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A MULTISCALAR APPROACH TO MODELING THE END OF THE NEOLITHIC ON THE GREAT HUNGARIAN PLAIN USING CALIBRATED RADIOCARBON DATES

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ABSTRACT. This article presents the results of a multiscalar analysis of 168 radiocarbon dates from Neolithic and Copper Age sites on the Great Hungarian Plain. We examined chronological patterns at different geographic scales to explore socioeconomic changes that occurred during the transition from the Neolithic to the Copper Age. The beginning and end of the Late Neolithic (5000–4500 cal BC) and Early Copper Age (4500–4000 cal BC) were modeled with ^{14}C dates calibrated with the CALIB 5.01 program and IntCal04 calibration curve. Our attempts to identify chronological subphases within these 500-yr-long periods were confounded by multiple intercepts in the calibration curve. The analysis indicated that terminal Late Neolithic (4700–4300 cal BC) and "transitional" Proto-Tiszapolgár occupations (4600–4250 cal BC) at tell sites were contemporary with initial Early Copper Age habitations (4450–4250 cal BC). Calibrated dates from small Early Copper Age settlements at Vésztő-Bikeri and Körösladány-Bikeri document changes in community and household organization that took place over several decades during the transition to the Copper Age. Bayesian analysis indicated that the small fortified sites were occupied contiguously in phases of 30–50 yr. The younger Körösladány-Bikeri site was established before the older Vésztő-Bikeri site was abandoned. When large nucleated Late Neolithic communities dispersed and established small Early Copper Age settlements, the pattern of vertical accretion that had created the Late Neolithic tells gave way to a pattern of horizontal settlement accretion at the smaller settlements.

INTRODUCTION: THE RADIOCARBON REVOLUTION CONTINUES

The "Radiocarbon Revolution" had a tremendous impact on our understanding of major events that affected the course of human social evolution across the globe, but especially within Europe (Renfrew 1973). New ^{14}C dating techniques forced prehistorians to reconsider the temporal and spatial relationships between different archaeological "cultures" and the timing and sequence of different events and processes. Our understanding of the beginning of agriculture in Europe was shaped by the analysis (and reanalysis) of calibrated ^{14}C dates that indicated a spread of farming from the southeast to the northwest between 8000 and 4000 cal BC (Ammerman and Cavalli-Sforza 1973; Thorpe 1996; Whittle 1996; Price 2000; Ammerman and Biagi 2003; Gkiasta et al. 2003; Robb and Miracle 2007). More recently, the development of accelerator mass spectrometry (AMS) techniques and innovative statistical methods, combined with the widespread availability of ^{14}C dating and the constant refinement of calibration curves, has allowed us to fine-tune the temporal and geographic contexts of the social relationships that existed between different cultural complexes.

The initial impact of the ^{14}C revolution was a major reworking of macroscale chronological frameworks spanning several millennia (with periods that were several centuries long) and regional cultural sequences covering hundreds of thousands of km^2 in southeast Europe. For example, Figure 1 depicts how calibrated ^{14}C dates shifted the Hungarian Copper Age from the 2nd and 3rd millennia BC back to the 4th and 5th millennia. Calibrated ^{14}C dates had a similar effect on the conventional Neolithic chronologies.

Our synthesis of 168 calibrated ^{14}C dates from Late Neolithic and Copper Age contexts on the Great Hungarian Plain demonstrates that these macroregional chronological periods (i.e. "Late Neolithic" and "Early Copper Age") are associated with several changes in material culture that are indicative

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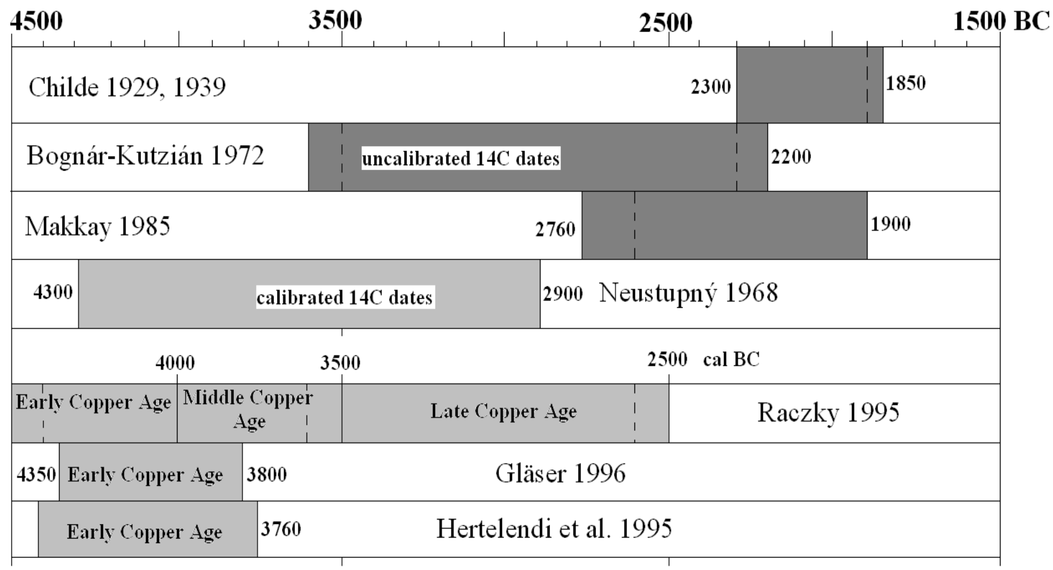

Figure 1 An example of how the "Radiocarbon Revolution" moved the Hungarian Copper Age from the 2nd and 3rd millennia BC back to the 4th and 5th millennia. The top 3 timeframes (dark shading) are based on correlations with historic records, stratigraphic sequences (e.g. the Tărtăria tablets, the sequence at Troy), and uncalibrated ^{14}C dates. The lower 4 chronologies (light shading) are based on calibrated ^{14}C dates. Calibrating ^{14}C dates had a similar effect on the Neolithic chronology. The most recent chronological frameworks, based on summed probabilities of calibrated ^{14}C dates at 1 σ, estimate the span of the Early Copper Age as 4500/4400–4000 cal BC (Raczky 1995), 4350–3800 cal BC (Gläser 1996), or 4410–3760 cal BC (Hertelendi et al. 1995).

of social changes that occurred throughout the eastern Carpathian Basin during the early 5th millennium BC. But more detailed analyses of these macroregional patterns at the regional and microregional (local) scales reveal more subtle processes that lasted decades (not centuries) and involved local groups of agriculturalists that lived in river drainage systems covering hundreds (not tens of thousands) of km^2 within the Great Hungarian Plain. By examining patterns at these different geographic and temporal scales, both long- and short-term patterns in settlement organization and landscape use can be documented. This, in turn, helps us better understand—in very explicit terms—how the transition from the Neolithic to the Copper Age actually took place.

A MULTISCALAR APPROACH TO THE NEOLITHIC-COPPER AGE TRANSITION

Our methodology in exploring the various changes that occurred at the end of the Neolithic builds upon other successful studies that integrate multiple scales of analysis (e.g. Neitzel 1999; Fowles 2002; Knapp 2002; Parkinson 2006a,b). We concentrate on 3 geographic and social scales: 1) the macroregional scale, which corresponds to the entirety of the Great Hungarian Plain, or *Nagy Alföld*, an area of approximately 52,000 km^2 in the eastern Carpathian Basin; 2) the regional scale, which corresponds to the eastern portion of the Körös-Berettyó river system in Békés County, Hungary, an area of ~2500 km^2 on the southeastern part of the Great Hungarian Plain; and 3) the microregional scale, which corresponds to 3 sites located on 1 branch of this river system, the Holt Sebes Körös near the modern town of Vésztő.

We also differentiate long-term temporal patterns on the order of several centuries or millennia from shorter patterns that span several generations. We assume that the ancient cultural processes in which we are interested were working simultaneously at the different geographic and temporal scales. Nevertheless, we have found it helpful to adopt an approach that examines related processes at different temporal and geographic scales because the information gained from examining 1 scale can be used to help interpret patterning at the other scales.

The macroregion we discuss includes the entirety of the Great Hungarian Plain in the eastern Carpathian Basin, a homogeneous, geographically discrete region encompassed by the floodplain of the Tisza River on the north, the sandy interfluve between the Danube and the Tisza rivers on the west, the floodplain of the Máros River on the south, and the Transylvanian foothills of the Carpathian Mountains on the east.

Our regional study area is the eastern portion of the Körös-Berettyó river system within the Great Hungarian Plain. This alluvial basin is almost perfectly flat, with elevations 83–102 m asl. Prior to the 19th century, a very complex river system with permanent and seasonal rivers and streams flowed through the region. The 3 branches of the Körös River, and the Berettyó River, still flow west from the Carpathian Mountains and merge before draining into the Tisza, which flows south to join the Danube (Figure 2). The Körös River system was the main west-east corridor throughout prehistory that linked the Great Hungarian Plain with the metal and lithic resources of Transylvania. Large marshlands fed by intermittent floods from the Berettyó and the Körös rivers also covered much of the Körös flatlands, inundating lower areas for weeks or even months.

Our microregional analysis focuses on 3 settlements located near the modern town of Vésztő along the Holt Sebes Körös River. These include the multicomponent tell site of Vésztő-Mágor, as well as the sites of Vésztő-Bikeri and Körösladány-Bikeri, 2 smaller fortified villages that have substantial Early Copper Age occupation layers (Figure 3).

Archaeological sites dating from the Early Neolithic to the end of the Middle Ages tend to be found almost exclusively at higher elevations in the Körös region, on low ridges stretching along the riverbanks and on the "islands" in the flooded marshlands. Late Neolithic farming groups established a complex settlement system centered on tells, which were inhabited for several centuries, and "flat" settlements, which were occupied for shorter intervals (Makkay 1982; Kalicz and Raczky 1987a; Raczky and Anders 2008). Late Neolithic material culture assemblages are characterized by increasing regionalization, which is exhibited in ceramic assemblage variability, trade networks, settlement organization, settlement patterns, and subsistence practices (Parkinson 2006a). Following the initial phase of the Late Neolithic (Tisza I/II, see Raczky 1992; Lichardus and Lichardus-Itten 1996; Horváth 2000), this regionalization resulted in the emergence of discrete archaeological "cultures" known as the Tisza-Herpály-Csőszhalom complex, roughly contemporary with Lengyel I–II cultures in Transdanubia and northern Hungary, the Iclod group and the Petreşti culture in Transylvania, and the Vinča B2-D2 phases in the northern Balkans (Bánffy 2007; Gläser 1996; Hertelendi et al. 1998a; Kalicz and Raczky 1987a:25–27; Raczky 1988, in press; Raczky and Anders 2008). Several scholars have identified a transitional period from the Late Neolithic to the Copper Age known as the Proto-Tiszapolgár phase (see Appendices 1 and 2). Artifacts associated with this phase have been recovered at sites across the Great Hungarian Plain (and beyond) and in the uppermost levels of several Late Neolithic tells (Lichardus and Vladár 1964; Šiška 1968; Horváth 1985, 2005; Kalicz and Raczky 1987a,b), but the phase remains poorly defined (Parkinson 2006a:50–1).

Many systematic excavations have been carried out on Late Neolithic tells and flat sites over the last 30 yr, but the succeeding Early Copper Age has received considerably less attention. The beginning of the Copper Age is marked by a gradual homogenization in ceramic style in the territory of the Tisza-Herpály-Csőszhalom complex as most tells and large flat settlements were abandoned. The

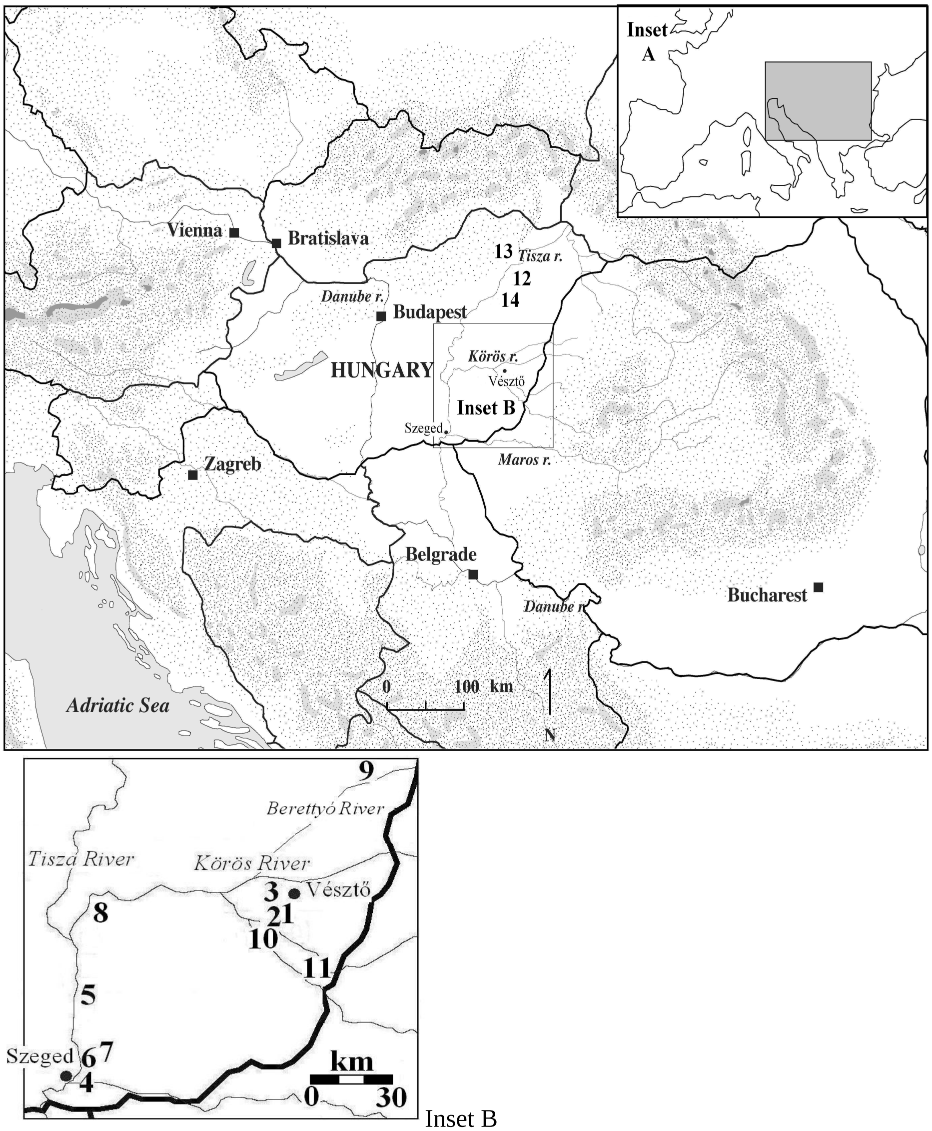

Figure 2 Map of the Great Hungarian Plain in the Carpathian Basin in southeast Europe (macroregion, see Inset A). The eastern part of the Körös-Berettyó river system is shown in Inset B. The Holt Sebes Körös River microregion is just west of the town of Vésztő, Hungary. Locations of sites discussed in this study (on Inset B): 1.Vésztő-Bikeri; 2. Körösladány-Bikeri; 3. Vésztő-Mágor; 4. Tápé-Lebő-A; 5. Szegvár-Tűzköves; 6. Hódmezővásárhely-Kökénydomb; 7. Hódmezővásárhely-Gorzsa; 8. Öcsöd-Kováshalom; 9. Berettyóújfalu-Herpály; 10. Bélmegyer-Mondoki domb; 11. Méhkerék 23; (on large map): 12. Polgár-Csőszhalom; 13. Tiszalúc-Sarkad; 14. Tiszapolgár-Basatanya.

Early Copper Age Tiszapolgár culture extended from the Banat in northern Serbia and southwestern Romania, across the entire Hungarian Plain, into the foothills of Transylvania and the mountains of eastern Slovakia (Bognár-Kutzián 1972). Although there were many cultural links between Late Neolithic and Early Copper Age groups, the end of the Neolithic also was marked by dramatic changes in social organization, technology, economy, house form, site layout, settlement distribution, and mortuary customs (Parkinson 2002:391–4). Similar changes occurred at this time across

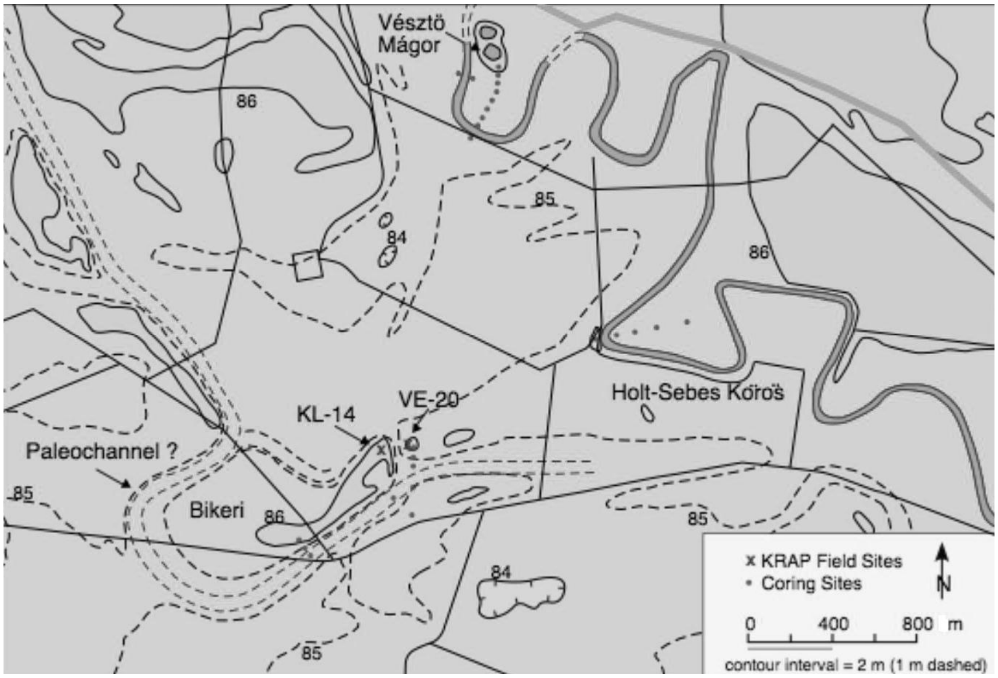

Figure 3 Locations of the Early Copper Age Vésztő-Bikeri (VE-20) and Körösladány-Bikeri (KL-14) sites and the Vésztő-Mágor tell in the Holt Sebes Körös River microregion (after Frolking 2004).

much of southeast Europe as populations dispersed to smaller sites and abandoned larger villages and tells (Demoule and Perlès 1993). On the Great Hungarian Plain, this transition affected many aspects of social organization—from households and villages to regional settlement systems. In contrast to previous researchers, who attributed the changes at the end of the Neolithic to the emigration of Indo-European speakers into the region (Childe 1939; Gimbutas 1997), most scholars now associate these changes with indigenous social processes (Bognár-Kutzián 1963, 1972; Bökönyi 1974, 1986; Makkay 1982; Kaiser and Voytek 1983; Siklódi 1983; Kalicz 1988; Bánffy 1994; Raczky 1995; Horváth 2005; Parkinson 2006a,b).

RADIOCARBON DATES AND CHRONOLOGY IN THE CARPATHIAN BASIN

An absolute chronology based on ^{14}C age determinations was not immediately accepted in southeast Europe, where most scholars were committed to typochronological approaches based primarily on ceramic seriations. During the 1960s and 1970s, Hungarian archaeologists used ^{14}C dates to help refine these conventional Neolithic and Copper Age typochronologies (Bognár-Kutzián 1963, 1972; Kalicz 1970). When the first ^{14}C samples were run by labs in Berlin and Groningen (Kohl and Quitta 1964, 1966; Vogel and Waterbolk 1963), the differences between the uncalibrated ^{14}C dates and the traditional absolute chronologies were so significant that some rejected all ^{14}C dates as inaccurate and unreliable (Hertelendi et al. 1995:239). Some scholars still contend that ^{14}C samples are only useful for dating much more recent events (e.g. Makkay 2007:217–30). Despite some resistance, when Hungarian dates (and other ^{14}C dates from Europe) were *calibrated* and analyzed by Neustupný (1968, 1970) and Renfrew (1970, 1973) it became clear that the traditional typochronologies were woefully inaccurate. The calibrated dates suggested that Neolithic and Copper Age cultures on the Great Hungarian Plain did not form neat, short, chronological sequences, but overlapped considerably (Hertelendi et al. 1995).

In the mid-1990s, 268 calibrated ^{14}C dates from Early Neolithic (n = 28), Middle Neolithic (n = 47), Late Neolithic (n = 185), and Copper Age (n = 8) contexts were used to refine conventional chronologies and to establish absolute temporal sequences for 4 stratified Late Neolithic tells on the Plain (Hertelendi and Horváth 1992; Hertelendi et al. 1995, 1998a,b; Horváth and Hertelendi 1994). Hertelendi and his colleagues used the CALIB 3.0.3 calibration program (Stuiver and Reimer 1993) on each group of dates and calculated the cumulative probability distributions at 1-σ (68.3%) confidence intervals to estimate the timespan for each period and for Neolithic and Copper Age levels within tell sequences. This data set formed the basic absolute chronology for the region, and has been essential for refining models of social organization and interaction, especially during the Late Neolithic (e.g. Kalicz and Raczky 1987a; Raczky and Anders 2008; Raczky, in press). But the lack of absolute dates from systematically excavated Early Copper Age settlement contexts impeded our understanding of the various social changes that occurred at the end of the Neolithic, when most of the tells on the Great Hungarian Plain were abandoned.

For this study, we synthesized 168 conventional ^{14}C dates from Late Neolithic (64%), Early Copper Age (28%), and Middle Copper Age (8%) contexts. We added 32 new ^{14}C samples from 2 Early Copper Age settlements in the Vésztő microregion[4] to the database that had been compiled by Ede Hertelendi and his colleagues[5] (Appendix 1). Using the CALIB 5.01 program (Stuiver and Reimer 1993) and the IntCal04 calibration curve (Reimer et al. 2004; Blackwell et al. 2006), we calibrated the new Copper Age dates and recalibrated conventional dates that had been analyzed using the IntCal98 curve (Appendix 2). We also employed Bayesian statistical methods of analysis that are included in the BCal (Buck et al. 1999) and OxCal 4 (Bronk Ramsey 1995, 2001)[6] programs to obtain higher resolution for dates and phases. The main advantage of the Bayesian approach is that it permits us to test the reliability of temporal frameworks independently of typochronologies, thus providing a more objective basis for comparing individual sequences from different sites (see Buck 1999, 2001).

Bayesian analysis is based on Bayes' theorem, which has 3 related components (where = means "is proportional to"):

$$\textit{posterior} = \textit{likelihood} \times \textit{prior}$$

The *likelihood* is a statement about the probability of obtaining specific data values given specific information about some parameters of the explanatory model. It can be denoted as $P(y|\theta)$, where P is probability and y is data that has been collected and θ are parameters of the model, and | is read as "given." It is a formal statement of the relationship between what is to be learned and the data that is collected. The *prior*, $P(\theta)$, is a formal statement of what was known before the latest data were collected. The *posterior* is what is to be learned, $P(\theta|y)$, a combination of the information contained in the data, the model, and the prior. It is the probability attached to specified values of the unknown parameters of the model given all of the observations. The posterior can be obtained by multiplying the likelihood by the prior and then normalizing the results so that the probabilities add up to 1

[4]See Gyucha et al. 2004, 2006; Parkinson et al. 2002, 2004a,b; Sarris et al. 2004; Yerkes et al. 2007 for details on investigations by the Körös Regional Archaeological Project (KRAP).

[5]We obtained a list of these dates from Éva Svingor of the Institute of Nuclear Research of the Hungarian Academy of Sciences at Debrecen. See Bognár-Kutzián 1985; Bognár-Kutzián and Csongor 1987; Hertelendi and Horváth 1992; Hertelendi et al. 1995, 1998a,b; Horváth and Hertelendi 1994; Kalicz 1985; Kalicz and Raczky 1987a for previously published dates on this list and summaries of their analyses.

[6]Webpages: http://bcal.sheffield.ac.uk and http://c14.arch.ox.ac.uk/embed.php?File=oxcal.html; also see Buck 1999, 2001 and other references on the webpages for details about the methods of Bayesian analyses.

(Zeidler et al. 1998:168–9; Buck 1999, 2001). The problem with calculating probabilities of this form is that they are multidimensional. For this reason, Markov chain Monte Carlo is used to obtain a representative sample of possible solutions for the posterior (Bronk Ramsey 1995, 2001).

We separated the dates in our data sets using stratigraphic information from excavations at the tells and flat sites (see Appendices 1 and 2), but did not assign any *a priori* dates to the beginning and ending of the cultural periods or phases. We tried to use groups of related dates to refine time ranges for occupation layers within tells and for occupation episodes at flat sites using these techniques, but our efforts were confounded by multiple intercepts in the calibration curve during the 5th millennium BC (Blackwell et al. 2006:411).

MACROREGIONAL AND LONG-TERM PATTERNS: DATING THE END OF THE NEOLITHIC PERIOD ACROSS THE GREAT HUNGARIAN PLAIN

Our recalibration of the 136 published ^{14}C dates from several Late Neolithic and Copper Age sites using the CALIB 5.01 program and the IntCal04 calibration curve (Figure 4) reinforces the absolute chronology established by Hertelendi and his colleagues in the 1990s. The summed probabilities for 107 Late Neolithic dates range from 5021–4402 cal BC (1 σ, Figure 4). When 4 Proto-Tiszapolgár phase dates are excluded, the summed probabilities for the remaining 103 Late Neolithic dates are nearly identical (5025–4450 cal BC). These results support the currently accepted timespan for the Late Neolithic on the Great Hungarian Plain: about 5000–4500 cal BC (Raczky 1988, 1992, in press; Parkinson 2006a). The summed probabilities for 39 dates from 4 early Tisza phase sites range between 5216 and 4856 cal BC.[7] This 360-yr interval is very close to the 400-yr span (5120–4710 cal BC, 1 σ) that Hertelendi et al. (1995:242) established for the early Tisza transitional formation using the CALIB 3.03 program. The oldest dates from the early Tisza levels at these sites overlap with the Middle Neolithic period (5330–4940 cal BC) and are contemporary with calibrated dates from other Linear Pottery (AVK) sites elsewhere on the Great Hungarian Plain (Raczky, in press). Summed probabilities (1 σ) for 29 dates from 3 Tisza sites are 4893–4497 cal BC. The results for 8 dates from Csőszhalom contexts at 3 Late Neolithic sites are 4942–4374 cal BC, while the summed probabilities for 27 samples from 3 Herpály sites, including 3 Proto-Tiszapolgár phase dates, are 4717–4455 cal BC. When the 3 Proto-Tiszapolgár phase dates are excluded, the range for the Herpály sites is reduced to 4721–4452 cal BC.

Most of the dates for Late Neolithic contexts in our sample came from a few multicomponent tell sites.[8] The summed probabilities of the dates from these sites suggest that they were occupied for 300–350 yr, or about 10 generations (Figure 5). This is close to the 285-yr average that Hertelendi et al. (1998b:664) calculated for the Öcsöd-Kováshalom, Polgár-Csőszhalom, Hódmezővásárhely-Gorzsa, and Berettyóújfalu-Herpály tells. Unfortunately, the multiple intercepts and plateaus on the calibration curve, the margin of error of the ^{14}C measurements, and the possibility of mixed depositional contexts make it difficult to reduce the date ranges from the individual tell levels to generations rather than centuries (see Appendix 2). For example, Hertelendi et al. (1998a,b) estimated that the timespan for 3 stratigraphic levels (Levels 1–3) at Polgár-Csőszhalom ranged from 151–265 yr for each level, while the span of the entire tell sequence was 280 yr. At Berettyóújfalu-Herpály,

[7]These samples included 17 dates from Tápé-Lebő-A (5300–4729 cal BC), 10 dates from Hódmezővásárhely-Kökénydomb (5205–4617 cal BC), 8 dates from Szegvár-Tűzköves (5214–4618 cal BC), and 4 dates from levels 3 and 4 at Vésztő-Mágor (5222–4798 cal BC).

[8]For the Tisza culture, 26 of the 29 dates (90%) came from Hódmezővásárhely-Gorzsa tell, 6 of the 8 dates (75%) for the Csőszhalom culture came from Polgár-Csőszhalom, and 25 of the 27 dates (93%) from the Herpály culture sites came from Berettyóújfalu-Herpály.

Hertelendi and his colleagues found that the time ranges for tell levels 5 through 9 varied from 215–376 yr, while the average for the entire Late Neolithic sequence at the tell was 280 yr. We had hoped that the new calibration curve would help resolve these discrepancies, but it did not.

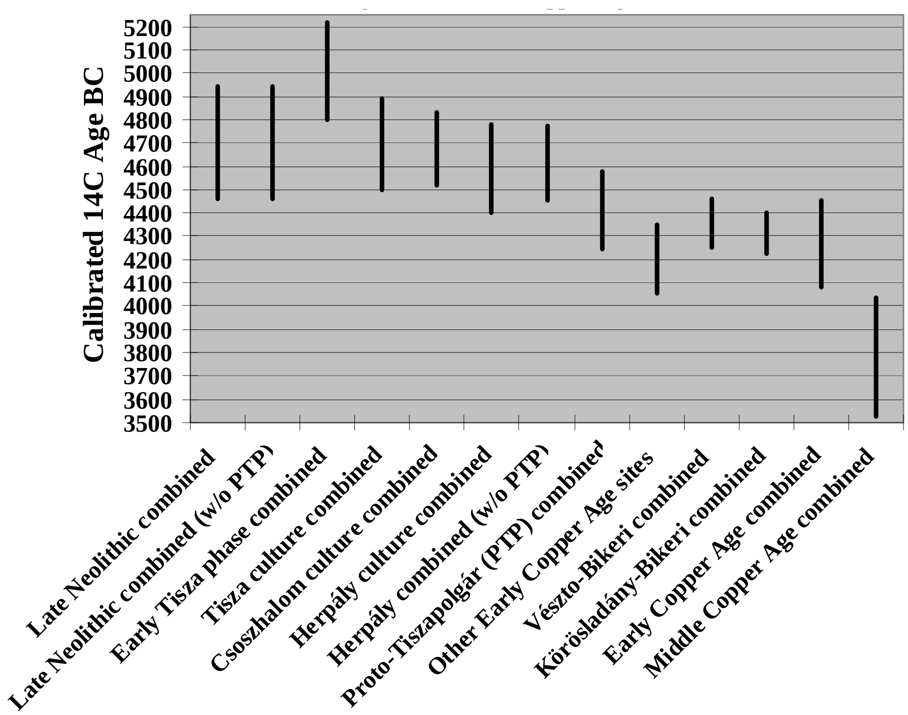

Figure 4 Summed probabilities at the 68.3% (1 σ) confidence interval for calibrated ^{14}C dates from Late Neolithic and Copper Age sites in the macroregion. The CALIB 5.01 program and IntCal04 curve were used. The summed probabilities for all 107 Late Neolithic (combined) samples are 5021–4402 cal BC. The summed probabilities for 103 Late Neolithic samples without (w/o) the 4 Proto-Tiszapolgár phase dates are nearly the same: 5025–4450 cal BC. The results for 39 early Tisza phase (combined) samples from Tápé-Lebő-A (17), Hódmezővásárhely-Kökénydomb (10), Szegvár-Tűzköves (8), and Vésztő-Mágor (Late Neolithic levels 3 and 4, four samples) are 5216–4856 cal BC. The results for 29 samples from Tisza culture (combined) sites at Hódmezővásárhely-Gorzsa (26), Kisköre-Gát (2) and Deszk-Ordos (1) are 4893–4497 cal BC. The summed probabilities (1 σ) for 8 Csőszhalom culture (combined) samples from Polgár-Csőszhalom (6), Bodrogzsadány-Akasztószer (1), and the Tiszapolgár-Basatanya cemetery (1) are 4942–4374 cal BC. The results for 27 Herpály culture (combined) samples from Berettyóújfalu-Herpály (25 samples, including 3 Proto-Tiszapolgár phase dates), Berettyóújfalu-Szilhalom (1), and Esztár-Fenyvespart (1) are 4717–4455 cal BC. Without the 3 Proto-Tiszapolgár phase dates (w/o PTP), the summed probabilities (1 σ) are 4721–4452 cal BC. When the 3 Proto-Tiszapolgár phase samples from the Berettyóújfalu-Herpály tell are combined with the Proto-Tiszapolgár phase sample from Deszk-Vénó the results are 4579–4243 cal BC. Summed probabilities for 15 other Early Copper Age samples from Tiszapolgár-Basatanya (6), Bélmegyer-Mondoki domb (1), Méhkerék 23 (1), Vésztő-Mágor (1), Tiszapolgár (1), and Hajdúböszörmény-Ficsori-tó-dűlő cemetery (5) are 4348–4052 cal BC (samples from Vésztő-Bikeri and Körösladány-Bikeri are not included). The results for 22 (combined) Early Copper Age samples from Vésztő-Bikeri are 4459–4253 cal BC, and the summed probabilities for 10 (combined) Early Copper Age samples from Körösladány-Bikeri site are 4401–4227 cal BC. The results for all 47 (combined) Early Copper Age samples are 4455–4079 cal BC. The combined results for 14 Middle Copper Age samples from Tiszapolgár-Basatanya (Bodrogkeresztúr Culture, 10 samples) and Tiszalúc-Sarkad (Hunyadihalom culture, 4 samples) are 4037–3523 cal BC. See Table 2 for summed probabilities for individual samples and sites. Most dates for the Late Neolithic Tisza-Csőszhalom-Herpály complex are from tells at Hódmezővásárhely-Gorzsa, Polgár-Csőszhalom, and Berettyóújfalu-Herpály.

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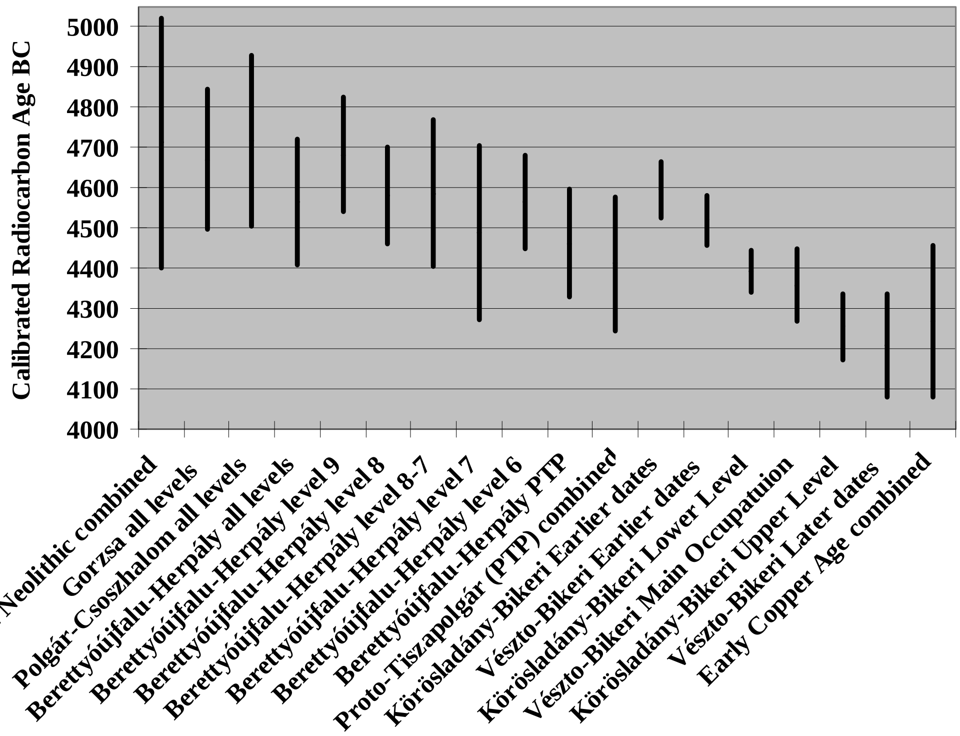

Figure 5 Summed probabilities at the 68.3% (1 σ) confidence interval for calibrated ^{14}C dates for all 107 Late Neolithic samples, from Late Neolithic tells at Hódmezővásárhely-Gorzsa (Gorzsa) and Polgár-Csőszhalom, and Proto-Tiszapolgár Levels at Berettyóújfalu-Herpály, occupation phases and earlier dates at the Early Copper Age Vésztő-Bikeri and Körösladány-Bikeri sites in the microregion, and the 47 Early Copper Age dates combined. The CALIB 5.01 program and IntCal04 curve were used. The summed probabilities (1 σ) for 107 Late Neolithic samples: 5021–4402 cal BC; for 26 samples from Hódmezővásárhely-Gorzsa (Gorzsa): 4846–4495 cal BC; for 6 samples from Polgár-Csőszhalom: 4942–4374 cal BC. Sample sizes and 1-σ ranges for the levels at Berettyóújfalu-Herpály are: All levels (including Proto-Tiszapolgár): 4720–4407 cal BC (27 samples); Level 9: 4825–4541 cal BC (3 samples); Level 8: 4702–4462 cal BC (8 samples); Levels 8–7: 4769–4403 cal BC (4 samples); Level 7: 4705–4273 cal BC (5 samples); Level 6: 4682–4449 cal BC (5 samples); Proto-Tiszapolgár levels (5 and 6–5): 4596–4328 cal BC (3 samples). Two earlier (older) dates from Körösladány-Bikeri: 4666–4526 cal BC; 3 earlier dates from Vésztő-Bikeri: 4582–4456 cal BC; 2 dates from the lower level (first occupation phase) at Körösladány-Bikeri: 4445–4341 cal BC; 15 dates from the main occupation phase at Vésztő-Bikeri: 4448–4269 cal BC; 6 dates from the upper level (second occupation phase) at Körösladány-Bikeri: 4336–4173 cal BC; 4 later (younger) dates from Vésztő-Bikeri: 4335–4079 cal BC; and the 47 combined Early Copper Age dates: 4455–4079 cal BC.

We recalibrated the published dates from Berettyóújfalu-Herpály (Appendices 1 and 2). The ranges for the summed probabilities were 284 yr for Level 9, 240 yr for Level 8, 366 yr for Levels 8–7, 432 yr for Level 7, and 233 yr for Level 6, while the summed probabilities for all of the Late Neolithic levels at Berettyóújfalu-Herpály spanned a 313-yr interval from 4720–4407 cal BC (Figure 5).

We also recalibrated 3 dates associated with Proto-Tiszapolgár contexts (Levels 5 and 6) at Berettyóújfalu-Herpály (Figure 5). The summed probabilities (1 σ) for these recalibrated dates (Appendix 2) spanned a 268-yr interval of 4596–4328 cal BC, which is only slightly younger than the 372-yr interval for the entire Berettyóújfalu-Herpály tell (4720–4407 cal BC, 1 σ). We combined these 3 dates with a single Proto-Tiszapolgár context date from the site of Deszk-Vénó (Figure 4, Appendices 1 and 2). The summed probabilities for these 4 Proto-Tiszapolgár dates produced a 336-yr interval of 4579–4243 cal BC (1 σ), which is very close to the span of 4570–4270 cal BC that Hertelendi et al. (1995) estimated for the Proto-Tiszapolgár phase. A recent ^{14}C date from an eastern Slovakian Proto-Tiszapolgár site (4607 ± 55 cal BC, Kaminská 2007) is slightly earlier than this time interval. This small collection of calibrated ^{14}C dates would place the Proto-Tiszapolgár phase (about 4600–4250 cal BC) in an overlapping position between the Tisza-Herpály-Csőszhalom complex (about 4900–4450 cal BC) and the span of the Early Copper Age (about 4400/4500–4000 cal BC).

The extent and duration of the Proto-Tiszapolgár phase is not the same in all parts of the Great Hungarian Plain. In Slovakia, the term Proto-Tiszapolgár is used to refer to settlements that can be distinguished from Late Neolithic and Early Copper Age sites (e.g. Kaminská 2007; Šiška 1968). At the center of the plain, Proto-Tiszapolgár levels are often found on the top of Neolithic tells. These upper levels contain Tiszapolgár-like ceramic assemblages that include dark, lightly burnished, vessels decorated with lugs (see Kalicz and Raczky 1987b:125; Horváth 1987:42). Proto-Tiszapolgár contexts at tell sites such as Berettyóújfalu-Herpály (4596–4328 cal BC) are contemporary with initial Early Copper Age Tiszapolgár culture occupations at settlements such as Vésztő-Bikeri and Körösladány-Bikeri (4459–4227 cal BC), which are located only a few dozen km away (Figure 2). These dates also provide temporal contexts for the process of settlement establishment and abandonment between those 2 adjacent Early Copper Age sites and the Vésztő-Mágor tell, located 2 km to the north (Hegedűs and Makkay 1987; see Figures 2 and 3).

By comparing these macroregional patterns with regional and microscalar trends, we can identify how the cultural processes that differentiated the Neolithic from the Copper Age played out at these more intimate social scales.

REGIONAL SHORT-TERM PATTERNS: THE TRANSITION TO THE COPPER AGE IN THE KÖRÖS-BERETTYÓ REGION

These broader temporal and geographic sequences are further enhanced by additional dates from new excavations that help clarify the chronological position of the Early Copper Age. In their calculations, Hertelendi et al. (1995) and Gläser (1996) used 8 dates to establish the interval of the Early Copper Age on the Great Hungarian Plain. Six of those Early Copper Age dates were from the early phase at the Tiszapolgár-Basatanya cemetery, 1 date was from Bélmegyer-Mondoki domb, and another was from the Méhkerék 23 site (Appendix 1). Hertelendi et al. (1995:242) proposed a 4410–3760 cal BC timespan for the period, while Gläser (1996) used OxCal v 2.13 to put the Early Copper Age between 4450 and 3800 cal BC (Figure 1).

We used the CALIB 5.01 program to recalibrate these 8 published Early Copper Age ^{14}C dates, and added 2 new dates from Tiszapolgár levels at Vésztő-Mágor, an unpublished date from "Tiszapolgár" (possibly from Tiszapolgár-Basatanya) and 5 new dates from the Hajdúböszörmény-Ficsori-tó-dűlő cemetery (Kovács and Váczi 2007; see Appendices 1 and 2). The summed probabilities for these 15 Early Copper Age samples (1 σ) produced a shorter 296-yr span of 4348–4052 cal BC that did not overlap the recalibrated Late Neolithic dates, but did overlap the Proto-Tiszapolgár dates (Figure 4). These new Tiszapolgár dates push the end of the Early Copper Age back 200 yr to ~4000 cal BC, which is more in line with the currently accepted dates for the Early Copper Age (4500/4400–4000 cal BC, with a Proto-Tiszapolgár phase of 4500–4400 cal BC between it and the Late Neolithic period of 5000–4500 cal BC, see Figure 1, Parkinson 2006a; Raczky 1995).

When we used CALIB 5.01 to calibrate samples collected during our own excavations at 2 other settlements in the Vésztő microregion, the estimated beginning of the Early Copper Age was pushed back to 4460 cal BC. These include 22 new dates from Vésztő-Bikeri and 10 new dates from Körösladány-Bikeri (Appendices 1 and 2). The summed probabilities (1 σ) for all 22 dates from Vésztő-Bikeri range from 4459–4253 cal BC, while the summed probabilities (1 σ) for the 10 dates from Körösladány-Bikeri were 4401–4227 cal BC (Figure 4). These dates fall at the very beginning of the time interval that Hertelendi et al. (1995) calculated for the Early Copper Age period (4410–3760 cal BC). Although they do not overlap the timespan for the summed probabilities (1 σ) for the Late Neolithic Tisza and Csőszhalom cultures, they do overlap with dates for the Herpály culture and are contemporary with much of the Proto-Tiszapolgár phase at the Berettyóújfalu-Herpály tell and the Deszk-Vénó site (Figure 4). The 2 Early Copper settlements in the Vésztő microregion were established not long after the end of the 10-generation-long Late Neolithic occupation sequences at the major tells of the Tisza-Herpály-Csőszhalom complex, and were contemporary with the final Late Neolithic and Proto-Tiszapolgár occupation phases at the Berettyóújfalu-Herpály tell.

The summed probability (1 σ) range for all 47 recalibrated early Copper Age dates in our database (22 from Vésztő-Bikeri, 10 from Körösladány-Bikeri, and 15 from Tiszapolgár contexts at other sites) is 4455–4079 cal BC (Figure 4), putting the Tiszapolgár timespan back in an interval that matches the position of the Early Copper Age in the revised chronology for the Great Hungarian Plain (4500/4400–4000 cal BC; see Raczky 1995), and no longer overlapping the timespan for the Middle Copper Age (4000–3500/3400 cal BC).

These recalibrated ^{14}C dates do not show as much overlap between the Late Neolithic, Early Copper Age, and Middle Copper Age as the earlier chronologies (Forenbaher 1993; Hertelendi et al. 1995; Gläser 1996), but there is significant continuity in material culture and social organization between the Late Neolithic, Early Copper Age, and Middle Copper Age on the plain. Based on these results, we suggest that the transition to the Early Copper Age took several centuries and began ~4550 cal BC at the end of the Late Neolithic period. Our investigations at 2 small Early Copper Age settlements in the Vésztő microregion, and the calibrated dates from those sites, indicate that changes in house size, burial practices, exchange patterns, and settlement organization during the Early Copper Age were more rapid, and spanned only a few generations (rather than centuries) in the Körös region.

MICROREGIONAL AND SHORT-TERM PATTERNS: THE BEGINNING OF THE COPPER AGE IN THE VÉSZTŐ MICROREGION

To place these regional patterns in perspective, it is helpful to see how the changes that characterize the end of the Neolithic played out at adjacent sites that were inhabited by related social units within a specific locality. To this end, we discuss the results of our analysis of 3 settlements within the Vésztő microregion: Vésztő-Bikeri and Körösladány-Bikeri (which are located only 70 m apart) and the well-known Vésztő-Mágor tell (which is just 2 km to the north, see Figure 3 and Hegedűs and Makkay 1987).

Results of a t test showed that the 22 calibrated ^{14}C dates from the Early Copper Age Tiszapolgár culture site of Vésztő-Bikeri are statistically different at the 95% level ($t = 105.81$, which is larger than the critical value of $t = 32.7$, at the 0.05 level when $df = 21$). The t test results for the 10 calibrated ^{14}C dates from the nearby ECA Tiszapolgár culture site of Körösladány-Bikeri also showed that the dates are statistically different at the 95% level ($t = 102.37$, critical value = 16.9, $df = 9$, 0.05 level). The ^{14}C samples from these sites were taken from several different depositional contexts, but most of the dates were from the fill of pits, wells, house wall trenches, and the circular palisades and ditches that surround the sites. As a result, most of the samples correspond to the end of the occupation episodes at the sites when the inhabitants were filling in and covering over features. At Vésztő-Bikeri, only 2 samples may be associated with activities that took place before the site was abandoned (Figure 6). Similarly, all of the ^{14}C samples from Körösladány-Bikeri derived from the fill of large bell-shaped storage/refuse pits, wall trenches, and ditches (Figure 7).

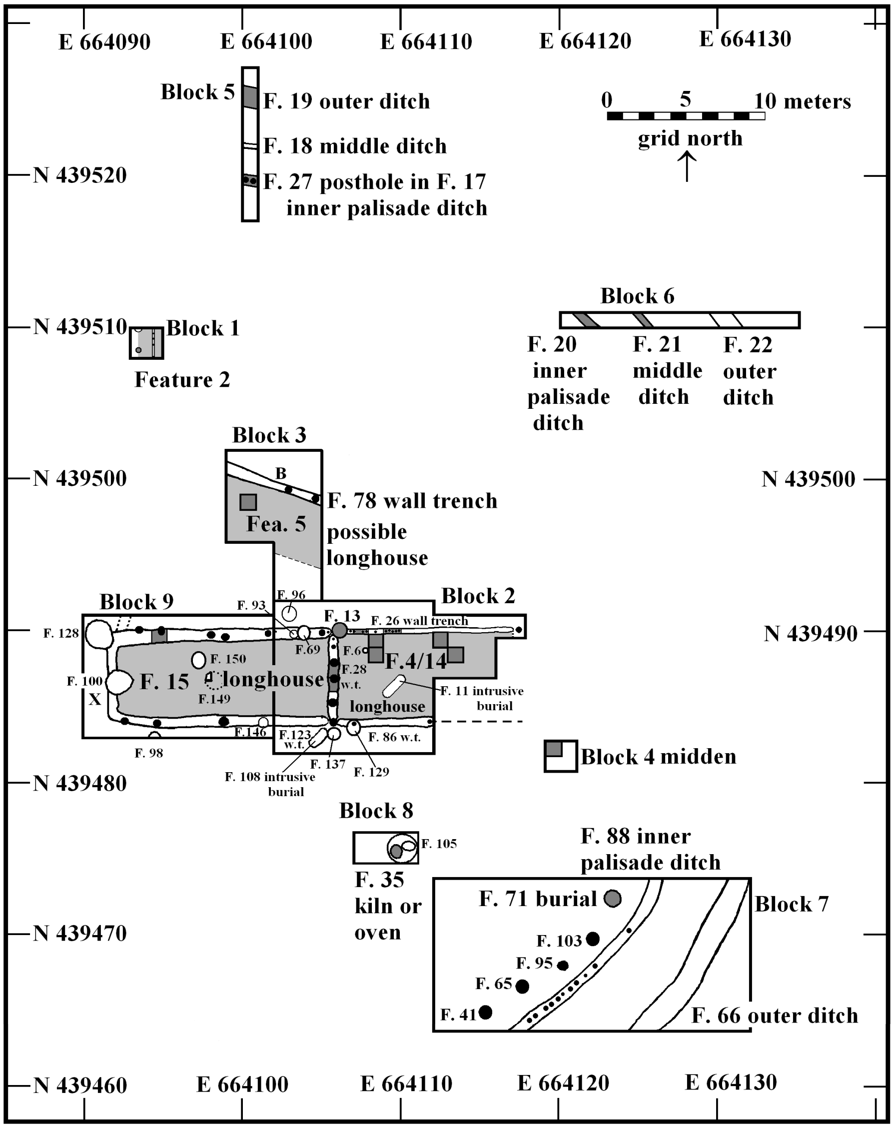

Figure 6 Plan of excavation blocks and Early Copper Age features at Vésztő-Bikeri showing where ^{14}C samples were taken. The sampled features and EUs (small squares) are dark shaded. Light shaded areas are floors of longhouse structures. Different feature numbers were used for the palisade and ditches in different Excavation blocks. Intrusive burials are from the Hungarian Conquest period (10th century AD).

Vésztő-Bikeri. The Bayesian and contextual analysis of the 22 calibrated ^{14}C dates from Vésztő-Bikeri suggested that there were 3 groups of dates. The contexts for these ^{14}C samples is shown on Figure 6 and listed in Appendix 1. The first group of 15 calibrated dates came from deposits that were (1) on or in the floor of the longhouse structure Feature 4/14 (Beta-162068 and Beta-179783), (2) in the fill of the wall-trenches of 2 structures that shared a common wall (Features 4/14 and 15, Beta-

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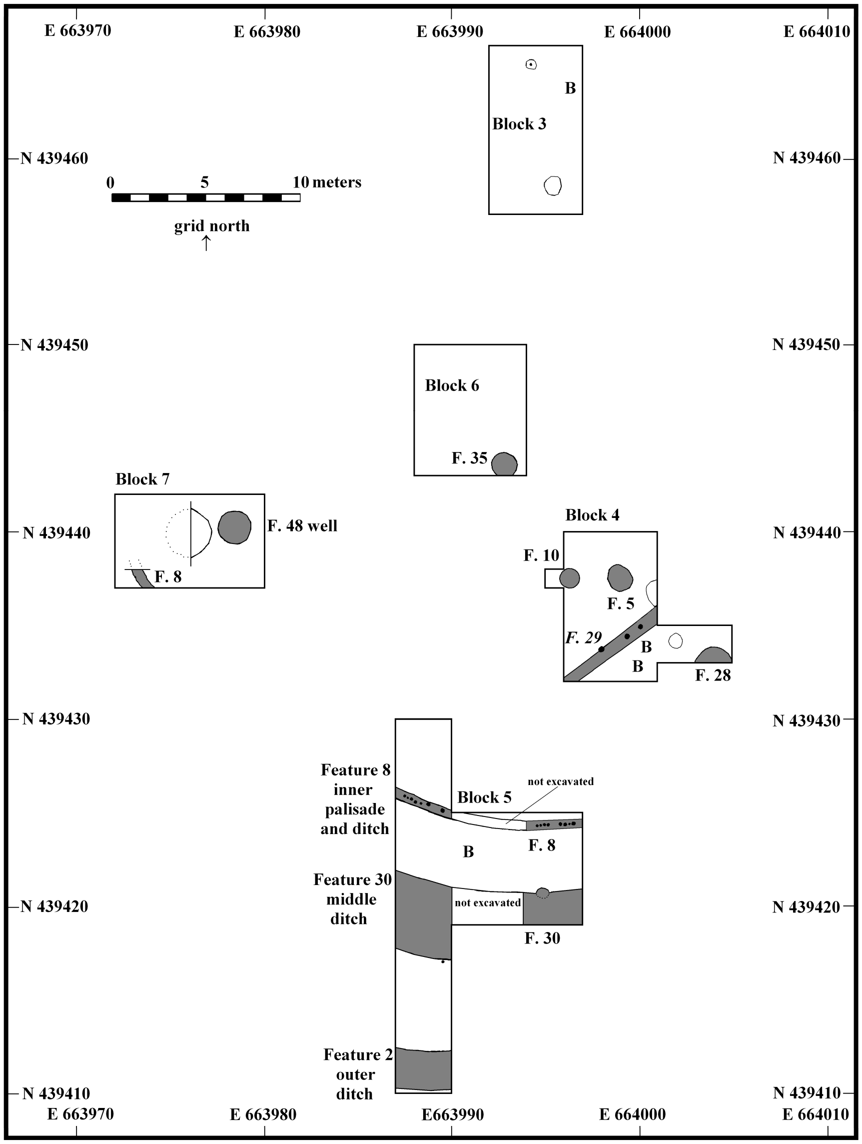

Figure 7 Plan of Excavation Blocks and Early Copper Age features at Körösladány-Bikeri showing where ^{14}C samples were taken. The sampled features are dark shaded. Letter "B" marks the location of infant burials that were laid on the surface.

179789, Beta-179788, Beta-179786, and Beta-179787) – the eastern wall trench of Feature 15 was reused as the western wall of feature 4/14; (3) in the fill of the north wall trench of the Feature 15 longhouse (Beta-214593); (4) in deposits at the base of the plowzone over Feature 5, another possible longhouse (Beta-162070); (5) in the fill of Feature 13, a bell-shaped pit at the NW corner of the Feature 4/14 longhouse (Beta-179785 and Beta-179784); (6) from charcoal associated with the Feature 71 burial that was placed above an extracted post inside of the palisade (Beta-214589); (7) in the fill of the inner palisade ditch Feature 20 (Beta-179792); (8) from Feature 27, a posthole in the inner palisade ditch (Beta-179791); (9) in the fill of the outer ditch, Feature 19 (Beta-179790); and (10) in

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the fill of the middle ditch, Feature 21 (Beta-179793). A *t* test on the first 14 of these dates showed that they are statistically similar at the 95% level (t = 19.56, critical value = 22.4, df = 13, 0.05 level). When the 15th date (Beta-179793) is added to the group, results of a *t* test showed that the dates are statistically different at the 95% level, but the results are very close (t = 24.37, critical value = 23.7, df = 14, 0.05 level). In the Bayesian analysis for the 15 dates with OxCal v 4, the agreement indices for all the dates were ≥73, so they seem to form a valid group of dates that can be used to estimate the time of the main occupation episode at Vésztő-Bikeri. The summed probabilities for these 15 dates (1 σ) ranged from 4448–4269 cal BC for this main occupation phase, while the Bayesian analysis put the starting boundary between 4407 and 4356 cal BC (mean = 4395 cal BC) and the ending boundary between 4349 and 4314 cal BC (mean = 4322 cal BC). The estimated span (or duration) of the main occupation at Vésztő-Bikeri was 0–76 yr, with a mean of 63 yr and a median of 52 yr—or for 1 or 2 generations.

Four of the ^{14}C dates from Vésztő-Bikeri are later (younger) than the 15 dates from the main occupation phase. Results of a *t* test show that these dates are statistically the same at the 95% level (t = 5.07, critical value = 7.81, df = 3, 0.05 level). Two dates are from deposits in the daub or cultural layers that cover the floor layers of a longhouse structure (Beta-179782 and Beta-162067), 1 date is from the fill in the oven or kiln (Feature 35) (Beta-214592), and the fourth is from a ring midden surrounding the settlement (Beta-162071). Summed probabilities (1 σ) for these 4 dates range from 4335–4079 cal BC. Bayesian analysis puts the starting boundary for these younger dates between 4377 and 4254 cal BC (mean = 4357 cal BC) and the ending boundary between 4256 and 4048 cal BC (mean = 4113 cal BC). The duration of this later phase was estimated at 0–143 yr (mean = 109 yr, median = 97 yr). These dates may be on younger charred materials that were deposited in the ring midden that encircles the site, incorporated into the covering deposits when the longhouse structure walls were burned and leveled, and deposited when the kiln/ovens were abandoned and covered over. These activities may have taken place after the inhabitants of Vésztő-Bikeri had relocated their settlement to the adjacent Körösladány-Bikeri site.

Körösladány-Bikeri. Two occupation levels were exposed at the Körösladány-Bikeri site. The contexts for the ^{14}C samples are listed in Appendix 1 and shown in Figure 7. Only 2 ^{14}C samples derive from the lower level (the first occupation phase). One came from the fill of a trench in Excavation Block 4 (Beta-234308), and one from the fill of a bell-shaped storage/refuse pit (Beta-234307). Results of a *t* test show that these dates are statistically the same at the 95% level (t = 0.5, critical value = 3.84, df = 1, 0.05 level). The summed probabilities (1 σ) for the 2 dates range from 4445–4341 cal BC. The Bayesian analysis puts the starting boundary for the lower level between 4512 and 4355 cal BC (mean = 4510 cal BC) and the ending boundary for the first occupation phase between 4433 and 4267 cal BC (mean = 4271 cal BC). The estimated span of the first occupation phase on the lower level is 0–39 yr, with a mean of 29 yr—about 1 generation. These dates fall within the timespan of the main occupation phase at Vésztő-Bikeri (Figure 5), suggesting that the settlement at Körösladány-Bikeri was established and occupied *before* Vésztő-Bikeri was abandoned entirely.

Six calibrated ^{14}C dates derive from the upper level (later occupation phase) at the Körösladány-Bikeri site. Results of a *t* test show that the 6 dates are statistically the same at the 95% level (t = 1.62, critical value = 11.1, df = 5, 0.05 level). The summed probabilities (1 σ) for the dates were 4336–4173 cal BC. The Bayesian analysis puts the starting boundary for the upper level between 4346 and 4263 cal BC (mean = 4313 cal BC) and the ending boundary for the second occupation phase between 4303 and 4223 cal BC (mean = 4244 cal BC). The duration of the second occupation phase on the upper level is estimated at 0–54 yr, with a mean of 44 yr—or a little more than 1 generation. The dates were run on samples from various deposits, including 3 from bell-shaped storage/

refuse pits (Beta-234312, Beta-214595, and Beta-234306). Two dates were on samples from a well (Beta-234313 and Beta-234314), and 1 date was on samples recovered in the bottom fill layer of the circular outer ditch that surrounded the site (Beta-214596). This outer ditch seems to have been excavated when the Körösladány-Bikeri site was expanded during the second occupation phase. The span of the dates from the upper level or second occupation phase at Körösladány-Bikeri falls within the time interval for the 4 younger dates from Vésztő-Bikeri (Figure 5). It seems like the kilns or ovens at Vésztő-Bikeri were used when the Körösladány-Bikeri site had reached it maximum size during this second habitation phase (represented by the upper level).

Early Outliers. Three ^{14}C dates from Vésztő-Bikeri are earlier (older) than the 15 dates from the main occupation. Results of a *t* test show that the dates are statistically the same at the 95% level (t = 1.60, critical value = 5.99, df = 2, 0.05 level). Two of the dates are from deposits on or in the floor of a longhouse structure (Beta-162066 and Beta-162069). The third is from the fill of a circular pit that may be associated with another structure (Beta-162065, see Appendix 1, Figure 6). The range for summed probabilities (1 σ) for these dates is 4582–4456 cal BC. These dates may have been acquired from older, perhaps reused, charred materials that later were incorporated into the pit fill and floor deposits.

Two dates on samples from the fill of the ditches at Körösladány-Bikeri also were older than the dates from the 2 habitation levels at the settlement. One sample came from a posthole in the inner palisade ditch (Beta-214597), while the other came from the fill of the large, deep middle ditch (Beta-234310, see Appendix 1 and Figure 7). Results of a *t* test showed that the dates are statistically the same at the 95% level (t = 0.03, critical value = 3.84, df = 1, 0.05 level). The range for the summed probabilities (1 σ) is 4666–4526 cal BC. These dates also seem to have been acquired from older charred materials that later were incorporated into the ditch fill.

These early dates from Tiszapolgár contexts at Vésztő-Bikeri and Körösladány-Bikeri fall at or near the end of sequences associated with Late Neolithic contexts at other sites in the region (Figure 5). It is possible that the inhabitants at these 2 small sites "curated" posts from palisades and structures at Late Neolithic tells and flat sites nearby, such as Vésztő-Mágor, a multicomponent tell only 2 km away. Unfortunately, this tell is not as well dated as some of the other tells of the Tisza-Herpály-Csőszhalom complex listed in Appendix 1. The 4 published dates from Late Neolithic levels 3 and 4 at Vésztő-Mágor fall at the beginning of the Late Neolithic period (early Tisza, see Appendix 2), while a single bone sample from the later Tiszapolgár occupation at the tell (Beta-162061) produced a date of 4345–4081 cal BC (1 σ). That date would line up with the younger dates from Vésztő-Bikeri and the upper level at Körösladány-Bikeri shown in Figure 5, suggesting that the tell and the small dispersed settlements all may have been inhabited during a later phase of the Early Copper Age.

The Early Copper Age in Context

Figure 5 shows the temporal relationship between the calibrated ^{14}C dates from the different occupations phases at the Tiszapolgár settlements of Vésztő-Bikeri and Körösladány-Bikeri, the combined dates from all 47 Early Copper Age Tiszapolgár sites in our database, the dates from Proto-Tiszapolgár contexts, Late Neolithic dates from 3 tells of the Tisza-Herpály-Csőszhalom complex, the 107 Late Neolithic dates combined, and dates from different levels at the Berettyóújfalu-Herpály tell. The earlier dates from Vésztő-Bikeri and Körösladány-Bikeri (about 4650–4450 cal BC)—both Early Copper Age sites—are contemporary with Late Neolithic contexts elsewhere (although the dates from the Early Copper Age sites may be on older recycled wooden posts or charred materials). The first habitation episodes at both Early Copper Age settlements (about 4450–4250 cal BC) over-

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lap the dates from Late Neolithic and Proto-Tiszapolgár levels at Berettyóújfalu-Herpály,[9] a nearby tell on the Berettyó River in the Körös region (Figures 2 and 5).

These dates from the initial occupations at Vésztő-Bikeri and Körösladány-Bikeri also are earlier than the dates from other Tiszapolgár settlements and cemeteries, which range from 4348–4052 cal BC (Figures 4 and 5). Patterns associated with the Tiszapolgár culture seem to have developed earlier in the Vésztő microregion than at other sites in the Körös region or in the northern part of the Great Hungarian Plain where Proto-Tiszapolgár phase occupations have been identified (Appendices 1 and 2; Figure 4).

The final occupation phases at Vésztő-Bikeri and Körösladány-Bikeri (about 4350–4050 cal BC), however, are contemporary with the range of dates from other Tiszapolgár cemeteries and settlements, including the Early Copper Age occupation at the Vésztő-Mágor tell (4345–4081 cal BC). The earlier phase of the Early Copper Age in the Vésztő microregion is temporally and spatially contiguous with the terminal phase of the Late Neolithic Tisza-Herpály-Csőszhalom complex. The later phase of the Early Copper Age is marked by the later habitation level at Körösladány-Bikeri (without longhouses) with continued use of some features at Vésztő-Bikeri, and with a Tiszapolgár settlement occupation on the Vésztő-Mágor tell. During this later phase of the Early Copper Age, formal cemeteries away from settlements first appeared across the Plain, after new patterns of settlement and household organization were established during the early phase of the Early Copper Age.

At the microregional scale, calibrated ^{14}C dates permit us to document changes in settlement and landscape use between nearby settlements, and to tease apart the timing of the various processes that characterize the Neolithic–Copper Age transition throughout the region. Settlement dispersal and tell abandonment preceded changes in household and settlement organization in the Vésztő microregion. All these processes preceded the emergence of large formal Tiszapolgár cemeteries located away from the small settlements.

CONCLUSIONS: TEMPORAL SCALES, ARCHAEOLOGICAL PATTERNS, AND SOCIAL PROCESSES

This article set out to discuss the relationship between chronologies based on calibrated ^{14}C dates and their expressions in the archaeological record. In attempting to model the various changes that characterize the end of the Neolithic on the Great Hungarian Plain, we have approached the topic from several different temporal, geographic, and social scales. Due to the nature of ^{14}C dates and the archaeological record itself, the degree of chronological resolution available to the researcher is related directly to the scale of analysis. At broader geographic and temporal scales, the absolute ^{14}C chronology for the Great Hungarian Plain is well supported by the distribution of archaeological assemblages associated with different cultures in the region. But at the regional and microregional scales, the ^{14}C dates indicate patterns of geographic and temporal variability in the social processes—and the material correlates of those processes—that we use to differentiate the Neolithic from the Copper Age. By approaching the topic at multiple scales, we have been able to examine the onset, duration, and extent of the processes that differentiate these macroscale chronological periods (i.e. Neolithic and Copper Age).

[9]There is significant overlap between the range for the summed probabilities (1 σ) for the main occupation at Vésztő-Bikeri, the lower occupation level at Körösladány-Bikeri, the summed probability range for Late Neolithic levels 8–7 and level 7 at Berettyóújfalu-Herpály, and the Proto-Tiszapolgár levels at that tell (Figure 5).

The groups of calibrated ^{14}C dates examined in this study can be aligned in a series of relatively short, overlapping cultural phases that span the Late Neolithic period and the Early Copper Age on the Great Hungarian Plain. Our recalibration of some of the Late Neolithic dates supports the findings of Ede Hertelendi and his colleagues that several Late Neolithic and Early Copper Age cultural complexes were contemporary and/or overlapping. The 4 Proto-Tiszapolgár dates (3 from Berettyóújfalu-Herpály) suggest a 300-yr timespan for the transitional period between the Late Neolithic and Early Copper Age, but more samples from sites in different areas within the Great Hungarian Plain have to be collected and analyzed in order to develop a more precise timeframe for this transition. We enlarged the sample of calibrated Early Copper Age ^{14}C dates from 15 to 47, and used the expanded sample to show that the Early Copper Age period lasted from about 4500 to 4000 cal BC—consistent with the time range that Raczky (1995) proposed, but slightly older than the timeframes that others had established using older calibration programs and calibration curves (see Figure 1).

Our analyses of calibrated dates revealed that after living on large nucleated tells for some 10 generations, agriculturalists of the Tisza-Herpály-Csőszhalom complex dispersed to small fortified sites like Vésztő-Bikeri and Körösladány-Bikeri (and other small sites without ditches and palisades)—but the dispersal began before the tells were entirely abandoned at the end of the Late Neolithic period (~4550 cal BC).

While there were many innovations and changes at the end of the late Neolithic period, the significant cultural continuity between the Late Neolithic and Early Copper Age groups is revealed in many aspects of material culture, but also in traditions such as dismantling and covering over houses and filling in pits, wells, and ditches at the end of each occupation episode. But instead of rebuilding on top of each layer and forming vertical tell sequences (like their Late Neolithic predecessors), Early Copper Age groups built new structures and features adjacent to the abandoned ones—they moved "horizontally" rather than "vertically." This is illustrated in the case of Feature 15, an early longhouse structure built in the center of Vésztő-Bikeri. After this house was abandoned, and its wall trenches were filled in, a new structure was built right next to it. The west wall of the new longhouse, Feature 4/14, was constructed in the abandoned and filled-in east wall trench of Feature 15 (Figure 6). When the settlement at Vésztő-Bikeri was finally abandoned, instead of building a new settlement on top of the old, the group seems to have moved 70 m west and established the new settlement at Körösladány-Bikeri (Figures 3 and 7).

The shift from vertical to horizontal (or lateral) movement of structures, features, and settlements is a significant cultural characteristic that distinguishes the Early Copper Age from the Late Neolithic, but there also is much evidence for cultural continuity. The 80–100 cm vertical stratigraphy at Vésztő-Bikeri, Körösladány-Bikeri, and in the Tiszapolgár levels at Vésztő-Mágor implies that the Early Copper Age farmers continued the building and leveling activities that went on at the multigeneration Neolithic tells and tell-like settlements—but on a smaller scale and over a few generations instead of centuries. The dispersal of large nucleated populations from the tells to the small flat settlements began around 4500 cal BC, or even earlier, but some of the tells might have not been abandoned entirely, and in the case of the large tell at Vésztő-Mágor, some were reoccupied after a hiatus of several centuries in the Early Copper Age (Hegedűs and Makkay 1987; Parkinson et al. 2004b).

Although there are gaps in the occupation sequence at the Vésztő-Mágor tell, the calibrated ^{14}C dates from Vésztő-Bikeri and Körösladány-Bikeri reveal an unbroken cycle of habitation within the microregion. The 2 adjacent sites of Vésztő-Bikeri and Körösladány-Bikeri were both surrounded by substantial palisades and ditches, but the artifacts and floral and faunal materials from the 2 sites are nearly identical. It appears that construction of the younger Körösladány-Bikeri site began before the older Vésztő-Bikeri site was entirely abandoned. Timbers from the palisade and domestic structures at the older site may have been reused in the palisade at the new site. The older dates from the 2 settlements could be on charred posts that had been curated since the end of the Late Neolithic period. It also appears that when this 2-site multiple phase habitation cycle ended, the Early Copper Age groups filled in both sites and covered them over before moving on.

Due to the multiple intercepts in the calibration curve, we are not able to produce short, precise chronologies for the occupation phases at the tells and the small flat settlements. Stratigraphic studies and ethnographic parallels suggest the wattle-and-daub structures and palisades needed to be dismantled and replaced every 20 yr or so, and our estimates from the Bayesian analyses indicate that the occupation episodes at these 2 Early Copper Age settlements spanned a generation or two.

As the aftershocks of the Radiocarbon Revolution continue to reverberate through our understanding of human prehistory, we find promise in a method that incorporates multiple scales of analysis. Having recovered from the immediate implications of the first ^{14}C revolution which forced prehistorians to dramatically rewrite their understanding of the temporal and social relationship between prehistoric societies, we now are afforded the opportunity to focus our efforts on fine-tuning specific chronological sequences. To that end, we have found it extremely helpful to work between several different temporal and geographic scales, using the patterns at 1 scale to help interpret those at the other scales.

The transition from the Neolithic to the Copper Age in the Carpathian Basin was marked by social processes that played out differently at several social, geographic and temporal scales. By analyzing the absolute chronological data at these different scales, we have been able to outline how macroregional period designations relate to archaeological patterns at the regional and microregional scales. Conversely, by placing those patterns into a broader geographic and temporal framework, we have been able to model what these grander period designations mean in terms of specific, local, social processes. We hope that this multiscalar approach will be helpful to those trying to understand similar relationships between macroscale period designations and their regional and microregional expressions in the archaeological record elsewhere in the world.

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APPENDICES

Appendix 1. Conventional ^{14}C dates from Late Neolithic, Early Copper Age and Middle Copper Age sites on the Great Hungarian Plain. **NOTE**: dates are listed in descending order from youngest to oldest by site. The conventional dates listed as "unpublished" were compiled by the late Ede Hertelendi of the Institute of Nuclear Research of the Hungarian Academy of Sciences at Debrecen and his colleagues and used in their earlier analyses (Hertelendi and Horváth 1992; Hertelendi et al. 1995; Hertelendi et al. 1998a,b; Horváth and Hertelendi 1994); however, the conventional dates and calibrations were not listed in all of their publications. GrN-1993 from Polgár-Csőszhalom was listed as GrN-1934 by Bognár-Kutzián (1972) and in other publications (see Vogel and Waterbolk 1963:184). Conventional, extended count, and AMS dates shown for Vésztő-Bikeri and Körösladány-Bikeri.

Appendix 1

Lab nr	Site	Context	^{14}C age BP	Reference
Middle Copper Age				
Hunyadihalom culture				
GrN-1615	Tiszalúc-Sarkad		4920 ± 60	Forenbaher 1993:238
GrN-1614	Tiszalúc-Sarkad		5020 ± 40	Forenbaher 1993:238
GrN-1613	Tiszalúc-Sarkad		5085 ± 40	Forenbaher 1993:238
GrN-1612	Tiszalúc-Sarkad		5100 ± 40	Forenbaher 1993:238
Bodrogkeresztúr culture				
Deb-441	Tiszapolgár-Basatanya (Mid-B)	Grave 133, Middle B phase	4090 ± 180	Benkő et al. 1989:1000
Deb-4	Tiszapolgár-Basatanya (Mid-B)		4820 ± 140	Bankoff and Winter 1990:188
Deb-5	Tiszapolgár-Basatanya (Mid-B)		4960 ± 130	Bankoff and Winter 1990:188
Deb-428	Tiszapolgár-Basatanya (Mid-A)	Grave 85, Middle A phase, bone sample	4240 ± 180	Benkő et al. 1989:1000
Deb-122	Tiszapolgár-Basatanya (Mid-A)	Grave 101a, Middle A phase, dual burial, bone	4850 ± 150	Benkő et al. 1989:1000
Deb-214	Tiszapolgár-Basatanya (Mid-A)	Grave 44, Middle A phase, bone sample	4980 ± 140	Benkő et al. 1989:1000
Deb-350	Tiszapolgár-Basatanya (Mid-A)	Grave 41, Middle A phase, bone sample	5010 ± 180	Benkő et al. 1989:1000

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Appendix 1 *(Continued)*

Lab nr	Site	Context	^{14}C age BP	Reference
Deb-465	Tiszapolgár-Basat-anya (Mid-A)	Grave 101b, Middle A phase, bone sample	5020 ± 170	Benkő et al. 1989:1000
Deb-481	Tiszapolgár-Basat-anya (Mid-A)	Grave 59, Middle A phase (above Grave 61), bone	5210 ± 170	Benkő et al. 1989:1000
Deb-355	Tiszapolgár-Basat-anya (Mid-A)	Grave 120, Middle A phase, bone sample	5220 ± 190	Benkő et al. 1989:1000
Early Copper Age				
Tiszapolgár culture				
Deb-348	Tiszapolgár-Basat-anya (Early)	Grave 23, Early phase, bone sample	5020 ± 180	Bognár-Kutzián and Csongor 1987
Deb-349	Tiszapolgár-Basat-anya (Early)	Grave 28, Early phase, bone sample	5060 ± 170	Bognár-Kutzián and Csongor 1987
Deb-342	Tiszapolgár-Basat-anya (Early)	Grave 54, Early phase, bone sample	5090 ± 190	Bognár-Kutzián and Csongor 1987
Deb-361	Tiszapolgár-Basat-anya (Early)	Grave 5, Early phase, bone sample	5350 ± 190	Bognár-Kutzián and Csongor 1987
Deb-464	Tiszapolgár-Basat-anya (Early)	Grave 61, Early phase, bone sample	5460 ± 170	Bognár-Kutzián and Csongor 1987
Deb-416	Tiszapolgár-Basat-anya (Early)	Grave 12, Early phase, bone sample	5600 ± 180	Bognár-Kutzián and Csongor 1987
Bln-?	Bélmegyer-Mondoki domb		5300 ± 70	Kalicz and Raczky 1987a:28–9
Bln-2165	Méhkerék 23		5385 ± 65	Kalicz and Raczky 1987a:28–9
Beta-162061	Vészt-Mágor	Unit 6-1, bone sample	5410 ± 70	Parkinson et al. 2004a:106
Deb-1936	Tiszapolgár	?	5450 ± 40	may be from Tiszapolgár-Basatanya
VERA-3789	Hajdúböszörmény-Ficsori-tó-dűlő	Grave, Nr. 57/61, animal bone	5360 ± 35	Kovács and Váczi 2007
VERA-3785	Hajdúböszörmény-Ficsori-tó-dűlő	Grave, Nr. 30/34, human bone	5370 ± 40	Kovács and Váczi 2007
VERA-3788	Hajdúböszörmény-Ficsori-tó-dűlő	Grave, Nr. 30/34, animal bone	5370 ± 45	Kovács and Váczi 2007
VERA-3787	Hajdúböszörmény-Ficsori-tó-dűlő	Grave, Nr. 57/61, human bone	5425 ± 35	Kovács and Váczi 2007
VERA-3786	Hajdúböszörmény-Ficsori-tó-dűlő	Grave, Nr. 71/75, human bone	5445 ± 35	Kovács and Váczi 2007
Beta-234313	Körösladány-Bikeri-upper level	F48 well, sample 1 EU7-64	5370 ± 60	conventional ^{14}C date
Beta-214596	Körösladány-Bikeri-upper level	F2 Outer circular ditch bottom fill EU5-53	5370 ± 40	AMS ^{14}C date
Beta-234312	Körösladány-Bikeri-upper level	F35 Bell-shaped pit fill EU6-46	5380 ± 40	AMS ^{14}C date
Beta-234306	Körösladány-Bikeri-upper level	F10 Bell-shaped pit fill EU4-103	5410 ± 80	conventional ^{14}C date
Beta-214595	Körösladány-Bikeri-upper level	F5 west 1/2 Bell-shaped pit (0–10 cm)EU4-48	5420 ± 40	AMS ^{14}C date
Beta-234314	Körösladány-Bikeri-upper level	F48 well, sample 2 EU7-64	5430 ± 50	conventional ^{14}C date
Beta-234307	Körösladány-Bikeri-lower level	F28 Bell-shaped pit fill EU4-144	5520 ± 40	AMS ^{14}C date
Beta-234308	Körösladány-Bikeri-lower level	F29 trench in lower occupation level EU4-103	5560 ± 40	AMS ^{14}C date
Beta-234310	Körösladány-Bikeri-older dates	F30 fill (L1) in middle circular ditch EU5-124	5730 ± 40	AMS ^{14}C date
Beta-214597	Körösladány-Bikeri-older dates	F8,9 posthole in Inner circular ditch EU5-48	5740 ± 40	AMS ^{14}C date

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Appendix 1 *(Continued)*

Lab nr	Site	Context	^{14}C age BP	Reference
Beta-179782	Vésztő-Bikeri-younger dates	F14 daub/cultural layer above floor EU2-223	5310 ± 50	conventional ^{14}C date
Beta-162067	Vésztő-Bikeri-younger dates	F4 daub layer above floor level EU2-27	5320 ± 60	AMS ^{14}C date
Beta-214592	Vésztő-Bikeri-younger dates	F35 kiln/oven in well/cistern EU8-34	5410 ± 40	AMS ^{14}C date
Beta-162071	Vésztő-Bikeri-younger dates	Block 4 midden base of plowzone EU4-3	5430 ± 40	AMS ^{14}C date
Beta-179793	Vésztő-Bikeri-main occupation	F21 Middle circular ditch fill EU6-4	5420 ± 50	AMS ^{14}C date
Beta-179792	Vésztő-Bikeri-main occupation	F20 Inner circular ditch fill EU6-6	5440 ± 50	AMS ^{14}C date
Beta-179787*	Vésztő-Bikeri-main occupation	F28 E wall trench F15, W. w.t. F4/14 EU2-310	5440 ± 140	extended count, conventional date
Beta-179789	Vésztő-Bikeri-main occupation	F26 house F4/14 N w.t. posthole EU2-347	5460 ± 50	AMS ^{14}C date
Beta-214593	Vésztő-Bikeri-main occupation	F15 North wall trench fill EU9-101	5480 ± 50	AMS ^{14}C date
Beta-162068	Vésztő-Bikeri-main occupation	F4 house floor level EU2-37	5480 ± 40	AMS ^{14}C date
Beta-162070	Vésztő-Bikeri-main occupation	F5 possible house base of plow-zone EU3-4	5490 ± 50	AMS ^{14}C date
Beta-179783	Vésztő-Bikeri-main occupation	F14 house floor level EU2-234	5520 ± 50	conventional ^{14}C date
Beta-179788	Vésztő-Bikeri-main occupation	F26 house F4/14 north wall trench EU2-337	5540 ± 40	AMS ^{14}C date
Beta-179786*	Vésztő-Bikeri-main occupation	F28 E wall trench F15, W. w.t. F4/14 EU2-284	5540 ± 60	extended count, conventional date
Beta-179790	Vésztő-Bikeri-main occupation	F19 Outer circular ditch fill EU5-3	5550 ± 40	AMS ^{14}C date
Beta-179785	Vésztő-Bikeri-main occupation	F13 Bell pit (yellow clay zone) EU2-271	5560 ± 50	AMS ^{14}C date
Beta-179784	Vésztő-Bikeri-main occupation	F13 Bell-shaped pit (zone G) EU2-251	5580 ± 50	AMS ^{14}C date
Beta-214589	Vésztő-Bikeri-main occupation	F71 burial near r. tibia (charcoal) EU7-58	5610 ± 40	AMS ^{14}C date
Beta-179791	Vésztő-Bikeri-main occupation	F27 posthole in Inner circular ditch EU5-6	5620 ± 40	AMS ^{14}C date
Beta-162066	Vésztő-Bikeri-older dates	F4 house floor level EU2-18	5660 ± 40	AMS ^{14}C date
Beta-162065	Vésztő-Bikeri-older dates	F2 circular pit fill EU1-13	5700 ± 40	AMS ^{14}C date
Beta-162069	Vésztő-Bikeri-older dates	F4 house floor level EU2-37	5790 ± 100	AMS ^{14}C date
Late Neolithic/Prototiszapolgár phase				
Deb-1201	Deszk-Vénó	Pit 3, Square II	5420 ± 60	Hertelendi and Horváth 1992:861–3
Bln-2583	Berettyóújfalu-Herpály	Levels 6–5	5490 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2493	Berettyóújfalu-Herpály	Level 5	5645 ± 55	Kalicz and Raczky 1987a:28–9
Bln-2668	Berettyóújfalu-Herpály	Levels 6–5	5750 ± 50	Kalicz and Raczky 1987a:28–9
Late Neolithic				
Csőszhalom culture				
Deb-417	Bodrogzsadány-Akasztószer	Sq.Ix, pit a, above ashy layer, charcoal	5400 ± 180	Bognár-Kutzián and Csongor 1987

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Appendix 1 *(Continued)*

Lab nr	Site	Context	^{14}C age BP	Reference
Deb-357	Tiszapolgár-Basat-anya	Grave 84, bone sample	5980 ± 200	Bognár-Kutzián and Csongor 1987
Bln-509	Polgár-Csőszhalom	House I/A (uppermost level, 0.3–0.4 m bs)	5575 ± 100	Kohl and Quitta 1970: 413
Bln-512	Polgár-Csőszhalom	burned floor H. I/F 16a (3.05 m bs) lowest level	5775 ± 100	Kohl and Quitta 1970: 413
GrN-1993	Polgár-Csőszhalom	House I/F, lowest level (charred grain)	5845 ± 60	Vogel and Waterbolk 1963:184
Bln-510	Polgár-Csőszhalom	layer in Sec. I/10 (1.85 m bs)	5871 ± 100	Kohl and Quitta 1970: 413
Bln-513	Polgár-Csőszhalom	burned House I/F (lowest level, 3.1–3.3 m bs)	5940 ± 100	Kohl and Quitta 1970: 413
BM-2321	Polgár-Csőszhalom	Layer 0.80–1.10 m deep	6020 ± 170	Ambers et al. 1987:188
Herpály culture				
Bln-2675	Berettyóújfalu-Szilhalom		5680 ± 100	Kalicz and Raczky 1987a:28–9
Bln-1679	Esztár-Fenyvespart		5770 ± 55	Kalicz and Raczky 1987a:28–9
Bln-2958	Berettyóújfalu-Herpály	Level 6	5630 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2494	Berettyóújfalu-Herpály	Level 6	5655 ± 50	Kalicz and Raczky 1987a:28–9
Bln-2923	Berettyóújfalu-Herpály	Level 6	5680 ± 80	Kalicz and Raczky 1987a:28–9
Bln-2584	Berettyóújfalu-Herpály	Level 6	5760 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2670	Berettyóújfalu-Herpály	Level 6	5810 ± 50	Kalicz and Raczky 1987a:28–9
Bln-2931	Berettyóújfalu-Herpály	Level 7	5500 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2993	Berettyóújfalu-Herpály	Level 7	5520 ± 70	Kalicz and Raczky 1987a:28–9
Bln-2706	Berettyóújfalu-Herpály	Level 7	5706 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2937	Berettyóújfalu-Herpály	Level 7	5770 ± 70	Kalicz and Raczky 1987a:28–9
Bln-2924	Berettyóújfalu-Herpály	Level 7	5820 ± 70	Kalicz and Raczky 1987a:28–9
Bln-2938	Berettyóújfalu-Herpály	Levels 8–7	5600 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2926	Berettyóújfalu-Herpály	Levels 8–7	5770 ± 80	Kalicz and Raczky 1987a:28–9
Bln-2929	Berettyóújfalu-Herpály	Levels 8–7	5800 ± 70	Kalicz and Raczky 1987a:28–9
Bln-2925	Berettyóújfalu-Herpály	Levels 8–7	5830 ± 70	Kalicz and Raczky 1987a:28–9
Bln-2673	Berettyóújfalu-Herpály	Level 8	5630 ± 70	Kalicz and Raczky 1987a:28–9
Bln-2939	Berettyóújfalu-Herpály	Level 8	5680 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2927	Berettyóújfalu-Herpály	Level 8	5710 ± 80	Kalicz and Raczky 1987a:28–9
Bln-2930	Berettyóújfalu-Herpály	Level 8	5710 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2932	Berettyóújfalu-Herpály	Level 8	5730 ± 70	Kalicz and Raczky 1987a:28–9

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Appendix 1 *(Continued)*

Lab nr	Site	Context	^{14}C age BP	Reference
Bln-2933	Berettyóújfalu-Herpály	Level 8	5830 ± 80	Kalicz and Raczky 1987a:28–9
Bln-2940	Berettyóújfalu-Herpály	Level 8	5840 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2928	Berettyóújfalu-Herpály	Level 8	5840 ± 70	Kalicz and Raczky 1987a:28–9
Bln-2934	Berettyóújfalu-Herpály	Level 9	5730 ± 80	Kalicz and Raczky 1987a:28–9
Bln-2935	Berettyóújfalu-Herpály	Level 9	5790 ± 60	Kalicz and Raczky 1987a:28–9
Bln-2936	Berettyóújfalu-Herpály	Level 9	5930 ± 60	Kalicz and Raczky 1987a:28–9
Tisza culture				
Bln-1934	Deszk-Ordos		5595 ± 100	Kalicz and Raczky 1987a:28–9
Bln-515	Kisköre-Gát	oak charcoal in fireplace in pit (XVII,6) 1.6 m	5890 ± 120	Kohl and Quitta 1970: 410
Bln-179	Kisköre-Gát	organic temper sherds 0.8–1.6 m bs (XVII,6)	5995 ± 80	Kohl and Quitta 1970: 410
Deb-1389	Hódmezővásárhely-Gorzsa	Square IX, Level 2	5570 ± 60	Hertelendi and Horváth 1992:861–3
Bln?	Hódmezővásárhely-Gorzsa	?	5580 ± 100	Kalicz and Raczky 1987a:28–9
Z-2009	Hódmezővásárhely-Gorzsa	C	5610 ± 110	Benkő et al. 1989:1000
Bln-3109	Hódmezővásárhely-Gorzsa	C	5640 ± 60	Benkő et al. 1989:1000
Fra-76	Hódmezővásárhely-Gorzsa	House 2 (burned), Blk III, L.10, 2.0 m depth	5650 ± 110	Protsch and Weninger 1984:191–2
Fra-77	Hódmezővásárhely-Gorzsa	House 2 (burned), Blk III, L.10, 2.1 m depth	5670 ± 100	Protsch and Weninger 1984:191–2
Deb-1238	Hódmezővásárhely-Gorzsa	Square XI, Level 10	5750 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1175	Hódmezővásárhely-Gorzsa	Sq.VIII, Levels 16–17b	5760 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1171	Hódmezővásárhely-Gorzsa	Square VI, Level 10	5760 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1384	Hódmezővásárhely-Gorzsa	Sq.VIII, Level 17c–e	5780 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1413	Hódmezővásárhely-Gorzsa	Grave 16, Square X	5790 ± 60	Hertelendi and Horváth 1992:861–3
Z-2010	Hódmezővásárhely-Gorzsa	C1	5820 ± 110	Benkő et al. 1989:1000
Deb-1354	Hódmezővásárhely-Gorzsa	Grave 16, Square X	5830 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1386	Hódmezővásárhely-Gorzsa	Sq.VIII, Lev. 16–17b	5840 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1172	Hódmezővásárhely-Gorzsa	Sq.VIII, Lev. 12–13	5850 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1174	Hódmezővásárhely-Gorzsa	Sq.VIII, L.17c–e	5860 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1173	Hódmezővásárhely-Gorzsa	Sq.XI, L.10, Ditch 1	5880 ± 60	Hertelendi and Horváth 1992:861–3
Z-2011	Hódmezővásárhely-Gorzsa	D	5890 ± 110	Benkő et al. 1989:1000
Deb-1387	Hódmezővásárhely-Gorzsa	Sq.XI, L.10, Ditch 1	5900 ± 60	Hertelendi and Horváth 1992:861–3

Appendix 1 *(Continued)*

Lab nr	Site	Context	^{14}C age BP	Reference
Deb-1240	Hódmezővásárhely-Gorzsa	Grave 42, Sq. IX	5900 ± 60	Hertelendi and Horváth 1992:861–3
Fra-114	Hódmezővásárhely-Gorzsa	C1	5910 ± 100	Benkő et al. 1989:1000
Deb-1191	Hódmezővásárhely-Gorzsa	Sq. XVIII, L.24–25	5910 ± 60	Hertelendi and Horváth 1992:861–3
Fra-108	Hódmezővásárhely-Gorzsa	Pits 2 and 3, Level 16 (earliest level)	5970 ± 100	Protsch and Weninger 1984:191–2
Fra-95	Hódmezővásárhely-Gorzsa	Block III/b, Level 1, 1.15 m depth with 3 pots	5970 ± 100	Protsch and Weninger 1984:191–2
Deb-1187	Hódmezővásárhely-Gorzsa	Grave 42, Sq. IX	5990 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1202	Hódmezővásárhely-Gorzsa	Grave 42, Sq. IX	6050 ± 60	Hertelendi and Horváth 1992:861–3
Early Tisza				
Deb-1222	Hódmezővásárhely-Kökénydomb	House 1, Level 3	5800 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1411	Hódmezővásárhely-Kökénydomb	House 1, Level 3	5850 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1255	Hódmezővásárhely-Kökénydomb	House 1, Level 3	5890 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1364	Hódmezővásárhely-Kökénydomb	Levels 3–4	5870 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1513	Hódmezővásárhely-Kökénydomb	Levels 3–5	5900 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1367	Hódmezővásárhely-Kökénydomb	Pit 2	5970 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1388	Hódmezővásárhely-Kökénydomb	House 1, Level 3	6090 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1412	Hódmezővásárhely-Kökénydomb	Level 6	6100 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1365	Hódmezővásárhely-Kökénydomb	Pit 1	6150 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1263	Hódmezővásárhely-Kökénydomb	House 1, Level 3	6190 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1221	Szegvár-Tűzköves	Pit 93, Level 20	5800 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1355	Szegvár-Tűzköves	Grave 1, Levels 10–12	5830 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1256	Szegvár-Tűzköves	Levels 19–20	6010 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1229	Szegvár-Tűzköves	Levels 26–27	6050 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1420	Szegvár-Tűzköves	Pit 105, Level 29	6100 ± 60	Hertelendi and Horváth 1992:861–3
BM-2323	Szegvár-Tűzköves	Pit in Tisza Layer over MN Szakalhát material	6120 ± 40	Ambers et al. 1987:188
Deb-1254	Szegvár-Tűzköves	Levels 23–24	6210 ± 60	Hertelendi and Horváth 1992:861–3
BM-2322	Szegvár-Tűzköves	Pit in Tisza Layer over MN Szakalhát material	6250 ± 190	Ambers et al. 1987:188
Bln-1342	Vésztő-Mágor	Level 3	5970 ± 80	Kalicz and Raczky 1987a:28–9
Bln-1626	Vésztő-Mágor	House in Level 4	6000 ± 60	Kalicz and Raczky 1987a:28–9
Bln-1625	Vésztő-Mágor	House in Level 3	6150 ± 60	Kalicz and Raczky 1987a:28–9

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Appendix 1 *(Continued)*

Lab nr	Site	Context	^{14}C age BP	Reference
Bln-1628	Vésztő-Mágor	House in Level 3	6250 ± 60	Kalicz and Raczky 1987a:28–9
Deb-1186	Tápé-Lebő-A	Levels 1–2	5860 ± 60	Hertelendi and Horváth 1992:861–3
Z-2007	Tápé-Lebő-A	?	5870 ± 110	Benkő et al. 1989:1000
Deb-1211	Tápé-Lebő-A	Level 8	5900 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1356	Tápé-Lebő-A	Ditch 14, Level 16	5950 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1363	Tápé-Lebő-A	Ditch 14, Level 16	6050 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1176	Tápé-Lebő-A	Levels 5–6	6060 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1264	Tápé-Lebő-A	Levels 12–13	6100 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1196	Tápé-Lebő-A	Pit 24, Level 6	6130 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1267	Tápé-Lebő-A	Pit 41, Level 14	6150 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1188	Tápé-Lebő-A	Level 10	6160 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1265	Tápé-Lebő-A	Pit 37, Level 12	6170 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1200	Tápé-Lebő-A	Pit 35, Level 12	6170 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1197	Tápé-Lebő-A	Pit 32, Level 12	6200 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1195	Tápé-Lebő-A	Levels 14–15	6210 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1189	Tápé-Lebő-A	Levels 12–14	6230 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1366	Tápé-Lebő-A	Pit 53, Level 16	6290 ± 60	Hertelendi and Horváth 1992:861–3
Deb-1643	Tápé-Lebő-A	Fea. 39, Level 17(12) charcoal	6370 ± 60	unpublished

Appendix 2. Calibrated ^{14}C dates from Late Neolithic, Early Copper Age, and Middle Copper Age sites on the Great Hungarian Plain listed by lab number. **NOTE**: 1- and 2-σ calibration ranges using CALIB Rev 5.01 and the IntCal04 calibration curve are shown. Staring and ending time ranges cal BC are given followed by the relative area under the calibration curve.

Appendix 2

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Middle Copper Age			
Hunyadihalom culture, Tiszalúc-Sarkad site			
GrN-1615	Tiszalúc-Sarkad	3763–3724(0.30); 3715–3647(0.70)	3934–3875(0.06); 3806–3632(0.92); 3558–3538(0.02)
GrN-1614	Tiszalúc-Sarkad	3936–3872(0.49); 3806–3760(0.39); 3741–3731(0.05); 3725–3714(0.70)	3944–3853(0.44); 3849–3709(0.56)

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Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
GrN-1613	Tiszalúc-Sarkad	3956–3927(0.26); 3918–3915(0.02); 3877–3804(0.72)	3967–3791(1.0)
GrN-1612	Tiszalúc-Sarkad	3962–3933(0.31); 3875–3806(0.69)	3972–3797(1.0)
Summed probabilities	**Tiszalúc-Sarkad all 4 dates**	**3958–3796(1.0)**	**3964–3653(1.0)**
Bodrogkeresztúr culture, Tiszapolgár-Basatanya cemetery (Middle B phase)			
Deb-441	Grave 133, Middle B phase	2899–2457(0.97); 2418–2407(0.01); 2375–2367(0.01); 2361–2352(0.01)	3264–3242(<0.01); 3103–2130(0.99); 2086–2050(0.01)
Deb-4		3760–3741(0.04); 3729–3726(0.01); 3714–3497(0.74); 3456–3377(0.21)	3959–3333(0.98); 3213–3188(0.01); 3154–3132(0.01)
Deb-5		3941–3857(0.28); 3842–3839(0.01); 3819–3641(0.71)	4039–4017(0.01); 3999–3506(0.97); 3427–3381(0.02)
Summed probabilities	**Tiszapolgár-Basatanya Middle B all 3 dates combined**	**3958–3493(0.79); 3466–3374(0.09); 2847–2842(<0.01); 2840–2812(0.02); 2737–3731(0.01); 2691–2688(<0.01); 2677–2572(0.08)**	**4039–4012(<0.01); 4001–3330(0.67); 3213–3185(<0.01); 3155–3126(<0.01); 3083–3064(<0.01); 3027–2199(0.32); 2155(<0.01)**
Bodrogkeresztúr culture, Tiszapolgár-Basatanya cemetery (Middle A phase, bone samples)			
Deb-428	Grave 85	3090–2573(1.0)	3365–2397(0.99); 2384–2346(0.01)
Deb-122	Grave 101a	3794–3499(0.88); 3432–3379(0.12)	3979–3332(0.99); 3213–3188(<0.01); 3155–3131(<0.01)
Deb-214	Grave 44	3943–3854(0.30); 3847–3830(0.06); 3825–3652(0.64)	4218–4214(<0.01); 4148–4135(<0.01); 4054–3498(0.97); 3437–3378(0.02)
Deb-350	Grave 41	4037–4021(0.02); 3994–3635(0.98)	4236–3496(0.96); 3460–3376(0.04)
Deb-465	Grave 101b	3986–3640(1.0)	4235–3501(0.98); 3429–3380(0.02)
Deb-481	Grave 59 (above Grave 61)	4239–3926(0.82); 3920–3914(0.02); 3877–3804(0.16)	4351–3660(1.0)
Deb-355	Grave 120	4259–3910(0.84); 3878–3802(0.16)	4446–4419(0.01); 4399–4381(0.01); 4374–3646(0.98)
Summed probabilities	**Tiszapolgár-Basatanya Middle A all 7 dates combined**	**4227–4199(0.03); 4169–4126(0.04); 4120–4090(0.03); 4079–3627(0.84); 3586–3528(0.06)**	**4357–3341(0.88); 3315–3291(<0.01); 3289–3272(<0.01); 3265–3236(<0.01); 3169–3162(<0.01); 3111–2568(0.11); 2514–2499(<0.01)**
Summed probabilities, Middle Copper Age	**all 14 dates combined**	**4037–4019(0.01); 3995–3263(0.91); 3602–3523(0.08)**	**4347–3336(0.88); 3260–3258(<0.01); 3207–3192(<0.01); 3149–3138(<0.01); 3096–2458(0.11)**

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Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Early Copper Age			
Tiszapolgár culture, Tiszapolgár-Basatanya cemetery (Early phase, bone samples)			
Deb-348	Grave 23	4037–4021(0.03); 3995–3638(0.97)	4241–3497(0.97); 3455–3377(0.03)
Deb-349	Grave 28	4038–4019(0.04); 3996–3657(0.96)	4317–4297(0.01); 4262–3519(0.99)
Deb-342	Grave 54	4219–4213(0.01); 4149–4135(0.02); 4054–3655(0.97)	4336–3518(0.999); 3392–3390(0.001)
Deb-361	Grave 5	4358–3969(1.0)	4549–3757(0.99); 3753–3750(<0.01); 3744–3713(<0.01)
Deb-464	Grave 61	4458–4220(0.68); 4212–4150(0.14); 4134–4055(0.18)	4691–3951(1.0)
Deb-416	Grave 12	4685–4320(0.94); 4294–4264(0.06)	4840–4040(0.999); 4014–4001(0.001)
Summed probabilities	**Tiszapolgár-Basatanya-Early**	**4351–3710(1.0)**	**4704–3622(0.98); 3602–3523(0.02)**
Tiszapolgár culture, Bélmegyer-Mondoki domb site			
Bln-?	Bélmegyer-Mondoki domb	4233–4187(0.24); 4183–4045(0.76)	4840–4040(0.996); 4014–4001(0.004)
Tiszapolgár culture, Méhkerék 23 site			
Bln-2165	Méhkerék 23	4333–4227(0.69); 4202–4168(0.18); 4128–4118(0.04); 4097–4077(0.09)	4342–4050(1.0)
Tiszapolgár culture, Vésztő-Mágor tell			
Beta-162061	Unit 6-1, bone sample	4345–4228(0.82); 4200–4170(0.14); 4126–4123(0.01); 4090–4081(0.04)	4364–4046(1.0)
Tiszapolgár culture, Tiszapolgár? site			
Deb-1936	Tiszapolgár, no other information	4345–4317(0.44); 4297–4262(0.56)	4360–4236(1.0)
Tiszapolgár culture, Hajdúböszörmény-Ficsori-tó-dűlő cemetery			
VERA-3789	Grave 57/61, animal bone	4319–4294(0.17); 4264–4227(0.33); 4203–4167(0.29); 4128–4117(0.07); 4098–4076(0.14)	4327–4283(0.17); 4271–4218(0.27); 4214–4148(0.28); 4135–4053(0.28)
VERA-3785	Grave 30/34, human bone	4325–4287(0.29); 4268–4228(0.36); 4201–4169(0.23); 4127–4120(0.04); 4094–4079(0.08)	4331–4221(0.54); 4211–4150(0.23); 4134–4055(1.23)
VERA-3788	Grave 30/34, animal bone	4326–4285(0.28); 4269–4227(0.33); 4202–4168(0.23); 4128–4118(0.05); 4097–4077(0.11)	4332–4218(0.52); 4214–4148(0.24); 4135–4054(0.24)
VERA-3787	Grave 57/61, human bone	4333–4312(0.33); 4302–4260(0.67)	4347–4233(0.99); 4187–4183(0.01)
VERA-3786	Grave 71/75, human bone	4341–4318(0.41); 4296–4263(0.59)	4350–4242(1.0)
Summed probabilities	**Hajdúböszörmény-Ficsori**	**4336–4231(0.93); 4190–4178(0.07)**	**4346–4221(0.70); 4208–4152(0.15); 4131–4057(0.15)**

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Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Tiszapolgár culture, Körösladány-Bikeri site-upper level			
Beta-234313	F48 well, sample 1	4327–4282(0.27); 4271–4226(0.29); 4204–4165(0.22); 4129–4114(0.08); 4100–4074(0.14)	4334–4051(1.0)
Beta-214596	F2 Outer circular ditch bottom fill	4325–4287(0.29); 4268–4228(0.36); 4201–4169(0.23); 4127–4120(0.04); 4094–4079(0.08)	4331–4221(0.54); 4211–4150(0.23); 4134–4055(0.23)
Beta-234312	F35 Bell-shaped pit fill	4328–4280(0.41); 4274–4229(0.42); 4197–4172(0.17); 4087–4085(<0.01)	4334–4223(0.65); 4208–4154(0.18); 4132–4059(0.17)
Beta-234306	F10 Bell-shaped pit fill	4347–4227(0.74); 4202–4168(0.15); 4128–4118(0.03); 4097–4077(0.08)	4444–4421(0.02); 4395–4386(<0.01); 4373–4042(0.98)
Beta-214595	F5 W1/2 Bell-shaped pit (0–10 cm)	4332–4258(1.0)	4351–4228(0.94); 4200–4170(0.05); 4090–4080(0.01)
Beta-234314	F48 well, sample 2	4339–4253(1.0)	4364–4225(0.89); 4205–4162(0.07); 4130–4112(0.01); 4103–4071(0.03)
Summed probabilities	**Körösladány-Bikeri-upper level all 6 dates combined**	**4336–4229(0.89); 4195–4173(0.11)**	**4349–4146(0.84); 4134–4052(0.16)**
Beta-234307	F28 Bell-shaped pit fill	4444–4421(0.28); 4394–4386(0.07); 4373–4335(0.65)	4453–4327(0.98); 4282–4272(0.02)
Beta-234308	F29 trench in lower level	4447–4418(0.40); 4402–4357(0.60)	4461–4338(1.0)
Summed probabilities	**Körösladány-Bikeri-lower level**	**4445–4418(0.33); 4398–4380(0.19); 4373–4341(0.48)**	**4459–4327(0.99); 4279–4273(0.01)**
Tiszapolgár culture, Körösladány-Bikeri site-older dates			
Beta-234310	F30 fill (L1) in middle ditch	4325–4287(0.29); 4268–4228(0.36); 4201–4169(0.23); 4127–4120(0.04); 4094–4079(0.08)	4331–4221(0.54); 4211–4150(0.23); 4134–4055(0.23)
Beta-214597	F8,9 posthole in Inner ditch	4678–4658(0.12); 4655–4637(0.13); 4619–4536(0.75)	4701–4700(0.001); 4694–4490(0.999)
Summed probabilities	**Körösladány-Bikeri-older dates**	**4675–4674(<0.01); 4668–4659(0.06); 4653–4637(0.11); 4617–4524(0.83)**	**4689–4486(0.99); 4475(<0.01); 4468–4464(<0.01)**
Summed probabilities, Körösladány-Bikeri site	**all 10 dates combined**	**4575(<0.01); 4550–4548(<0.01); 4446–4416(0.07); 4401–4227(0.80); 4200–4168(0.08); 4126–4120(0.01); 4091–4078(0.03)**	**4683–4631(0.04); 4622–4499(0.13); 4453–4218(0.66); 4211–4148(0.09); 4133–4053(0.08)**
Tiszapolgár culture, Vésztő-Bikeri site-younger dates			
Beta-179782	F14 daub/cultural layer above floor	4231–4194(0.24); 4176–4144(0.20); 4138–4052(0.56)	4317–4296(0.03); 4263–4037(0.92); 4022–3994(0.05)

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Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Beta-162067	F4 daub layer above floor level	4235–4146(0.51); 4136–4053(0.49)	4325–4286(0.07); 4269–4036(0.88); 4023–3993(0.05)
Beta-214592	F35 kiln/oven in well/cistern	4329–4251(0.99); 4246–4246(0.01)	4347–4227(0.89); 4203–4167(0.07); 4128–4117(0.01); 4097–4076(0.02)
Beta-162071	Block 4 midden base of plowzone	4336–4311(0.35); 4304–4259(0.65)	4354–4231(0.98); 4194–4176(0.02)
Summed probabilities	**Vésztő-Bikeri site-younger dates**	**4335–4227(0.84); 4199–4169(0.12); 4089–4079(0.04)**	**4340–4047(1.0)**
Tiszapolgár culture, Vésztő-Bikeri site-main occupation			
Beta-179793	F21 Middle circular ditch fill	4335–4244(1.0)	4357–4224(0.84); 4206–4160(0.09); 4130–4070(0.07)
Beta-179792	F20 Inner circular ditch fill EU6-6	4342–4259(1.0)	4439–4425(0.01); 4369–4226(0.92); 4203–4166(0.05); 4128–4116(0.01); 4098–4074(0.02)
Beta-179787	F28 E w.t. F15, W. w.t. F4/14	4446–4419(0.07); 4399–4381(0.05); 4374–4223(0.55); 4208–4155(0.15); 4132–4064(0.18)	4551–3963(1.0)
Beta-179789	F26 (in F4/14) N w.t.,posthole	4353–4313(0.52); 4301–4260(0.48)	4447–4418(0.04); 4402–4231(0.95); 4193–4177(0.01)
Beta-214593	F15 North wall trench fill	4366–4315(0.64); 4299–4261(0.36)	4448–4415(0.09); 4405–4240(0.91)
Beta-162068	F4 house floor level	4360–4323(0.70); 4289–4267(0.30)	4446–4419(0.06); 4399–4382(0.02); 4374–4250(0.92)
Beta-162070	F5 possible house base of pz	4441–4424(0.11); 4370–4321(0.65); 4293–4265(0.24)	4450–4255(1.0)
Beta-179783	F14 house floor level	4446–4419(0.28); 4399–4381(0.17); 4374–4334(0.55)	4459–4318(0.93); 4296–4263(0.07)
Beta-179788	F26 (in F4/14) north wall trench	4446–4420(0.36); 4398–4382(0.20); 4374–4345(0.44)	4455–4335(1.0)
Beta-179786	F28 E w.t. F15, W. w.t. F4/14	4448–4415(0.35); 4405–4342(0.65)	4499–4318(0.95); 4296–4263(0.05)
Beta-179790	F19 Outer circular ditch fill	4446–4419(0.39); 4400–4379(0.27); 4375–4351(0.35)	4457–4338(1.0)
Beta-179785	F13 Bell pit (yellow clay zone)	4448–4415(0.40); 4405–4355(0.60)	4491–4334(1.0)
Beta-179784	F13 Bell-shaped pit (zone G)	4452–4364(1.0)	4512–4511(0.001); 4503–4338(0.999)
Beta-214589	F71 burial near r. tibia (charcoal)	4487–4476(0.09); 4464–4438(0.30); 4426–4369(0.61)	4519–4356(1.0)
Beta-179791	F27 posthole in Inner circular ditch	4493–4444(0.55); 4422–4372(0.45)	4530–4361(1.0)
Summed probabilities	**Vésztő-Bikeri-main occupation**	**4448–4325(0.93); 4283–4269(0.07)**	**4528–4229(0.99); 4195–4173(0.01)**

Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Tiszapolgár culture, Vésztő-Bikeri site-older dates			
Beta-162066	F4 house floor level EU2-18	4536–4456(1.0)	4593–4439(0.89); 4426–4369(0.11)
Beta-162065	F2 circular pit fill EU1-13	4584–4487(0.92); 4476–4465(0.08)	4681–4636(0.07); 4619–4455(0.93)
Beta-162069	F4 house floor level EU2-37	4769–4753(0.05); 4744–4733(0.03); 4730–4526(0.92)	4897–4865(0.02); 4852–4446(0.97); 4419–4399(0.01); 4380–4375(<0.01)
Summed probabilities	**Vésztő-Bikeri site-older dates**	**4582–4566(0.07); 4562–4456(0.93)**	**4777–4443(0.97); 4421–4393(0.02); 4385–4372(0.01)**
Summed probabilities, Vésztő-Bikeri site all dates		**4459–4253(1.0)**	**4602–4046(1.0)**
Summed probabilities Tiszapolgár culture		**4455–4227(0.89); 4199–4168(0.07);**	**4688–3934(0.99); 3872–3807(0.01)**
	all 47 dates combined	**4126–4120(0.01); 4091–4079(0.03)**	
Late Neolithic/Proto-Tiszapolgár phase, Deszk-Vénó site			
Deb-1201	Pit 3, Square II	4344–4233(0.97); 4188–4182(0.03)	4362–4219(0.75); 4213–4148(0.13); 4135–4054(0.12)
Late Neolithic/Proto-Tiszapolgár phase, Berettyóújfalu-Herpály tell			
Bln-2583	Levels 6–5	4444–4421(0.15); 4394–4387(0.04); 4373–4318(0.56); 4296–4263(0.25)	4459–4233(0.999); 4186–4185(0.001)
Bln-2493	Level 5	4542–4446(0.83); 4420–4398(0.13); 4382–4374(0.4)	4605–4355(1.0)
Bln-2668	Levels 6–5	4683–4633(0.37); 4622–4543(0.63)	4715–4487(0.997); 4469–4465(0.003)
Summed probabilities	**Berettyóújfalu-Herpály PTP**	**4596–4328(1.0)**	**4691–4256(1.0)**
Summed probabilities, Proto-Tiszapolgár phase		**4579–4570(0.02); 4554–4406(0.42);**	**4706–4227(0.96); 4200–4168(0.03);**
	all 4 samples combined	**4402–4379(0.06); 4374–4243(0.50)**	**4126–4119(<0.01); 4092–4078(0.01)**
Late Neolithic Csőszhalom culture, Bodrogzsadány-Akasztószer site			
Deb-417	Sq.Ix, pit a, above ashy layer	4443–4422(0.04); 4392–4390(<0.01); 4372–4038(0.91); 4019–3997(0.05)	4611–3892(0.96); 3884–3798(0.04)
Late Neolithic Csőszhalom culture, Tiszapolgár-Basatanya cemetery			
Deb-357	Grave 84, bone sample	5207–5161(0.07); 5137–5129(0.01); 5120–5095(0.04); 5080–4679(0.85); 4657–4655(<0.01); 4637–4619(0.03)	5338–5334(0.001); 5329–4447(0.995); 4417–4403(0.004)
Late Neolithic Csőszhalom culture, Polgár-Csőszhalom tell			
Bln-509	H. I/A uppermost level, 0.3–0.4 m bs	4518–4335(1.0)	4683–4632(0.03); 4622–4237(0.97)
Bln-512	H. I/F 16a (3.05 m bs) lowest level	4724–4500(1.0)	4844–4443(0.97); 4423–4372(0.03)
GrN-1993	H. I/F, lowest level (charred grain)	4788–4667(0.84); 4663–4653(0.04); 4639–4618(0.12)	4839–4547(1.0)
Bln-510	layer in Sec. I/10 (1.85 m bs)	4873–4871(0.01); 4848–4599(0.99)	4985–4500(1.0)

Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Bln-513	H. I/F (lowest level, 3.1–3.3 m bs)	4949–4708(1.0)	5194–5181(0.01); 5060–4548(0.99)
BM-2321	Layer 0.80–1.10 m deep	5206–5162(0.09); 5136–5130(0.01); 5119–5105(0.02); 5097–5096(0.01); 5079–4755(0.87)	5319–4528(1.0)
Summed probabilities, Polgár-Csőszhalom tell		**4930–4921(0.01); 4909–4517(0.98); 4505(<0.01)**	**5205–5160(0.01); 5135–5128(<0.01); 5118–5102(<0.01); 5097–5095(<0.01); 5079–4325(0.98); 4284–4268(<0.01)**
Summed probabilities, Csőszhalom culture (*n* = 8)		**4942–4445(0.97); 4417–4400(0.02); 4379–4374(0.01)**	**5214–4141(0.98); 4138–4051(0.02)**
Late Neolithic Herpály culture, Berettyóújfalu-Szilhalom site			
Bln-2675	Berettyóújfalu-Szilhalom	4677–4675(0.01); 4669–4659(0.03); 4654–4638(0.06); 4618–4446(0.81); 4419–4399(0.07); 4381–4374(0.02)	4764–4758(0.003); 4727–4339(0.997)
Late Neolithic Herpály culture, Esztár-Fenyvespart site			
Bln-1679	Esztár-Fenyvespart	4687–4553(1.0)	4767–4755(0.01); 4742–4736(0.01); 4728–4488(0.98); 4467–4466(<0.01)
Late Neolithic Herpály culture, Berettyóújfalu-Herpály tell			
Bln-2958	Level 6	4520–4442(0.63); 4424–4371(0.37)	4596–4348(1.0)
Bln-2494	Level 6	4546–4448(0.94); 4416–4404(0.06)	4906–4362(1.0)
Bln-2923	Level 6	4651–4642(0.03); 4616–4447(0.92); 4417–4403(0.05)	4701–4700(0.003); 4694–4358(0.997)
Bln-2584	Level 6	4687–4545(1.0)	4763–4759(0.004); 4727–4460(0.996)
Bln-2670	Level 6	4723–4594(1.0)	4785–4544(1.0)
Summed probabilities	**Berettyóújfalu-Herpály Level 6**	**4682–4632(0.20); 4621–4449(0.80)**	**4725–4356(1.0)**
Bln-2931	Level 7	4446–4419(0.19); 4399–4381(0.11); 4374–4324(0.55); 4288–4268(0.15)	4459–4238(1.0)
Bln-2993	Level 7	4451–4329(1.0)	4502–4236(1.0)
Bln-2706	Level 7	4611–4461(1.0)	4708–4446(0.98); 4419–4400(0.02); 4379–4375(<0.01)
Bln-2937	Level 7	4704–4544(1.0)	4778–4462(1.0)
Bln-2924	Level 7	4770–4752(0.09); 4746–4586(0.91)	4835–4504(1.0)
Summed probabilities	**Berettyóújfalu-Herpály Level 7**	**4705–4518(0.60); 4447–4414(0.11); 4404–4237(0.28); 4278–4273(0.01)**	**4781–4307(0.94); 4304–4258(0.06)**
Bln-2938	Levels 8–7	4487–4477(0.07); 4464–4361(0.93)	4545–4339(1.0)
Bln-2926	Levels 8–7	4714–4534(1.0)	4822–4820(0.002); 4799–4451(0.998)

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Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Bln-2929	Levels 8–7	4720–4554(1.0)	4826–4816(0.007); 4801–4490(0.993)
Bln-2925	Levels 8–7	4782–4606(1.0)	4844–4515(0.997); 4510–4504(0.003)
Summed probabilities	**Berettyóújfalu-Herpály Levels 8–7**	**4769–4753(0.05); 4745–4733(0.03); 4730–4520(0.83); 4484–4479(0.01); 4463–4447(0.04); 4417–4403(0.04)**	**4796–4352(1.0)**
Bln-2673	Level 8	4528–4438(0.63); 4426–4369(0.37)	4652–4640(0.01); 4617–4340(0.99)
Bln-2939	Level 8	4597–4452(1.0)	4685–4628(0.10); 4625–4438(0.80); 4426–4369(.10)
Bln-2927	Level 8	4677–4675(0.01); 4669–4659(0.05); 4655–4638(0.08); 4618–4460(0.86)	4719–4368(1.0)
Bln-2930	Level 8	4647–4645(0.01); 4614–4463(0.99)	4710–4447(0.98); 4418–4402(0.02); 4376(<0.01)
Bln-2932	Level 8	4682–4635(0.25); 4620–4499(0.75)	4674–4758(<0.01); 4727–4445(0.97); 4420–4397(0.02): 4383–4374(0.01)
Bln-2933	Level 8	4776–4773(0.01); 4771–4751(0.11); 4749–4612(0.88)	4832–4813(0.02); 4808–4541(0.98)
Bln-2940	Level 8	4785–4653(0.87); 4640–4617(0.13)	4836–4546(1.0)
Bln-2928	Level 8	4788–4612(1.0)	4892–4890(<0.01); 4882–4869(0.01); 4849–4522(0.99)
Summed probabilities	**Berettyóújfalu-Herpály Level 8**	**4702–4462(1.0)**	**4822–4820(<0.01); 4799–4365(0.999)**
Bln-2934	Level 9	4685–4629(0.28); 4625–4495(0.72)	4769–4753(0.01); 4744–4734(0.01); 4729–4442(0.94); 4424–4371(0.04)
Bln-2935	Level 9	4710–4581(0.91); 4571–4555(0.09)	4782–4502(1.0)
Bln-2936	Level 9	4893–4889(0.02); 4883–4869(0.08); 4849–4724(0.90)	4982–4970(0.01); 4964–4687(0.99)
Summed probabilities, Berettyóújfalu-Herpály Level 9		**4825–4817(0.02); 4820–4541(0.98)**	**4933–4451(1.0)**
Summed probabilities, Berettyóújfalu-Herpály tell		**4720–4448(0.995); 4411–4407(0.005)**	**4831–4812(0.01); 4807–4324(0.98); 4285–4268(0.01)**
Summed probabilities, Berettyóújfalu-Herpály w/out PTP		**4721–4452(1.0)**	**4835–4330(1.0)**
Summed probabilities, Herpály culture (*n* = 27)		**4717–4455(1.0)**	**4832–4811(0.01); 4808–4331(0.99)**
Late Neolithic Tisza culture, Deszk-Ordos site			
Bln-1934	Deszk-Ordos	4529–4344(1.0)	4686–4310(0.96); 4304–4259(0.04)
Late Neolithic Tisza culture, Kisköre-Gát site			
Bln-515	fireplace in pit (XVII,6) 1.6 m	4930–4924(0.02); 4910–4610(0.98)	5052–4462(1.0)

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Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Bln-179	sherds 0.8–1.6 m bs (XVII,6)	4989–4792(1.0)	5205–5168(0.02); 5075–4693(0.98)
Summed probabilies, Kisköre-Gát site		**4988–4718(1.0)**	**5201–5174(0.01); 5070–4513(0.99); 4506–4503(<0.01)**
Late Neolithic Tisza culture, Hódmezővásárhely-Gorzsa tell			
Deb-1389	Square IX, Level 2	4453–4356(1.0)	4531–4331(1.0)
Bln?	?	4520–4337(1.0)	4683–4633(0.03); 4622–4241(0.97)
Z-2009	C	4552–4339(1.0)	4711–4254(1.0)
Bln-3109	C	4539–4444(0.75); 4421–4394(0.17); 4386–4373(0.08)	4611–4349(1.0)
Fra-76	H.2 (burned), Blk III, L. 10, 2.0 m	4593–4362(1.0)	4767–4755(<0.01); 4741–4739(<0.01); 4728–4323(0.98); 4290–4266(0.01)
Fra-77	H.2 (burned), Blk.III, L.10, 2.1 m	4613–4441(0.80); 4424–4370(0.20)	4724–4336(1.0)
Deb-1238	Square XI, Level 10	4866–4540(1.0)	4722–4459(1.0)
Deb-1175	Sq.VIII, Lev. 16–17b	4687–4545(1.0)	4763–4759(0.004); 4727–4460(0.996)
Deb-1171	Square VI, Level 10	4687–4545(1.0)	4763–4759(0.004); 4727–4460(0.996)
Deb-1384	Sq.VIII, L.17c–e	4701(0.006); 4695–4552(0.994)	4778–4495(1.0)
Deb-1413	Grave 16, Square X	4710–4581(0.91); 4751–4555(0.09)	4782–4502(1.0)
Z-2010	C1	4796–4541(1.0)	4948–4448(0.99); 4416–4404(0.01)
Deb-1354	Grave 16, Square X	4776–4773(0.01); 4771–4751(0.11); 4749–4612(0.88)	4832–4813(0.02); 4808–4541(0.98)
Deb-1386	Sq.VIII, Lev. 16–17b	4785–4653(0.87); 4640–4617(0.13)	4836–4546(1.0)
Deb-1172	Sq.VIII, Lev. 12–13	4792–4668(0.86); 4660–4654(0.03); 4638–4618(0.01)	4842–4548(1.0)
Deb-1174	Sq.VIII, L.17c–e	4824–4818(0.02); 4800–4678(0.88); 4672–4670(0.01); 4658–4655(0.01); 4637–4619(0.08)	4877–4871(0.005); 4848–4549(0.995)
Deb-1173	Sq.XI, L.10, Ditch 1	4831–4813(0.10); 4808–4689(0.90)	4928–4925(<0.01); 4909–4862(0.05); 4858–4584(0.95)
Z-2011	D	4906–4863(0.12); 4856–4648(0.79); 4644–4615(0.09)	5034–4494(1.0)
Deb-1387	Sq.XI, L.10, Ditch 1	4841–4709(1.0)	4936–4650(0.97); 4643–4615(0.03)
Deb-1240	Grave 42, Sq. IX	4841–4709(1.0)	4936–4650(0.97); 4643–4615(0.03)
Fra-114	C1	4935–4686(1.0)	5039–4539(1.0)
Deb-1191	Sq. XVIII, L.24–25	4846–4712(1.0)	4944–4667(0.97); 4663–4654(0.01); 4639–4617(0.02)

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Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Fra-108	Pits 2 and 3, Level 16 (earliest level)	4981–4971(0.03); 4963–4727(0.97)	5207–5159(0.03); 5152–5151(<0.01); 5136–5129(<0.01); 5120–5095(0.01); 5080–4606(0.96)
Fra-95	Block III/b, L. 1, 1.15 m with 3 pots	4981–4971(0.03); 4963–4727(0.97)	5207–5159(0.03); 5152–5151(<0.01); 5136–5129(<0.01); 5120–5095(.01); 5080–4206(0.96)
Deb-1187	Grave 42, Sq. IX	4945–4797(1.0)	5020–4725(1.0)
Deb-1202	Grave 42, Sq. IX	5029–4882(0.89); 4870–4849(0.11)	5207–5159(0.05); 5136–5129(<0.01); 5119–5103(0.01); 5097–5096(<0.01); 5080–4792(0.93)
Summed probabilities, Hódmezővásárhely-Gorzsa		**4846–4495(1.0)**	**4994–4344(1.0)**
Summed probabilities, Tisza culture (*n* = 49)		**4893–4887(0.01); 4883–4867(0.03); 4849–4497(0.96)**	**5003–4339(1.0)**
Late Neolithic Early Tisza culture, Hódmezővásárhely-Kökénydomb tell			
Deb-1222	House 1, Level 3	4719–4582(0.94); 4568–4557(0.06)	4790–4514(0.99); 4510–4504(0.01)
Deb-1411	House 1, Level 3	4792–4668(086); 4660–4654(0.03); 4638–4618(0.10)	4842–4548(1.0)
Deb-1255	House 1, Level 3	4837–4703(1.0)	4932–4919(0.01); 4913–4607(0.99)
Deb-1364	Levels 3–4	4830–4814(0.07); 4806–4685(0.91); 4629–4625(0.02)	4896–4866(0.03); 4851–4580(0.96); 4572–4555(0.01)
Deb-1513	Levels 3–5	4841–4709(1.0)	4936–4650(0.97); 4643–4615(0.03)
Deb-1367	Pit 2	4936–4789(1.0)	4998–4719(1.0)
Deb–1388	House 1, Level 3	5203–5172(0.12); 5072–4930(0.82); 4924–4909(0.05); 4862–4859(0.01)	5209–4879(0.96); 4871–4848(.04)
Deb-1412	Level 6	5206–5166(0.18); 5117–5109(0.03); 5078–4935(0.79)	5213–4893(0.97); 4889–4883(<0.01); 4869–4849(0.03)
Deb-1365	Pit 1	5208–5034(1.0)	5292–5251(0.03); 5228–4938(0.97)
Deb-1263	House 1, Level 3	5218–5054(1.0)	5302–4998(1.0)
Summed probabilities, Hódmezővásárhely-Kökénydomb		**5205–5163(0.08); 5131–5130(0.01); 5118–5106(0.02); 5078–4980(0.20); 4968–4963(0.01); 4894–4866(0.05); 4849–4667(0.58); 4659–4653(0.01); 4637–4617(0.04)**	**5215–4580(0.99); 4570–4554(0.01)**
Late Neolithic Early Tisza culture, Szegvár-Tűzköves tell			
Deb-1221	Pit 93, Level 20	4719–4582(0.94); 4568–4557(0.06)	4790–4514(0.995); 4510–4504(0.005)
Deb-1355	Grave 1, Levels 10–12	4776–4773(0.01); 4771–4751(0.11); 4749–4612(0.88)	4832–4813(0.02); 4808–4541(0.98)

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Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Deb-1256	Levels 19–20	4987–4835(0.995); 4812–4810(0.005)	5053–4766(0.98); 4756–4729(.02)
Deb-1229	Levels 26–27	5029–4882(0.89); 4870–4849(0.11)	5207–5159(0.05); 5136–5129(<0.01); 5119–5103(0.01); 5097–5096(<0.01); 5080–4792(0.93)
Deb-1420	Pit 105, Level 29	5206–5166(0.18); 5117–5109(0.03); 5078–4965(0.79)	5213–4893(0.97); 4889–4883(<0.01); 4869–4849(0.03)
BM-2323	Pit in Tisza Layer over Szakalhát	5206–5165(0.26); 5118–5108(0.04); 5078–4986(0.70)	5208–4953(1.0)
Deb-1254	Levels 23–24	5223–5200(0.18); 5177–5067(0.82)	5297–5055(1.0)
BM-2322	Pit in Tisza Layer over Szakalhát	5465–5442(0.04); 5422–5407(0.03); 5381–4991(0.93)	5556–4767(0.99); 4755–4742(<0.01); 4735–4729(<0.01)
Summed probabilities, Szegvár-Tűzköves tell		**5214–4847(0.90); 4717–4680(0.07); 4655–4655(<0.01); 4635–4618(0.03)**	**5303–4540(1.0)**
Late Neolithic Early Tisza, Vésztő-Mágor tell			
Bln-1342	Level 3	4950–4768(0.94); 4754–4743(0.04); 4734–4729(0.02)	5197–5179(0.01); 5063–4683(0.99); 4633–4622(<0.01)
Bln-1626	House in Level 4	4976(0.01); 4961–4826(0.91); 4816–4800(0.08)	5038–4764(0.97); 4758–4728(0.03)
Bln-1625	House in Level 3	5208–5034(1.0)	5292–5251(0.03); 5228–4938(0.97)
Bln-1628	House in Level 3	5310–5207(0.76); 5161–5137(0.11); 5129–5120(0.05); 5102–5100(0.01); 5095–5080(0.07)	5352–5351(0.001); 5345–5046(0.999)
Summed probabilities, Vésztő-Mágor E. Tisza		**5283–5273(0.02); 5223–5191(0.08); 5182–5056(0.32); 4992–4795(0.58)**	**5308–4765(0.98); 4755–4727(0.02)**
Late Neolithic Early Tisza culture, Tápé-Lebő-A tell			
Deb-1186	Levels 1–2	4824–4818(0.02); 4800–4678(0.88); 4672–4670(0.01); 4658–4655(0.01); 4637–4619(0.08)	4877–4871(0.005); 4848–4549(0.995)
Z-2007		4892–4889(0.01); 4883–4869(0.03); 4849–4589(0.96)	5000–4486(0.99); 4478–4464(0.01)
Deb-1211	Level 8	4841–4709(1.0)	4936–4650(0.97); 4643–4615(0.03)
Deb-1356	Ditch 14, Level 16	4927–4925(0.01); 4909–4862(0.28); 4858–4768(0.63); 4754–4743(0.05); 4734–4729(0.03)	4988–4709(1.0)

Appendix 2 *(Continued)*

Lab nr		1-σ calib. range BP	2-σ calib. range BP
Deb-1363	Ditch 14, Level 16	5029–4882(0.89); 4870–4849(0.11)	5207–5159(0.05); 5136–5129(<0.01); 5119–5103(0.01); 5097–5096(<0.01); 5080–4792(0.93)
Deb-1176	Levels 5–6	5029–4882(0.89); 4870–4849(0.11)	5207–5159(0.05); 5136–5129(<0.01); 5119–5103(0.01); 5097–5096(<0.01); 5080–4792(0.93)
Deb-1264	Levels 12–13	5206–5166(0.18); 5117–5109(0.03); 5078–4935(0.79)	5213–4893(0.97); 4889–4883(<0.01); 4869–4849(0.03)
Deb-1196	Pit 24, Level 6	5207–5145(0.33); 5138–5127(0.05); 5121–5093(0.13); 5081–4996(0.49)	5223–4900(0.99); 4864–4854(0.01)
Deb-1267	Pit 41, Level 14	5208–5034(1.0)	5292–5251(0.03); 5228–4938(0.97)
Deb-1188	Level 10	5208–5034(1.0)	5292–5251(0.03); 5228–4938(0.97)
Deb-1265	Pit 37, Level 12	5213–5049(1.0)	5297–4980(0.99); 4971–4963(0.01)
Deb-1200	Pit 35, Level 12	5213–5049(1.0)	5297–4980(0.99); 4971–4963(0.01)
Deb-1197	Pit 32, Level 12	5223–5054(1.0)	5303–5005(1.0)
Deb-1195	Levels 14–15	5291–5268(0.11); 5226–5195(0.18); 5180–5061(0.71)	5308–5016(1.0)
Deb-1189	Levels 12–14	5298–5206(0.57); 5165–5118(0.26); 5108–5078(0.17)	5320–5027(1.0)
Deb-1366	Pit 53, Level 16	5338–5334(0.02); 5329–5212(0.98)	5464–5445(0.01); 5420–5409(0.01); 5380–5197(0.83); 5179–5063(0.15)
Deb-1643	Fea. 39, Level 17(12) charcoal	5466–5437(0.20); 5425–5405(0.13); 5384–5305(0.67)	5473–5286(0.90); 5272–5224(0.10)
Summed probabilities, Tápé-Lebő-A tell		**5300–4931(0.94); 4920–4911(0.01); 4793–4777(0.02); 4772–4769(0.01); 4750–4746(0.01); 4732–4729(0.01)**	**5461–5449(<0.01); 5375–4652(0.99); 4638–4616(0.01)**
Summed probabilities, Early Tisza culture (*n* = 39)		**5216–4906(0.75); 4862–4856(0.01); 4834–4710(0.24)**	**5320–4580(0.99); 4570–4554(0.01)**
Summed probabilities, Late Neolithic (*n* = 107)		**5021–5000(0.02); 4949–4446(0.96); 4416–4402(0.02)**	**5297–4328(1.0)**
Summed probabilities, Late Neolithic w/o PTP (*n* = 103)		**5025–4999(0.03); 4949–4450(0.97)**	**5293–5249(0.02); 5228–4339(0.98)**