of the 1st and 2nd suburbs of Tabulová hora. This may be remnants of a wartime event involving archers firing at the ramparts. The

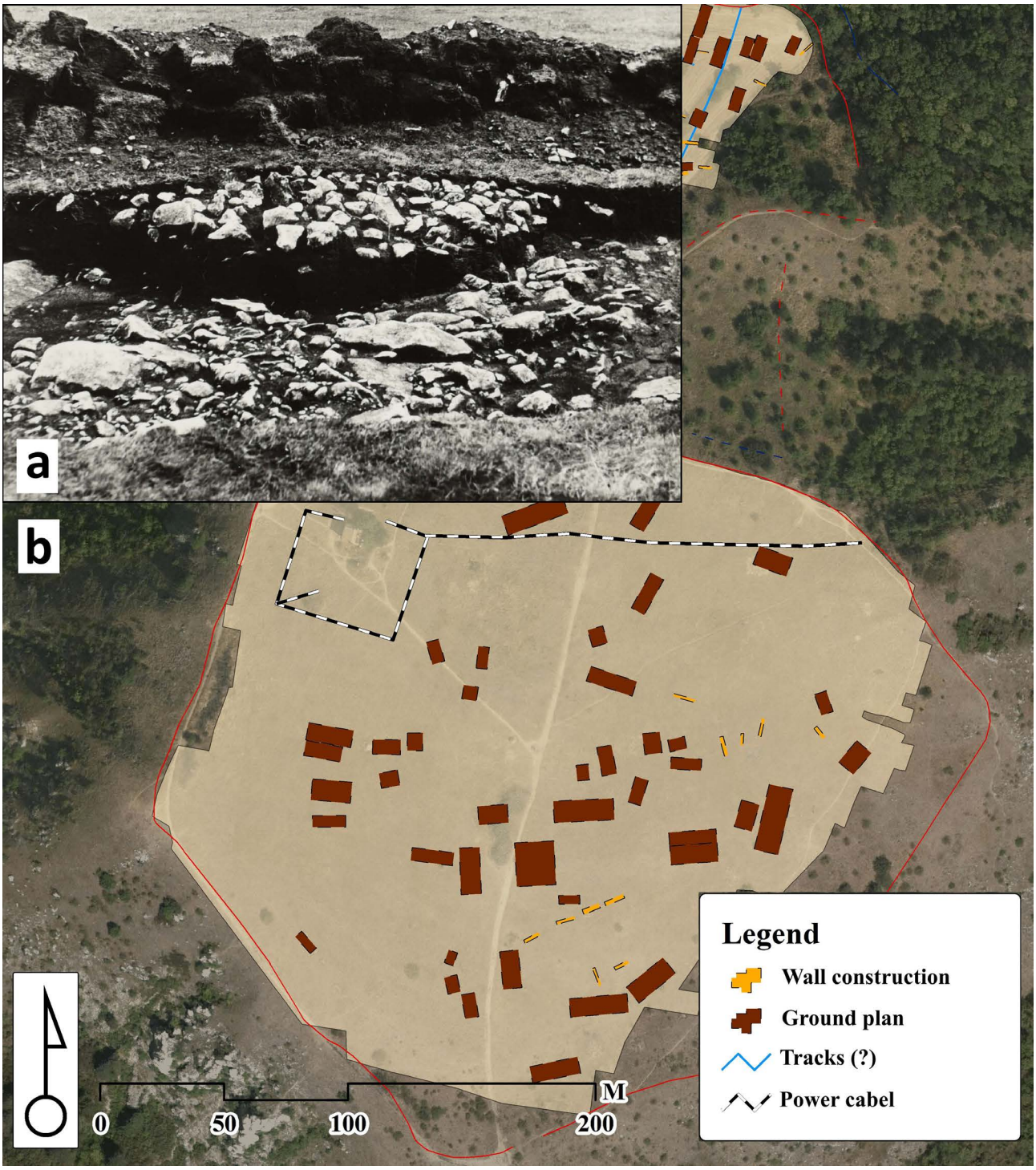

Fig. 20: Building traces on Tabulová hora after excavation in 1952 and magnetometrical survey in 2019. a – house floor according to Říhovský 1959. b – interpretation of magnetometrical survey according to Navrátil/Bíško/Tencer 2020.

skeletal remains, in the ditch at the southern entrance of the hillfort, uncovered in 1952, may also be related to the event. The finds may therefore represent another contribution to our knowledge about Bronze Age warfare.

Traces of metallurgy in the form of waste from the casting process concentrate mainly on Tabulová hora and the adjacent settlement on the Klentnice – Nad hřbitovem site. Together with data from the metal-detecting surveys of other Urnfield sites in Moravia, we can assume that the casting activities concentrated at some hillforts, such as Tabulova hora, however, they were also common part of the life in open settlements[96].

The artefacts from surveys alone do not prove the presence of elites. Indirectly, however, the size of the site, the length of the fortification and its multi-level structure, evidence of long-distance contacts, and the presence of lesser elite burials at the adjacent burial site all testify to their presence on Tabulová hora. Moreover, the geographic and geomorphological location combines ideal conditions for self-presentation and the role of the hillfort as a social node on long-distance trade routes.

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