Radiocarbon, Vol 00, Nr 00, 2022, p 1–20 DOI:10.1017/RDC.2022.76

SOCIETY IN TRANSITION: CULTURAL CHANGE IN THE EARLY BRONZE AGE CEMETERY AT NIŽNÁ MYŠĽA IN THE LIGHT OF ABSOLUTE CHRONOLOGY

Mateusz Jaeger[1]* • Mateusz Stróżyk[2] • Ladislav Olexa[3]

[1]Adam Mickiewicz University in Poznań, Poznań, Poland
[2]Archaeological Museum in Poznań, Poznań, Poland
[3]Slovak Academy of Sciences, Košice, Slovakia

ABSTRACT. The article presents the results of research on the absolute chronology of the Nižná Myšľa cemetery. Due to its scale and location in a key region of the Carpathian Basin, it should be considered one of the most important Early Bronze Age sites in Central Europe. Many years of archaeological research have so far failed to provide adequate data on absolute chronology. This text presents the results of statistical and spatial analyses on a series of newly acquired ^{14}C dates. They allowed us to present a model of the spatial and chronological development of the funerary space and to capture the stage of significant cultural change associated with the adoption of a new raw material—bronze.

KEYWORDS: chronology, culture change, grave goods, metallurgy, Otomani-Füzesabony culture.

INTRODUCTION

The Nižná Myšľa (henceforth NM) cemetery, located in eastern Slovakia, is the largest and essentially the only large-scale investigated and published funerary site of the Otomani-Füzesabony (henceforth OF) culture (Figure 1). The term is used to describe an assemblage of material culture elements, mainly morphological features and ornamentation of ceramics and some types of metal objects, distributed over several modern countries: Slovakia, Hungary, Romania, Poland and Ukraine. Researchers in each of these countries have developed their own terminology and typochronological systems to account for the regional specificities found in their study areas (Bader 1998; Gancarski 2002; Fischl and Kienlin 2020).

OF communities have been considered for decades as a potential link between Northern Europe, Central Europe and the Mediterranean basin (Kristiansen and Larsson 2005; Vandkilde 2014). However, a discussion on the development of the network of long-distance links of the European Bronze Age is only possible on the basis of absolute chronological data, which allow for a proper synchronization of cultural phenomena in the different regions of the Continent. All the chronological schemes presented so far for the development of the entire OF circle were based on the typological analysis of pottery from cemeteries (Thomas 2008). However, in none of the cases were sources available that could be referred to an absolute age. From this perspective, the determination of the absolute chronology of cemetery development in NM may provide a basis for further, more precise typochronological studies in the future. Given the above, the attempt presented here to reconstruct the dynamics of cemetery development in NM is an important element in the broader discussion of the European Bronze Age.

The cemetery at NM is part of a larger archaeological site which also includes the remains of two OF fortified settlements of different chronology (Olexa 2003; Fischl and Olexa 2020). The cemetery itself, associated with the older settlement, has been the subject of systematic excavations since the late 1970s. Between 2013 and 2017, three catalogs were published containing basic information about 792 graves, their burial furnishing and data on the age

*Corresponding author. Email: jaeger@amu.edu.pl

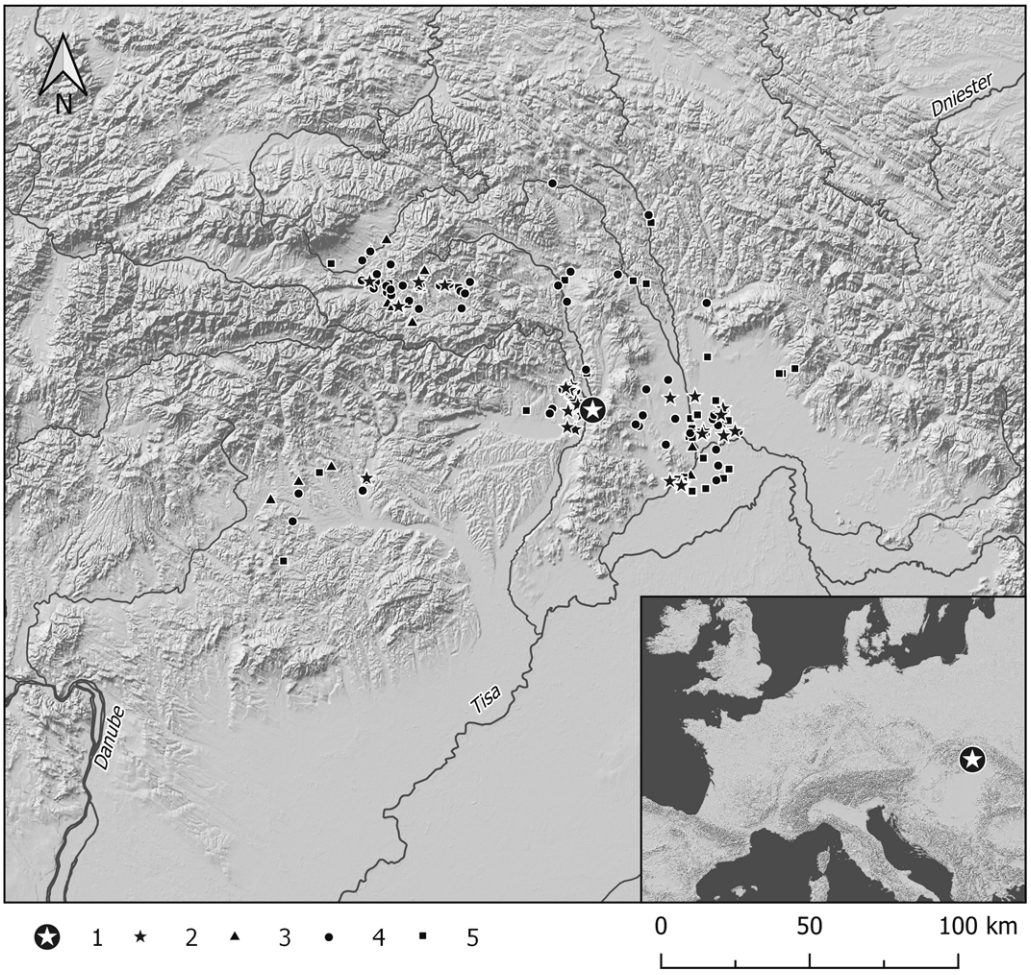

Figure 1 Location of NM site (1) and general distribution of Otomani-Füzesabony culture sites in the territory of present-day Slovakia: 2 – cemeteries, 3 – hilltop or fortified settlements, 4 – open settlements, 5 – stray finds.

and sex of the deceased (Figure 2) (Olexa and Nováček 2013, 2015, 2017). These catalogs, together with numerous collection of aspect-based publications on individual finds and features (Olexa 2003; Jaeger 2016, and further literature therein), constitute the basic sources of knowledge about the cemetery.

The main research problem associated with the site of interest is the absence of absolute chronological determinations. Relative sequences were defined for both settlements and the cemetery. Available radiocarbon dates come from the younger settlement and from two unique metallurgists' burials (Jaeger and Olexa 2014; Jaeger 2016). The small number of dated contexts and the vague archaeological characterization of contexts hinder a proper reconstruction of the chronological dynamics of the development of any of the elements of the NM site (Jaeger et al. 2021).

The main objective of the presented article is a detailed study of the absolute chronology of the cemetery carried out on the basis of new radiocarbon dates. We consider the reconstruction of

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

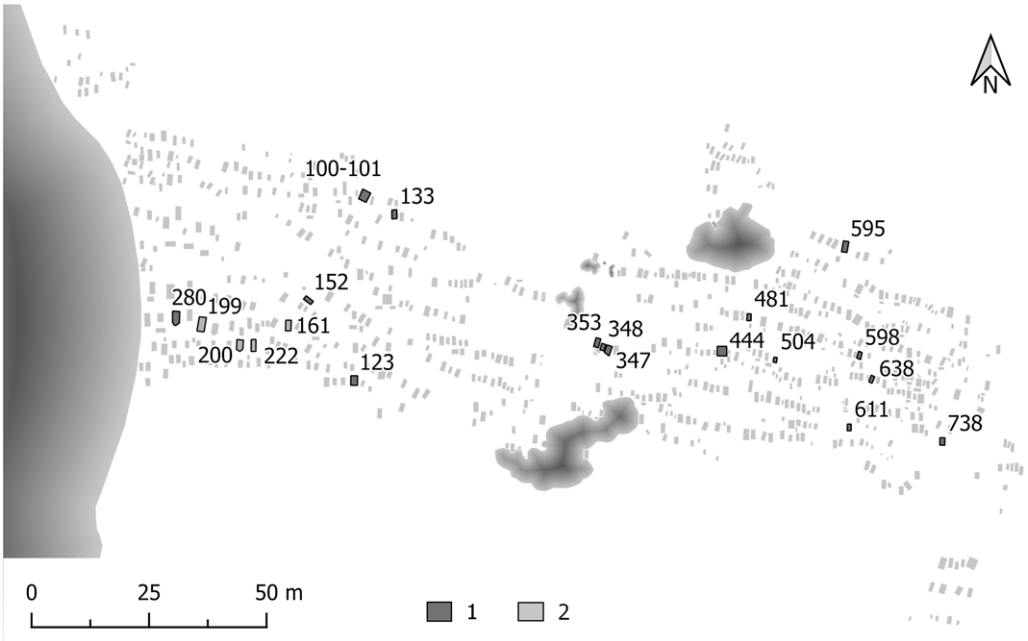

Figure 2 Plan of the cemetery in NM. 1 – radiocarbon dated graves, 2 – graves mentioned in the text.

the dynamics of the development of the funerary space as a necessary element for deeper analyses concerning the observed differences in the grave gifts and the relations linking them to the sex and age of the deceased. We pose a hypothesis that points to the key role of metal (bronze) as a raw material that has become a factor in the transformation of the local community. Our aim is to capture chronological stages that essentially mark stages of cultural development linked to adoption and acceptance of the new raw material.

Funerary Rites of the OF culture in Slovakia

The funerary rite of the OF culture in Slovakia is archaeologically well-documented. Currently 34 sites are known, where varying (mostly several) numbers of burials were discovered (Horváthová 2011; Tóth et al. 2019). The scale of the NM cemetery is exceptional, not only within Slovak sites, but also across the entire OF occurrence area. Regardless of the size of the discovered cemeteries, certain constant principles governing the funerary rites of OF communities can be stated (Olexa 2002). The dead were buried in skeleton graves, in a flexed position on the side. The orientation of the burial differed according to the sex of the deceased. Men were buried on the right side, on a south-north axis, while women were placed in the grave on the left side, on a north-south axis. The faces of the deceased were directed to the east. In addition to ceramics, burials were furnished with ornaments made of various materials (boar tusks, animal teeth, bronze, gold, amber, faience), and more rarely tools and weapons. In addition to the predominant single burials, examples of double burials are known, either of adults and children, or adults only. A very frequently identified phenomenon was the secondary opening of graves. With the exception of the cemetery in NM (see below), we do not have sufficient data which would indicate the existence of separate rules for burying the dead of different ages. In some cases children's

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

Table 1 Relative chronology schemes of NM cemetery development in relation to modified Reinecke Bronze Age chronology system.

Točík 1964 (based on Reinecke 1924)	Thomas (2008)	Olexa and Nováček (2017)
A1	Phase 1	Pre-classical phase
A2	Phase 2	Early classical phase (A3a)
A3	Phase 3	Late classical phase
B1	Phase 4 and 5	Post-classical phase
B2		Final phase

burials were furnished more poorly than those of adults. However, this was not a constant and repeatable rule.

Relative Chronology of the NM Cemetery

All systems of periodization of the Bronze Age in the Carpathian Basin are based on two groups of sources. The first are bronze hoards, which were used to delineate a number of chronological horizons, most often with blurred boundaries and a rather large capacity calculated in calendar years (David 2002, and further literature therein). The second group of sources were ceramics from cemeteries (Staniuk 2021). What is characteristic, in the case of grave pottery, it was also used to date the pace of development of individual settlements. Over the decades of research on the issue of relative chronology, many attempts were made to correlate the "ceramic" and "metal" systems, which were then reconciled with the classical language of relative chronology by P. Reinecke (1924) with further modifications (Točík 1964) (Table 1). The cemetery from NM also played a role in such studies. The first system of internal cemetery periodization was proposed in the 1980s by the excavation leader L. Olexa (1987). The author distinguished five phases. With reference to this system, M. Thomas (2008) proposed a periodization scheme describing the chronology of not only the materials from the NM, but also other cemeteries of the OF culture in Slovakia and Hungary, again in frames of 5 phases. In fact, none of the cemeteries forming the basis of the typochronological division in M. Thomas's system have been studied and published in a complete way. At the time of working on this system the author could not yet have full knowledge of the sources from the cemetery in NM. The created scheme allowed therefore to catch the similarities visible in the few ceramic sources published until 2008. However, it did not provide any help in strictly locating specific phases on the calendar age axis. For the NM cemetery itself, a separate chronological division, correlated with the Reinecke periods, was proposed during the work on the catalogs mentioned above. Accordingly, the pottery from the cemetery was divided into 5 phases (Olexa and Nováček 2017). The total duration of the phases was set at about 300 years (1900–1600 BC).

The periodization scheme proposed by L. Olexa and T. Nováček in the cited catalogs was verified based on statistical analyses and related to absolute age on the basis of radiocarbon dating of finds known from burials from the NM but coming from other

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

areas of Central Europe (Stockhammer et al. 2015). As a result, it was proposed to describe the development of funerary space use at NM in two phases, i.e., A1 and A2, dated to 2100/2000–1900 BC and 1900–1650/1550 BC, respectively (Jaeger et al. 2021). Results of verification of this chronological model are presented below.

MATERIALS AND METHODS

Funerary Rites in the NM Cemetery

By 2017, 792 funerary features (single graves, mass graves, and cenotaphs) had been published, containing the remains of 782 individuals in total. The entire osteological collection was subjected to anthropological analyses, which made it possible to determine the age and sex of the deceased. In several dozen cases it was not possible to determine one or both parameters; sex of 50 and the age of 46 individuals was undetermined. In total, 387 female and 355 male burials were identified in the cemetery. Most of the deceased fall under the *adultus* age category (317 individuals). Less numerous were burials of children (*infans* 0–10; 245 individuals) and individuals in the *iuvenis* age category (177 individuals) (Nováček 2017). Moreover, only 7 burials of *maturus* individuals were documented and no burial of a *senilis* individual was discovered[1] (Jaeger et al. 2021). Irrespective of the representation of the oldest individuals in the archaeological record of NM, both sexes were placed in graves according to formalized rules (males—right side S-N axis, females—left side, N-S axis). Grave gifts varied according to the sex of the deceased and the chronology of the burial (Jaeger et al. 2021). In the earlier part of the cemetery (phase A1) the dead were generally buried with fewer objects. At that point in time, some artifacts deposited in graves represented specific types of activity of the deceased during their lifetime. In female burials there were awls and needles (= weaving, leatherworking, and fur processing), while in male burials, obsidian arrowheads, boar tusks, and pendants, as well as characteristic plates used as clothing or belt appliqués (= hunting) were very common. The most numerous metal objects were simple pins of the *Rollenkopf I* type (Figure 3). In earlier burials (phase A1) ornaments made of faience were also deposited, in some cases in very large numbers of several hundred beads (e.g., grave 118 with a necklace consisting of 3252 beads). In later burials (phase A2) the number of burials furnished with bronze, gold, and amber objects increased. New forms of pins (*Kugelkopf* and *Hülsenkopf* types) appeared, as well as a few heavier tools (chisels, awls) and weapons (daggers, one specimen of a low-flanged axe). In this period a greater unification of the equipment of the deceased of both sexes is noticeable. Significant changes can be observed in the cemetery space. Burials within the whole cemetery were located in rows running from the west to the east. In individual rows, however, groupings differing in size and number of buried dead are visible. In the earlier phase these groupings usually included about 4 graves. In the later part of the cemetery, on the other hand, groupings of 7 or more burials prevail. This probably indicates a different type of relationship between deceased during their lives. The linear arrangement of the graves in the NM and only two cases of superposition of funerary features of the same chronology indicate some kind of marking them on the surface. In addition to the dominant single burials at NM, 23 double graves, two graves containing the remains of three deceased and one grave containing the bodies of four people were also discovered.

[1]We treat a small number of burials of mature women and men (*maturus*) as those which, from the point of view of the existing ritual rules, were related to a group of adults (*adultus*). The age limit separating both categories is conventional and is the assumption of modern science. As a consequence, we accept the thesis according to which people in mature and old age (*maturus* and *senilis*) were not buried in the form documented in the cemetery.

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

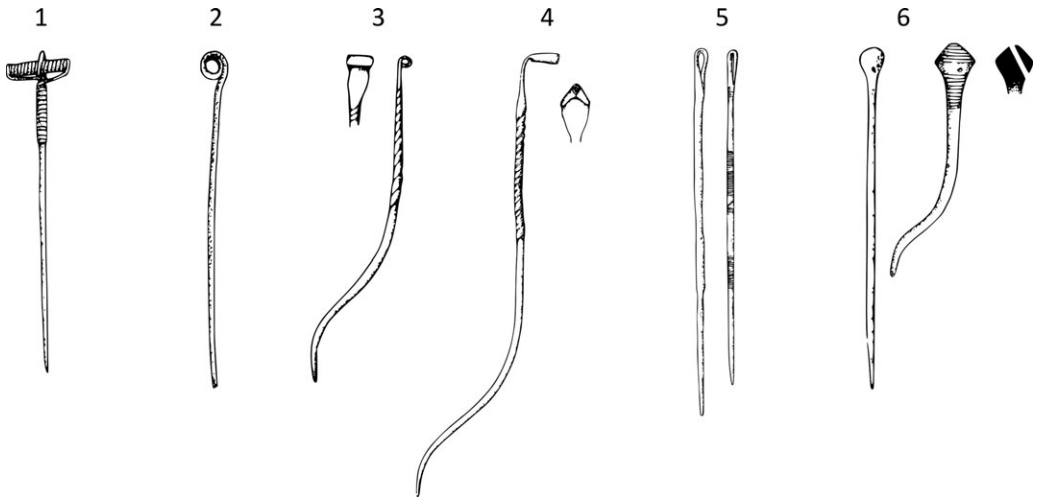

Figure 3 Types of bronze pins discovered in the NM cemetery: 1 – Cypriot pin, 2 – *Rollenkopf I* pin, 3 – *Rollenkopf II* pin, 4 – *Hülsenkopf* pin, 5 – needle-like pin, 6 – *Kugelkopf* pin.

The dead were buried approximately in rectangular graves; in some cases the remains of wooden coffins were discovered. As in other regions of the Early Bronze Age Slovakia, cases of secondary grave opening were identified in NM. In total, traces of disturbance of 90 graves were identified (Nováček 2017). In the vast majority, burials were reopened near the upper body of the deceased, including the skull. This indicates that the way graves were marked on the surface also carried information regarding the orientation of the body, and thus the sex, of the deceased.

Sampling for ^{14}C Dates at NM Cemetery

The analyses presented here are based on ^{14}C datings obtained from human bones of 19 individuals buried in 18 graves (Table 2) (graves: 100-101/two samples, 123, 133, 152, 280, 347, 348, 353, 444, 481, 504, 595, 598, 611, 638, 742, 783). With the exception of grave 100/101, which is the only case of a mass grave of 4 individuals known from the NM cemetery, all other dated features are single graves. Graves 133, 280 and 598 contained male burials. In the remaining cases the dated bone samples were from female burials. In the case of grave 742 it was not possible to determine the sex of the deceased, but the northward location of the skull suggests that most probably a woman was buried in this grave. From the aforementioned mass grave 100/101 (an adult woman, a man and two children—according to body position probably a boy and a girl), samples from a male and a female adults were dated. The bone samples obtained for radiocarbon dating represent both the earlier and the later phase of the cemetery (Jaeger et al. 2021). The selection was based on the criterion of the presence of amber ornaments in the burial furnishings[2], hence the predominance of female burials in the collection. Previous datings from the so-called metallurgists' graves (graves 133 and 280; Jaeger and Olexa 2014) were also included in the

[2]The selection of burials furnished with amber objects was dictated by the main goal of the grant funding the presented research on the chronology of the cemetery in NM. This goal is to identify the raw material and chronology of the Early Bronze Age amber finds in Slovakia, Romania, and Hungary (grant no. 2015/17/D/HS3/00704, financed by the National Science Centre, Poland).

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

Table 2 List of radiocarbon dated samples from NM.

Grave no	Material	Sex	Age	Laboratory no Poz-	^{14}C BP	% collagen	δ^{15}N %	δ^{13}C %
100/101	Metatars II (dx)	Male	Adultus	140326	3490 ± 30	5.1	1.4	5.7
100/101	Metatars II (dx)	Female	Adultus	140327	3465 ± 35	4.7	2.6	9.4
123	Tooth 17	Female	Adultus	140413	3415 ± 35	6.1	2.0	6.2
133	Vertebral bone L5	Male	Adultus	41433	3540 ± 35	?	2.5	6.6
152	Os temporale (sin)	Female	Adultus	140414	3435 ± 35	7.8	0.8	2.1
280	Os temporale (sin)	Male	Adultus	140374	3450 ± 35	6.6	2.3	5.6
280	Vertebral bone L3	Male	Adultus	41434	3540 ± 35	?	1.4	4.3
347	Metatars I (dx?)	Female	?	140372	3485 ± 35	7.3	1.5	5.6
348	Pp metacarp I	Female	Infans	140373	3460 ± 35	4.7	3.4	7.7
353	Os temporale (sin)	Female	Iuvenis	140415	3415 ± 35	5.4	2.0	5.4
444	Metatars II (dx)	Female	Adultus	140324	3420 ± 30	3.8	2.5	8.2
481	Tooth 55	Female	Iuvenis	140325	3415 ± 30	4.1	1.5	5.3
504	Os temporale (sin)	Female	Iuvenis	140328	3405 ± 30	7.4	1.9	5.8
595	Os temporale (sin)	Female	Adultus	140332	3435 ± 30	5.6	1.7	5.1
598	Os temporale (sin)	Male	Iuvenis	140330	3395 ± 30	5.5	2.2	7.4
611	Os temporale (sin)	Female	Iuvenis	140334	3370 ± 30	8.1	3.1	8.0
638	Tooth 14/15	Female	Adultus	140331	3340 ± 35	6.4	2.4	7.5
783	Os temporale (sin)	Female	Iuvenis	140333	3360 ± 30	10.1	3.5	8.5

analyses. Dating using the accelerator technique (AMS) was performed in the Poznań Radiocarbon Laboratory. Samples were derived from skull, metatarsal, and vertebral bones and teeth. Collagen extraction was performed using the Longin method (1971) together with an ultrafiltration procedure (Bronk Ramsey et al. 2004). The obtained dates were calibrated in OxCal v. 4.4.4 based on the IntCal20 atmospheric curve (Reimer et al. 2020). The standard errors of the ^{14}C determinations obtained were in the range of 30–35 years. For samples from graves with two ^{14}C determinations (graves 100/101 and 280), all analyses used the *Combine* function. In the course of the analyses on the detailed chronology of the cemetery, two models were proposed.

Bayesian Chronological Modeling

The first model (Model I) was constructed on the basis of the archaeological context of the dated burials, which reflects the division into chronological phases (Figure 4a). The typological classification was based on the results of correspondence analyses (Figure 4b) (see further Jaeger et al. 2021). Based on the results obtained, the elements of the burial inventories dominating in the two stages of the cemetery's existence, corresponding to periods A1 and A2, were distinguished (Stockhammer et al. 2015). In the case of the first mentioned phase (A1), the deceased's equipment set consisted of a boar's tusk and/or a boar's tusk pendant, an obsidian arrowhead, a bone awl, a bone needle, a *Rollenkopf I* pin, a shell, an earring (*Lockenring*), and a DC jug and PB cup[3]. In the case of phase A2, the characteristic assemblage consisted mainly of needle-like pins, *Rollenkopf II*, *Kugelkopf*, and *Hülsenkopf* pins, faience, amber and vessels, i.e., DA and DB jugs, PB beaker, HB pot, MB2 bowl (Jaeger et al. 2021). Radiocarbon dated graves were classified into the described phases in terms of the highest similarity to the idealised grave goods sets. The latter were determined on the basis of correspondence analyses. In this case, the statistical calculation of chronology assumed that the phases followed each other (Needham et al. 1998). In this model we estimate the dates of start, transition and end (function *Boundary*) using all radiocarbon dates for both phases (A1 and A2).

The second model (Model II) was created on the basis of the previous one (Model I), however, it was supplemented with data obtained from spatial analyses of distribution of particular objects (Figure 5a). The key role in this case was played by bronze pins, which showed a specific regularity in location within the cemetery area. The distribution of artifacts within the site suggests a temporal variation in the deposition and use of particular types of pins (Figure 5b). In the western part of the cemetery only *Rollenkopf I* pins are found. In the center we can observe co-occurrence of *Rollenkopf II* type (which is a later variant of *Rollenkopf I* type) and pins of needle-like form. In the eastern part of the cemetery the *Hülsenkopf*- and *Kugelkopf*-type pins are concentrated with the simultaneous occurrence of already used pins of needle-like form (see further Jaeger et al. 2021). Based on the previously adopted division into two phases (Model I), the A1/A2 transformation stage was distinguished. It is characterized by the occurrence of *Rollenkopf II* pins and pins of needle-like form with equipment typical for both A1 and A2 phases. The model assumed that the different phases, understood in typological terms, may have been independent (Needham et al. 1998). In this model we estimate the dates of start and end (function *Boundary*) separately for groups of dates related to phases A1, A1/A2, and A2.

[3]In the text, typological terminology is that developed in catalogs presenting the results of excavations in NM (Olexa and Nováček 2013, 2015, 2017).

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

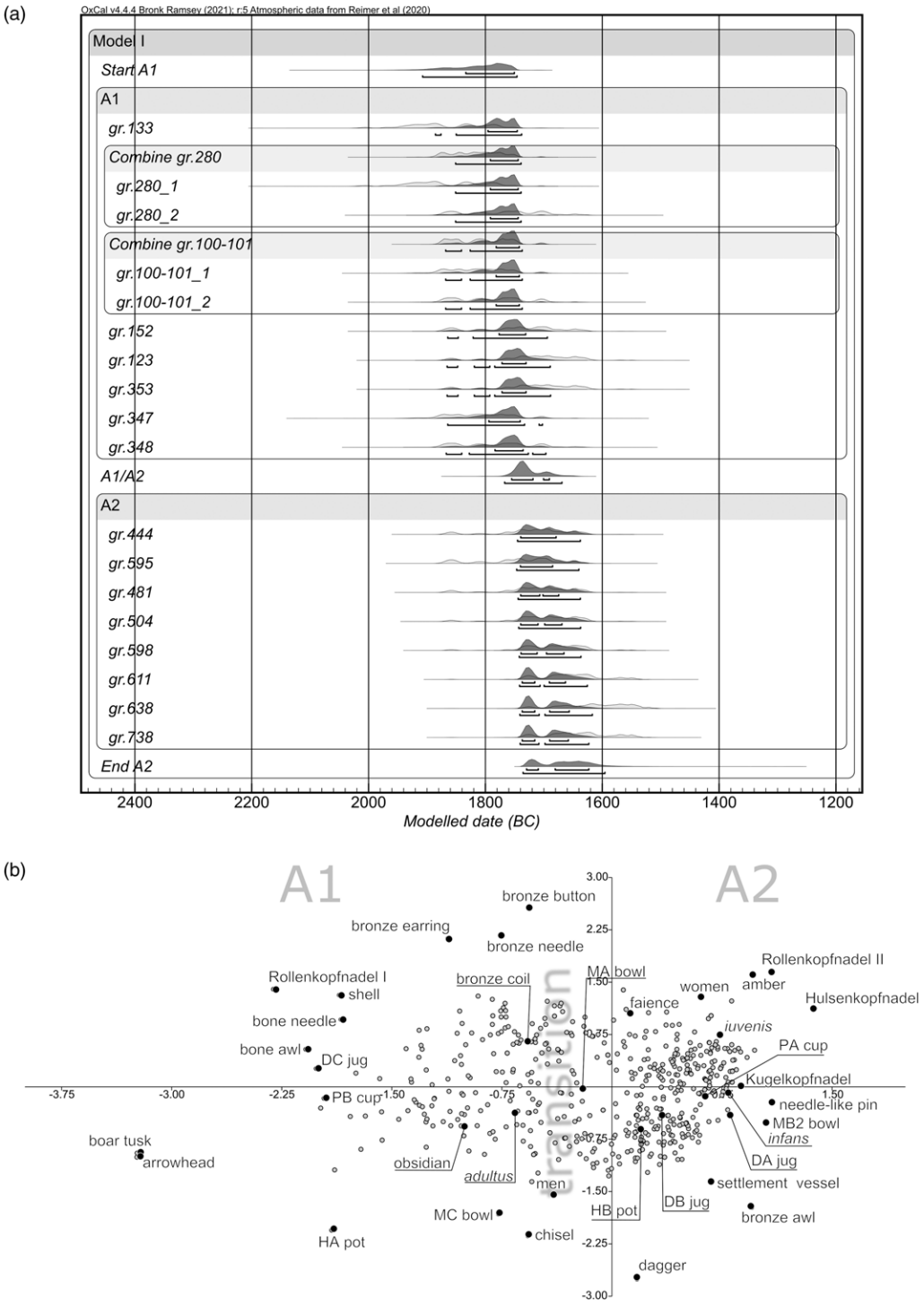

Figure 4 Two-phase chronological model of ^{14}C dates (Model I) (a); results of correspondence analyses of grave goods from all burials (b).

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

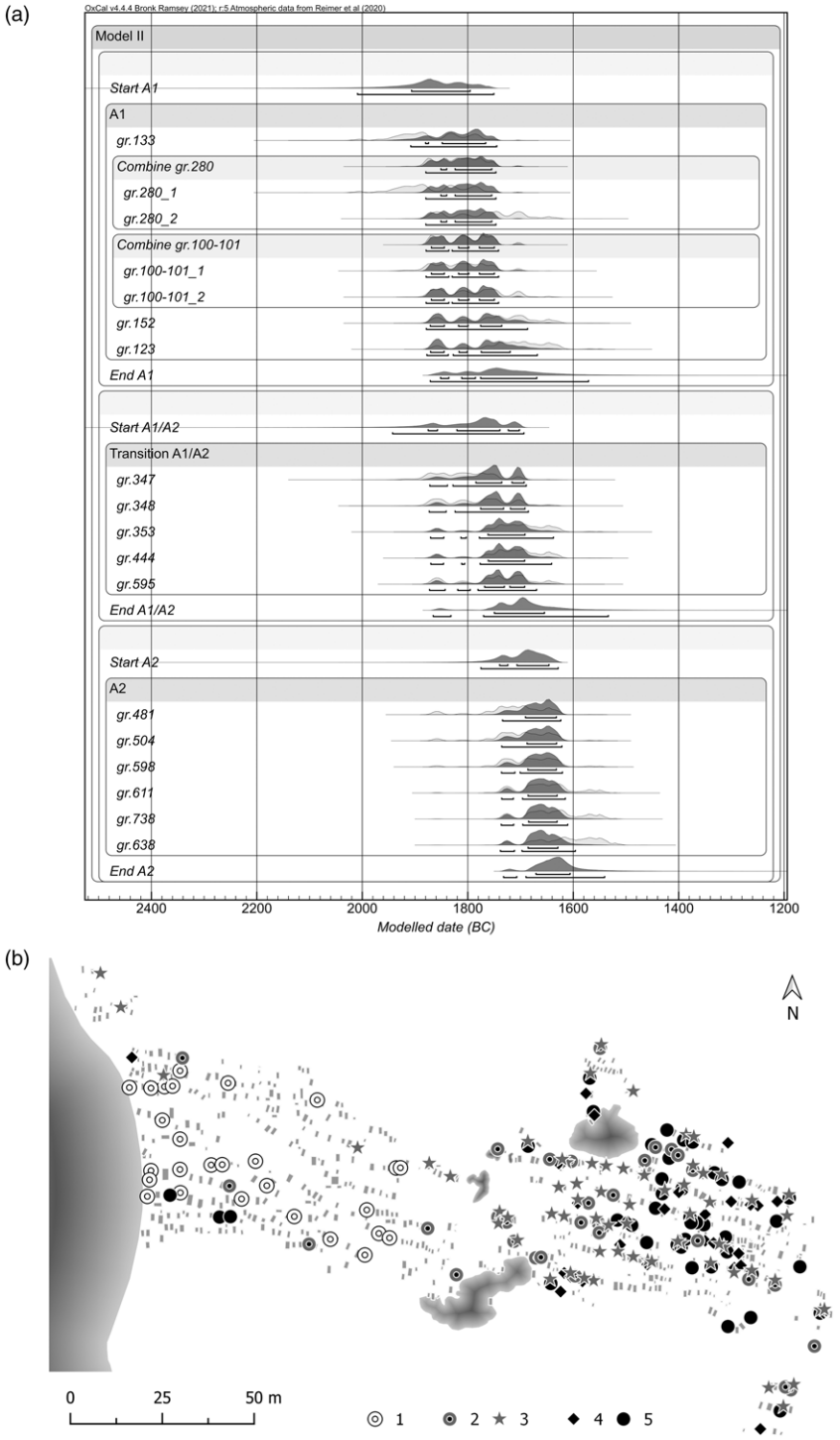

Figure 5 Three-phase chronological model of ^{14}C dates (Model II) (a); distribution of selected types of bronze pins in the cemetery (b): 1 – *Rollenkopf I* pin, 2 – *Rollenkopf II* pin, 3 – needle-like pin, 4 – *Hülsenkopf* pin, 5 – *Kugelkopf* pin.

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

Spatial Analyses of ^{14}C Dates

The presented models reflect different approaches to the process of cemetery formation and development in NM. Model I, with its two phases, in a general sense reflects the typological layout of the finds discovered at the site. However, the lack of a clear boundary between the two phases, which is manifested by the co-occurrence of individual finds (earlier and later in typological terms), leads us to suggest that Model II is the most probable one. Apart from the typological division, spatial information concerning the dispersion of bronze pins, which in this case is the most sensitive indicator of change (both cultural and chronological; Jaeger et al. 2021:7-8, Fig.5), was used to create this model.

Statistical spatial analyses were used to apply the obtained division to the entire cemetery area. The calculations were based on centroids generated for the analyzed graves, which were assigned a median attribute of calibrated radiocarbon dates. The *ordinary kriging* algorithm was used for spatial interpolation, assuming that a value at an unknown point expresses the average of known values occurring in its vicinity (Barceló et al. 2014). In addition, due to the high dispersion and irregularity of the points, a type of *block kriging* algorithm was used, which uses an estimate of the average expected value in an indicated area (block) around the point (Mason et al. 1994). In this case, *block kriging* provides better variance estimation and smoothing of the interpolated area.

RESULTS

Model I

The resulting model presents a high level of agreement ($A_{model} = 82\%$). The chronological limits of the cemetery use are defined by the period 1908–1596 BC (with 95.4% confidence), with the highest probability (with 68.3% confidence) for the period 1834–1624 BC. The range of use of the cemetery would have been successively between 24–277 (with 95.4% confidence) years and 44–203 years (with 68.3% confidence). Phase A1 would have lasted between 1908–1670 BC (at 95.4% confidence) with the highest probability (at 68.3% confidence) for 1834–1691 BC, while A2 would have lasted between 1768–1596 BC (at 95.4% confidence) with the highest probability (at 68.3% confidence) for 1756–1624 BC. Thus, the lifetime would be A1 between 0–205 (with 95.4% confidence) years and 0–115 years (with 68.3% confidence) and A2 between 0–148 (with 95.4% confidence) years and 0–81 years (with 68.3% confidence), respectively.

Model II

The result obtained from the above assumptions presents a high level of agreement ($A_{model} = 89{,}8\%$). The chronological limits of the cemetery use are defined by the period 2010–1541 BC (with 95.4% confidence), with the highest probability (with 68.3% confidence) for the years 1907–1607 BC. The range of use of the cemetery would have been extended and would be between 36–517 (with 95.4% confidence) years and 161–320 years (with 68.3% confidence). The A1 phase would have lasted between 2010–1670 BC (with 95.4% confidence) with the highest probability (with 68.3% confidence) for 1907–1572 BC. The transition phase would fall in the period 1943–1534 BC (with 95.4% confidence) with the highest probability (with 68.3% confidence) for 1876–1655 BC. Phase A2 would fall within the period 1776–1541 BC (with 95.4% confidence) with the highest probability (with 68.3% confidence) for the years 1740–1607 BC. Thus, the

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

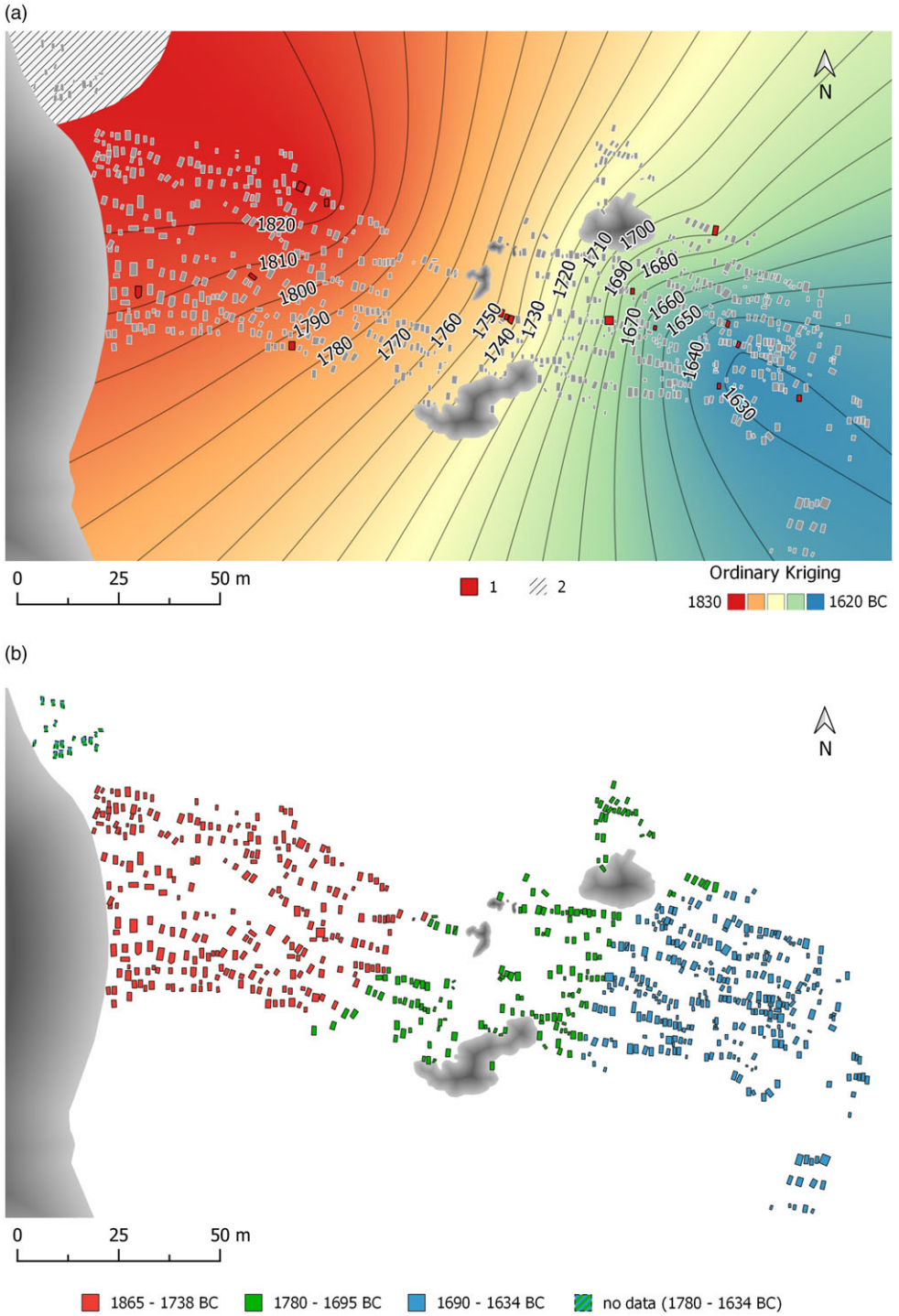

Figure 6 Model of spatio-temporal cemetery development; 1 – radiocarbon dated graves, 2 – graves excluded from interpolation (a); division of graves into three chronological phases (b).

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

lifetime would be A1 between 0–398 (with 95.4% confidence) years and 0–172 years (with 68.3% confidence); A1/A2 between 0–344 (with 95.4% confidence) years and 0–136 years (with 68.3% confidence); A2 between 0–201 (with 95.4% confidence) years and 0–80 years (with 68.3% confidence).

Spatial Statistics (Modeling)

The analyses resulted in a statistical spatial model representing the distribution of dating values within the whole cemetery (Figure 6a). Taking the median values obtained in the chronological analyses, the range of individual phases can be defined as follows:

- phase A1—1865–1738 BC
- phase A1/A2—1780–1695 BC
- phase A2—1690–1634 BC.

On the basis of the obtained surface isolines (isochrones) were generated in the range from 1865–1634 BC with intervals of 10 years. The model area values were added as an attribute for each grave. The graves were then divided according to previous findings into three cemetery phases (cf. above) (Figure 6b). A grouping of 17 graves located in the northwest was excluded from the estimation, as the grave inventory represents materials related from A1/A2 to A2 periods. As a result, we obtained a distribution of graves in the cemetery according to chronological phases. Period A1 is represented by 277 graves. The A1/A2 transitional phase potentially included 175 graves, with 62 graves corresponding to the period 1780–1738 BC, which could represent both the A1 and A1/A2 phases (concurrence of phases, cf. notes above). The greatest number of graves (323) were associated with phase A2.

DISCUSSION

Burial rites, grave goods and funeral space of the NM cemetery in the light of absolute chronology

Of the chronological models presented above, Model II was considered the most probable and reliable. Assuming average values, it determines an approximate 230-year period of use of the cemetery at NM. The excavations identified a total of 792 graves, in which 782 individuals were buried (Olexa and Nováček 2013, 2015, 2017). Although this number does not seem high given the relatively long existence of the cemetery, it suggests that not all members of the local community were buried there. No mature or senile deceased were identified in the graves. Furthermore, the continued excavation of the site by L. Olexa already provided evidence of other, previously unpublished burials.

The spatially linear arrangement graves generally reflects the chronological trend, but the proposed typochronological description naming individual parts of the cemetery according to the phases of Reinecke's scheme (Olexa and Nováček 2017; Nováček 2017) does not imply discontinuity in the dimension of culture and funerary ritual. On the contrary, the visible changes are characterized by fluidity.

On the basis of the analyses of the dispersion and chronology of individual types of bronze pins, the gradual adoption of new elements of material culture can be clearly seen, with the simultaneous use of previously known forms. The continuity reflected in this way is a process in which the phenomenon of cultural change was contained (Kadrow 2012). It is

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

manifested, on the one hand, by the adoption of new forms of bronze pins and the unification of the remaining grave inventory with respect to both sexes. On the other hand, there is a gradual disappearance in the equipment of the deceased of both sexes of objects that can still be associated with the post-Neolithic tradition. In the case of male graves, these are objects made of bone and antler, boar tusks, ornaments made of them and obsidian arrowheads. These items formed a specific set, which can be described as a "hunter's package". In the female burials, on the other hand, there are the above-mentioned objects made of bone and antler connected with leather/fur processing and weaving. The ornaments of the deceased often included necklaces and pendants made of faience beads. At this stage bronze in the equipment of the deceased of both sexes was mainly present in the form of purely functional pins of the *Rollenkopf I* type, devoid of ornamentation and individual characteristics. In the later stage of the functioning of the cemetery we can identify the process of widening access to metal. This is clearly visible in the change of the raw material used for the production of awls, which previously were made only from bone, whereas in later graves almost exclusively bronze pieces were deposited. What is most interesting, it is in the older part of the cemetery that the only two metallurgists' graves are located. In these graves (Figure 7) (nos. 133 and 280; Olexa 1987; Jaeger and Olexa 2014), casting mould used for the production of *Rollenkopf* pins (probably *Rollenkopf I*; grave 133) and *Kugelkopf* pins (grave 280) were discovered. The varying level of equipment richness in these graves has been interpreted elsewhere as reflecting the different levels of skill and metallurgical knowledge possessed by the two buried men (Jaeger and Olexa 2014).

Metal as an Agent of Cultural Change

In light of the current results of the chronological analyses of the cemetery, the above mentioned two metallurgists' graves can be treated as reflecting a wider process of emergence and adoption of technological innovation (metallurgy) by the local community. Particularly important in this context is the location and chronology of grave 280. This male burial was richly furnished, including items connected with metallurgy (the above-mentioned casting mould, a tuyère, a stone hammer, a ready-made bronze pin) and numerous objects characteristic for the earlier period of the functioning of the cemetery. These primarily include bone awls, a necklace of (imported) shells, an antler buckle, wild boar tusk pendants and the most numerous set of wild boar tusk appliqués/plates discovered in the cemetery (Figure 7).

In close proximity to grave 280, there were two graves equipped with the only two examples of Cypriot pins known from the cemetery (Figure 2:1) (graves 161 and 199), which confirm the early chronology of this part of the site (Ernée et al. 2009; Stockhammer et al. 2015:19, Figure 6). The *Kugelkopf* pins produced by the man from grave 280, in the eastern, earlier part of the cemetery are only known from the furnishings of three burials (200, 280, and 222). Graves 200 (male) and 222 (female) are directly adjacent to each other. The female burial 222 is at the same time one of the richest in the earlier part of the cemetery. Apart from a ceramic vessel, two bone awls, several bronze buttons and seven bronze earrings (*Lockenringe*), a necklace of shells and bronze spirals as well as a total of 2100 faience beads (some of them in the form of *Dentalium* shells) were found in the grave. Although the furnishings of grave 280 clearly testify to the technical capabilities of the local production of *Kugelkopf* pins, they are in the earlier part of the cemetery absolutely unique elements of grave goods. Even their location is clearly spatially restricted to three graves in close proximity to each other. As mentioned above, the dominant form of pins (and, more broadly, bronze objects) in the furnishings of the earlier burials at NM were simple *Rollenkopf I* pins. In addition to these,

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

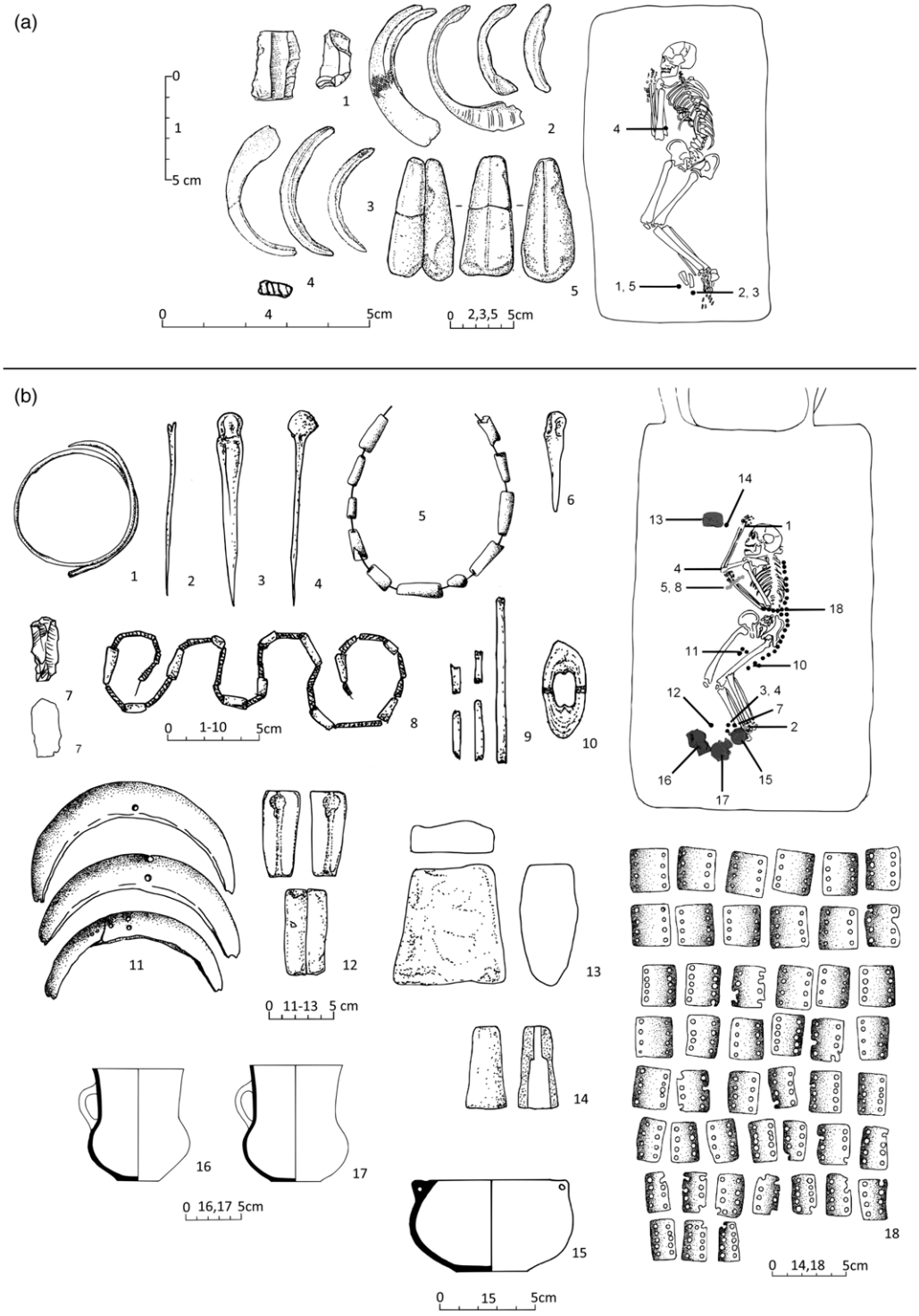

Figure 7 Graves of metallurgists from NM. Furnishing of grave 133 (a), furnishing of grave 280 (b).

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

earrings (*Lockenringe*) were also deposited among bronze objects in earlier graves. It seems justified to state that the local community was not interested in possessing and including in their ritual instruments not only a new type of ornament (*Kugelkopf* pin), but also a large number of various metal objects. The expression of local identity and cultural self-identification were objects associated with hunting (hunting = men) and the processing of the raw materials thus obtained (leather/fur processing, weaving = women).

In this context, the earlier stage of cemetery development would have reflected the condition of the community at a time of significant cultural change associated with the development of metallurgy. It was a condition anchored in a post-Neolithic tradition, characteristic of a larger area covering not only eastern Slovakia, but also southeastern Poland (Lesser Poland region). In the latter area, in the Early Bronze Age, the Mierzanowice culture developed. It is known from very numerous and well identified settlements (including fortified settlements) and hundreds of skeletal graves. It developed from ca. 2200 to 1600 BC, in the so-called local group phase (1900–1600 BC) showing a number of relationships with the Carpathian Basin region (Kadrow and Machnik 1997; Madej and Valde-Nowak 2020). Characteristically, these relationships were not reflected in the form of imports of metal objects. From the area of Lesser Poland and the contexts of the Mierzanowice culture, bronze objects not only of the Carpathian style but also Únětice imports are unknown. There was also no tradition of bronze hoarding. The communities of the Mierzanowice culture equipped their deceased with bone and antler objects, flint products (arrowheads, bifacial tools, sickles) and copper (simple sheet and wire ornaments) as well as faience beads. Moreover, various cord impressions can be considered the main characteristic of pottery decoration (except for the Classic phase and despite some regional differences). Bronze Age culture developing in the neighboring areas, understood as an acceptance of a new raw material (= bronze) being an element of a new model of life—rituals (hoards, bronze objects in graves), social and economic phenomena (hierarchization, monopolization, long-distance exchange of metals and amber)—was a phenomenon completely separate from the internal development processes of the Mierzanowice communities. It seems that a similar phenomenon, although on a smaller scale, is observed in the earlier stage of development of communities in NM.

The chronological analyses of the burials from the cemetery of interest to us reflects the gradual incorporation of new objects into use, the increasingly full acceptance of metal and the wider cultural phenomena associated with it. In the central part of the site, which was created in the A1/A2 phase, we can see burials containing, apart from already known objects, new products. A characteristic object of this phase of transformation is an eminently local type of pin of needle-like form. This pin was based on a bone needle form known in the A1 phase. In the new version the raw material from which it was produced changed (bronze replaced bone), as well as its size (which precluded the possibility of effective use of pins as needles). In the new metal form some pins of that type were also ornamented. In the same period, the oldest form of the pin also changed; *Rollenkopf I* was replaced by a modified form of *Rollenkopf II*. Both the latter and the previously mentioned pin of needle-like form co-occurred in the furnishings of many graves (e.g., 347, 353). In the youngest stage of the spatial development of the cemetery, as mentioned, completely new forms of pins appear. Alongside the *Hülsenkopf* type, the previously unaccepted *Kugelkopf* type, often with rich decoration, becomes one of the more common pin types. In this phase (A2) all of the above-mentioned pin types, with the exception of the archaic *Rollenkopf I* form, very often co-occur within the furnishings of the

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

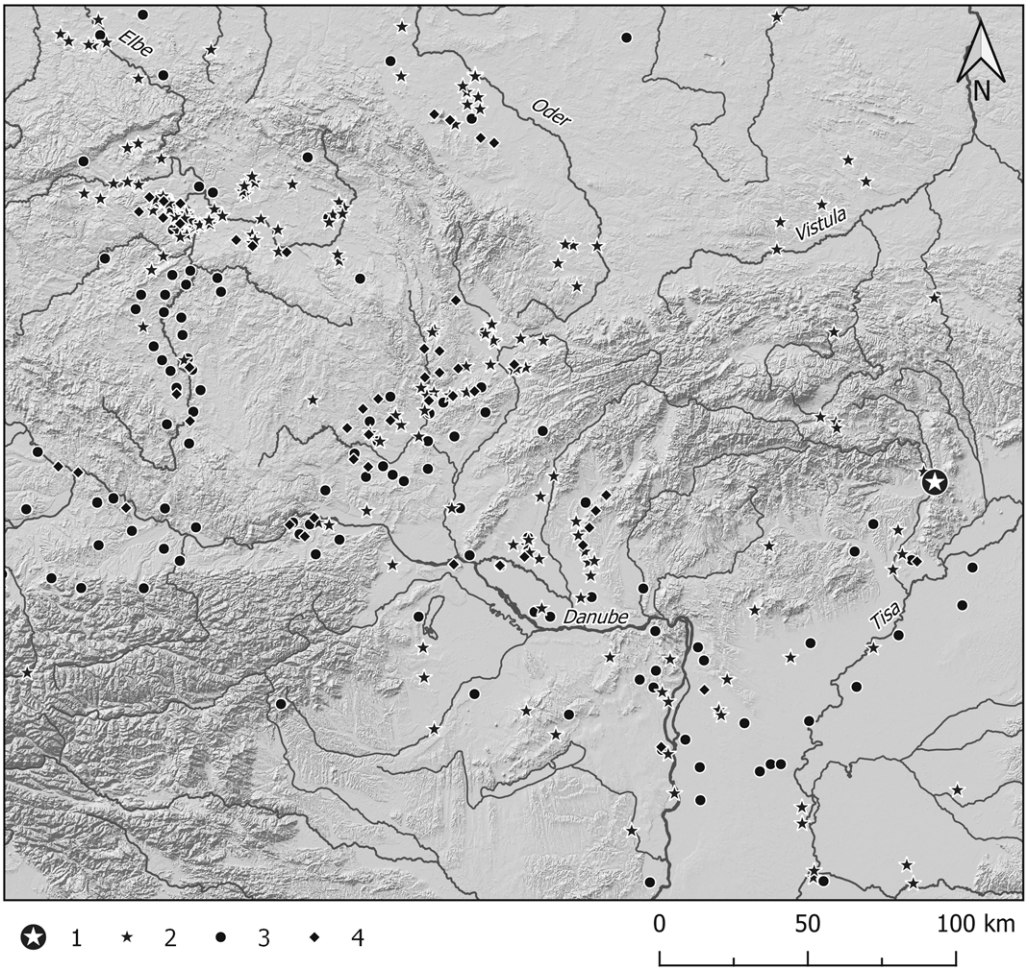

Figure 8 Location of NM site (1) and distribution of selected Early Bronze Age finds in Central Europe: 2 – amber finds, 3 – *Kugelkopfnadel* pins, 4 – *Hülsenkopfnadel* pins.

same burials (*Kugelkopf* + pin of needle-like form, e.g., graves 513, 553; *Hülsenkopf* + pin of needle-like form, e.g., graves 528, 680; *Rollenkopf II* + pin of needle-like form, e.g., graves 347, 353; *Hülsenkopf* + *Kugelkopf* + pin of needle-like form, e.g., grave 633). In the youngest stage of the development of the funerary space, daggers and bronze chisels also enter the set of objects deposited in graves in greater numbers.

Interestingly, for the A2 period, which was very likely characterized by an increase in the available quantity of raw material, its wide acceptance and an expansion of the range of manufactured objects, no metallurgist's burial is known. It seems that not only the status of the new raw material, its availability and acceptance, but also the perception of metallurgists changed at that time. The cultural change which has been identified in the study of the absolute chronology of the cemetery is probably related to the development of new relations between the local community and other areas of Early Bronze Age Central

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

Europe. The increase in the number of burials equipped with Baltic amber beads[4], as well as the increase in the number of beads themselves used for making ornaments in the later stages of the cemetery development, may indicate the areas northwest of the NM (the area of western Slovakia, Moravia, Bohemia), as the starting point for new styles of bronze objects (*Hülsenkopf* and *Kugelkopf* pins) and succinite itself (Figure 8).

CONCLUSION

The presented results of radiocarbon dating analyses allowed the refinement of previous knowledge on the chronology of NM cemetery. A more complete knowledge of its development over time has made it possible to understand the specific spatial changes observed. Based on information related to the distribution of the most typologically diversified and chronologically sensitive artifacts, i.e., bronze pins, a pattern of development of the burial space at NM within three phases was determined: A1, A1/A2, and A2.

The observations made in the course of the radiocarbon dating analyses regarding the changing grave goods allowed us to address the wider issue of cultural change that the local community underwent during its development. This change was evident in the gradual transition from the world of the post-Neolithic tradition of equipping the dead in close relation to their gender and assigned social and economic roles to the world of the Bronze Age. The latter is understood as a stage of full acceptance of the new raw material along with the values, beliefs and package of cultural associations it entailed (Kadrow 2016:71). Characteristically, bronze, in light of the grave finds, was not used primarily as a raw material for the production of utilitarian objects, such as weapons and tools. Its main use was in the production of personal objects —ornaments representing new accepted media of self-identification.

The acceptance of bronze by the local community does not seem, in light of the available sources, to be the result of a technological imperative resulting from an appreciation, in the first place, of the better technical parameters of the metal (hardness, malleability, etc.). In principle, this can only be seen as the abandonment of the production of bone awls in favor of new ones made of bronze. The presented results and conclusions allow the indication again that some of the objects known from typologically earlier periods (A1) served also in later periods. The language of typology and relative chronology of the European Bronze Age, which has its roots in the findings of P. Reinecke, in fact does not always tell us a story about the straightforward and linear variation of objects over time (Stockhammer et al. 2015; Kadrow 2016). In fact, the typological changes observed were not sequential steps. They were more complex and multidimensional. Rather, in cases such as the cemetery in NM, typology framed by calendar age served to tell the story of a community remaining at different stages of grappling with the bronze innovation and the consequences of accepting it.

ACKNOWLEDGMENTS

This article was written in frames of grant no 2015/17/D/HS3/00704, financed by the National Science Centre (Poland) and grant no 2/0084/18, financed by Vedecká grantová agentúra (Slovakia). We would like to thank Anthony Harding (Exeter) and two anonymous

[4]Infrared (FTIR) spectral analyses showed that all of the NM amber beads analyzed were made from Baltic raw material (succinite) (unpublished results from the NCN project 2015/17/D/HS3/00704 led by M. Jaeger).

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press

reviewers for their comments on the earlier version of this paper. It is understood that all opinions and errors are ours.

REFERENCES

Bader T. 1998. Bemerkungen zur Bronzezeit im Karpatenbecken. Otomani/Füzesabony-Komplex. Überblick und Fragestellung. Jahresschrift für Mitteldeutsche Vorgeschichte 80:43-108. doi: 10.11588/jsmv.1998.1.83073.

Barceló JA, Capuzzo G, Bogdanović I. 2014. Modeling expansive phenomena in early complex societies: the transition from Bronze Iron Age in Prehistoric Europe. Journal of Archaeological Method and Theory 21:486–510. doi: 10.1007/s10816-013-9195-2.

Bronk Ramsey C, Higham T, Bowles A, Hedges REM. 2004. Improvements to the pretreatment of bone at Oxford. Radiocarbon 46(1):155–163. doi: 10.1017/S0033822200039473.

Bronk Ramsey C. 2017. Methods for summarizing radiocarbon datasets. Radiocarbon 59(2): 1809–1833. doi: 10.1017/RDC.2017.108.

Brunner M, von Felten J, Hinz M, Hafner A. 2020. Central European Early Bronze Age chronology revisited: A Bayesian examination of large-scale radiocarbon dating. PlosOne 15(12):e0243719. doi: 10.1371/journal.pone.0243719.

David W. 2002. Studien zu Ornamentik und Datierung der bronzezeitlichen Depotfundgruppe Hajdúsámson-Apa-Ighiel_Zajta I-II. Bibliotheca Musei Apulensis 18. Alba Iulia: Verlag ALTIP S. A.

Ernée M, Müller J, Rassmann K. 2009. Ausgrabung des frühbronzezeitlichen Gräberfelds der Aunjetitzer Kultur von Prag-Miškovice: Vorläufige Auswertung und erste Ergebnisse der naturwissenschaftlichen Untersuchungen. 14C-Daten und Metallanalysen. Germania: Anzeiger der Römisch-Germanischen Komission des Deutschen Archäologischen Instituts 87(2):355–410.

Fischl KP, Kienlin TL, editors. 2020. Beyond divides—the Otomani-Füzesabony phenomenon. Current approaches to settlement and burial in the north-eastern Carpathian Basin and adjacent areas. Universitätsforschungen zur prähistorischen Archäologie 345. Bonn: Dr. Rudolf Habelt GmbH.

Fischl KP, Olexa L. 2020. The settlement network of the Otomani-Füzesabony cultural complex in the southern Hornád Valley and the Košice Basin. In: Fischl KP, Kienlin TL, editors. Beyond divides—the Otomani-Füzesabony phenomenon. Current approaches to settlement and burial in the north-eastern Carpathian Basin and adjacent areas. Universitätsforschungen zur prähistorischen Archäologie 345. Bonn: Dr Rudolf Habelt GmbH. p. 121–142.

Gancarski J. 2002. Kultura Otomani-Füzesabony po północnej stronie Karpat. In: Gancarski J, editor. Między Mykenami a Bałtykiem. Kultura Otomani-Füzesabony. Krosno and Warszawa: Muzeum Podkarpackie w Krośnie. p. 103–124.

Horváthová E. 2011. Pohrebisko otomanskej kultúry v Seni. Študijné Zvesti Archeologického Ústavu Slovenskej akadémie vied 49:115–142.

Jaeger M, Olexa L. 2014. The metallurgists from Nižná Myšl'a. A contribution to the discussion on the Metallurgy in defensive settlements of the Otomani-Füzesabony culture. Archäologisches Korrespondenzblatt 44:163–176.

Jaeger M, Stróżyk M, Olexa L. Nováček T. 2021. Dating the ladies. Spatio-temporal development of the Early Bronze Age Cemetery at Nižná Myšľa (Slovakia). Documenta Praehistorica 48:340–353. doi: 10.4312/dp.48.21.

Jaeger M. 2016. Bronze Age fortified settlements in Central Europe. Studien zur Archäologie in Ostmitteleuropa/Studia nad Pradziejami Europy Środkowej 17. Poznań and Bonn: Wydawnictwo Nauka i Innowacje. In Kommision bei Dr. Rudolf Habelt GmbH.

Kadrow S. 2012. Źródła i mechanizmy zmiany kulturowej. Przypadek wczesnego eneolitu. In: Gediga B, Grossman A, Piotrowski W, editors. Rytm przemian kulturowych w pradziejach i średniowieczu. Biskupin and Wrocław. p. 233–259.

Kadrow S. 2016. About the chronology of the beginning of the metal ages. Analecta Archaeologica Ressoviensia 11:65–78. doi: 10.15584/anarres.2016.11.4.

Kadrow S, Machnik J. 1997. Kultura mierzanowicka. Chronologia, taksonomia i rozwój przestrzenny. Prace Komisji Archeologicznej 29. Kraków: Polska Akademia Nauk Oddział w Krakowie.

Kristiansen K, Larsson TB. 2005. The rise of the Bronze Age societies: travels, transmissions and transformations. Cambridge: Cambridge University Press.

Longin R. 1971. New method of collagen extraction for radiocarbon dating. Nature 230:241–242. doi: 10.1038/230241a0.

Madej P, Valde-Nowak P. 2020. Kultura mierzanowicka w Karpackim dorzeczu Wisły. Krosno: Muzeum Podkarpackie w Krośnie.

Mason DC, O'Conaill M, McKendrick I. 1994. Variable resolution block kriging using a hierarchical spatial data structure. International Journal of Geographical Information Systems 8(5):429–449. doi: 10.1080/02693799408902012.

Needham S, Bronk Ramsey C, Coombs D, Cartwright C, Pettitt PB. 1998. an independent chronology for British Bronze Age metalwork: the results of the Oxford Radiocarbon Accelerator Programme. Archaeological Journal 154(1):55–107. doi: 10.1080/00665983.1997.11078784.

Nováček T. 2017. Vyhodnotenie materiálu pohrebiska otomansko-füzesabonyského kultúrneho komplexu v Nižnej Myšli (hroby 1–792) [unpublished PhD thesis]. Brno: Masaryk University Brno.

Staniuk R. 2021. Early and Middle Bronze Age chronology of the Carpathian Basin revisited: questions answered or persistent challenges? Radiocarbon 63(5):1525–1546 doi: 10.1017/RDC.2021.83.

Olexa L. 1987. Gräber von metallgiessern in Nižna Myšľa. Archeologické Rozhledy 39(3): 255–257.

Olexa L. 2002. Cmentarzyska i ceremoniał pogrzebowy/Burial grounds and funeral ceremonies. In: Gancarski J, editor. Między Mykenami a Bałtykiem. Kultura Otomani-Füzesabony. Krosno and Warszawa: Muzeum Podkarpackie w Krośnie. p. 53–85.

Olexa L. 2003. Nižná Myšľa. Osada a pohrebisko z doby bronzovej. Košice: Archeologický ústav Slovenskej akadémie vied v Nitre.

Olexa L, Nováček T. 2013. Pohrebisko zo staršej doby bronzovej v Nižnej Myšli, Katalóg I (hroby 1–310). Nitra: Vydavateľstvo Slovenskej akadémie vied Bratislava.

Olexa L, Nováček T. 2015. Pohrebisko zo staršej doby bronzovej v Nižnej Myšli, Katalóg II (hroby 311–499). Nitra: Vydavateľstvo Slovenskej akadémie vied Bratislava.

Olexa L, Nováček T. 2017. Pohrebisko zo staršej doby bronzovej v Nižnej Myšli, Katalóg III (hroby 500–792). Nitra: Vydavateľstvo Slovenskej akadémie vied Bratislava.

Reimer P, Austin W, Bard E, Bayliss A, Blackwell P, Bronk Ramsey C, Butzin M, Cheng H, Edwards R, Friedrich M, Grootes P, Guilderson T, Hajdas I, Heaton T, Hogg A, Hughen K, Kromer B, Manning S, Muscheler R, Palmer J, Pearson C, van der Plicht J, Reimer R, Richards D, Scott E, Southon J, Turney C, Wacker L, Adolphi F, Büntgen U, Capano M, Fahrni S, Fogtmann-Schulz A, Friedrich R, Köhler P, Kudsk S, Miyake F, Olsen J, Reinig F, Sakamoto M, Sookdeo A, Talamo S. 2020. The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP). Radiocarbon 62:725–757. doi: 10.1017/RDC.2020.41.

Reinecke P. 1924. Zur chronologischen Gliederung der süddeutschen Bronzezeit. Germania: Anzeiger der Römisch-Germanischen Komission des Deutschen Archäologischen Instituts 8:43–44.

Stockhammer PW, Massy K, Knipper C, Friedrich R, Kromer B, Lindauer S, Radosavljević J, Wittenborn F, Krause J. 2015. Rewriting the Central European Early Bronze Age chronology: evidence from large-scale radiocarbon dating. PlosOne 10(10):e0139705. doi: 10.1371/journal.pone.0139705.

Thomas M. 2008. Studien zu Chronologie und Totenritual der Otomani-Füzesabony-Kultur. Saarbrücker Beiträge zur Altertumskunde 86. Bonn: Dr Rudolf Habelt GmbH.

Točík A. 1964. Opevnená osada z doby bronzovej vo Veselom. Archaeologica Slovaca Fontes 5. Bratislava: Vydavatel'stvo Slovenskej Akadémie Vied.

Tóth P, Oravkinová D, Pokutta D. 2019. Spatio-temporal data for modeling the settlement organisation and cultural change of the Otomani-Füzesabony cultural complex in Slovakia. Mendeley Data V1. doi: 10.17632/ts8bzptsv4.1.

Vandkilde H. 2014. Breakthrough of the Nordic Bronze Age: transcultural warriorhood and a Carpathian crossroad in the sixteenth century BC. European Journal of Archaeology 17(4): 602–633. doi: 10.1179/1461957114Y.0000000064.

https://doi.org/10.1017/RDC.2022.76 Published online by Cambridge University Press