Modelling the Rhythm of Neolithisation Between the Carpathians and the Dnieper River

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Dorsoduro 3246, 30123 Venezia | edizionicafoscari.unive.it/ | ecf@unive.it

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Abstract

This book proposes a discontinuous model for the Neolithisation in southern Eastern Europe based on the Bayesian modelling of the available radiocarbon dates. This model suggests that establishing agriculture and settled life required multiple attempts, interspersed with phases of hunter-gatherer resurgence. The Author posits that Mesolithic communities persisted in the region until the end of the seventh millennium BCE. Following the significant climatic event of 8200 cal BP, the first evidence of ceramic container production emerges north of the Black Sea. The rapid spread of early ceramics among hunter-gatherer groups in the early sixth millennium BCE likely cannot be explained solely by the gradual diffusion of ideas.
The first early farming communities appeared east of the Carpathian Mountains around 5700-5400 BCE, represented by groups of the late Criş culture, who introduced a full set of Neolithic cultivated plants. A subsequent wave of Neolithisation is linked to the expansion of the Linear Pottery Culture, whose groups went around the Carpathians from the north, reaching the Dnieper and Southern Buh rivers between 5250 and 5050 BCE. The decline of the LBK culture led to a resurgence of hunter-gatherer societies. Precucutenian groups brought agriculture and a sedentary way of life to Central Ukraine during a rapid expansion phase around the 47th and 45th centuries BCE. The Eneolithic societies appeared in the second half of the fifth millennium BCE.
The challenging continental climate and the difficulty of cultivating soils likely posed significant obstacles to the sustainability of early farming. Agricultural practices remained fragile for an extended period, often leading to episodes of cultural landscape abandonment on a regional scale. In contrast, the abundant natural resources of major river valleys supported a thriving riverine lifestyle, enabling fishers, hunters, and gatherers to persist for a prolonged period in southern Eastern Europe.

Keywords Radiocarbon chronology. Bayesian modelling. Early farmers. Ceramic hunter-gatherers. Microregional approach.

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The book also incorporates the results of joint research with many esteemed colleagues: Prof. N. Kotova, Prof. S. Ivanova, Prof. W. Tinner, Prof. E. Nielsen, Prof. S. Szidat, O. Tuboltsev, Dr. M. Lobanova, Dr. S. Radchenko, Dr. D. Werra, and Dr. O. Demchenko. I am grateful to Rhoda Allanic for her proofreading efforts. Additionally, I thank Anzhelika Kolesnychenko for her assistance with graphics and Simon Radchenko for mapping figures 4-7 to 4-10. Any drawings without specific attribution are by the Author; otherwise, they are credited to the aforementioned individuals, with my sincere thanks.

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To the memory of my grandmother,
Maria Kiosak (Zakharchenko)

Introduction

The Neolithic farming societies of Europe embarked on a rapid journey across diverse landscapes,[1] sparking significant debates over their movements, particularly in the last three decades.[2] Several theories have been proposed to explain the Neolithic agricultural expansion, yet most available data stem from research conducted in Western and Central Europe.[3] Meanwhile, the eastern frontier of early farming, encompassing the steppe and forest-steppe regions north of the Black Sea (including present-day Moldova, western and southern Ukraine), remains poorly understood.

The primary objective of this work is to present and discuss the southeasternmost distribution of early farming communities, as revealed by recent excavations in eastern Romania, the Republic of Moldova, and southwestern Ukraine. This region, extending from the Carpathian Mountains in the west to the Dnieper River valley in the east (Carpathian-Dnieper region, **[fig. 1: B]**), has provided significant new insights into the spread of early agriculture.

This book is primarily based on a newly acquired series of radiocarbon dates that have greatly improved our understanding of the

1 Biagi et al. 2005; Dolukhanov et al. 2005; Fort 2022; Krauß et al. 2018; Shennan 2018.

2 Allentoft et al. 2024; Bickle, Whittle 2013; Binder et al. 2017; Perrin, Manen 2021.

3 For an overview, see Shennan 2018.

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chronology of early farmers and their contemporaries in southern Eastern Europe. Accelerator Mass Spectrometry (AMS) dating has resolved several long-standing chronological disputes, reducing previous uncertainties of up to half a millennium to estimates within a century or two. However, for dating to be meaningful, it is crucial to understand precisely what is being dated. Therefore, this book also incorporates the latest advances in field research and the reinterpretation of previously known archaeological complexes. While the publication of archaeological materials is not the primary focus, it is necessary to characterise these findings to formulate the research questions addressed through dating.

By integrating new radiocarbon dates with current archaeological research, the study aims to provide a more accurate timeline and a deeper understanding of the early farming communities in the Carpathian-Dnieper region. New radiocarbon dates have created some imbalance in the structure of our knowledge of the Neolithic in southern Eastern Europe. Certain phenomena have received radiocarbon dates that are radically different from those expected.[4] The current chronology requires changes in our understanding of historical flow of events in the region; first of all, a radical restructuring of the typo-chronological schemes, often not confirmed by radiocarbon dating. Moreover, the very perception of the groupings identified by the typo-chronological method now needs to be re-examined – the concept of a well-defined chronologically limited package of material culture seems to have to be replaced by various possible chronological relationships between the identified phenomena.[5] Coexistence, partial or complete, seems to occur more often than was assumed in the development of typo-chronologies.[6] Furthermore, the sequence of phases, when the first one leads to the next, is questioned because frequently, where a smooth development has been expected, the radiocarbon chronology shows suspicious gaps.[7]

The Neolithic period marked a pivotal phase in cultural and technological advancement, namely, the move from a lifestyle centred around hunting and foraging to one predominantly centred on agriculture: the Neolithic way of life. It included a change towards more enduring or permanent habitation, the emergence of robust housing structures, the inception of pottery usage, and profound shifts in human beliefs and ideologies.[8]

4 Biagi et al. 2007; Kiosak et al. 2023c; Lillie et al. 2020a; Motuzaite Matuzeviciute et al. 2015; Shatilo 2021; Videiko 2016.

5 Nakoinz, Knitter 2016.

6 Diachenko et al. 2024.

7 Nielsen et al. 2019.

8 Childe 1925; Dennell 1983; Shennan 2018; Whittle 1996.

The expansion of the Neolithic way of life is known as 'Neolithisation'. The advantage of this term is its ambiguity. It refers to:

1. the spread of the Neolithic way of life with the migration of its carriers;
2. the spread of the Neolithic as an idea.[9]

Since the former is extensively documented, and the latter is subjected to a reasonable doubt in our region under study, it seems reasonable to use the term Neolithisation, referring to the processes of agricultural spread in the Carpathian-Dnieper region.[10] Neolithisation laid the groundwork for many of the material and cultural achievements that would contribute to later developments in the prehistoric period.

Some scholars believe agriculture in the Balkans north of the Rhodope Mountains began around 6050 BCE, with available data supporting the arrival of early farmers in the region east of the Carpathians around 5800-5700 BCE.[11] These settlers, belonging to the later stages of the Criş culture **[fig. 1: I]**, established their villages up to the western bank of the Dniester River.[12] Only in a subsequent phase, from 5250-5100 BCE, did the Neolithisation process expand to encompass the broad territories of Podillia and Volhynia, extending as far as the Southern Buh and Dnieper rivers.[13] During this period, groups of the Linear Pottery culture (hereafter LBK **[fig. 1: II]**) founded more than 300 sites in the study region. The third wave of agricultural colonisation was attributed to the Trypillia-Cucuteni people during the fifth millennium BCE **[fig. 1: III]**, as they ventured across the Dnieper River and settled in the Central Ukrainian uplands. Over at least two millennia, the easternmost periphery of the Neolithic world traversed the plains of southern Eastern Europe, sometimes pausing for extended periods without apparent geographic barriers. The question is, did this movement lead to contact with the local population?

In the sixth and fifth millennia BCE, the Carpathian-Dnieper region acted as a zone where two distinct subsistence economy systems lived side by side. The intrusive lifestyle was represented by early farmers originating from the Balkans and Central Europe.[14] They inhabited settlements and shared religious beliefs and group

9 Budja 1993.

10 Kotova 2009.

11 Dergachev, Dolukhanov 2007; Ursulescu 1984.

12 Yanushevich 1989.

13 Saile 2020.

14 Dergachev, Dolukhanov 2007; Lillie et al. 2020b; Telegin 1987.

identity expressions, such as linear-decorated pottery. In contrast, the local tradition exhibited characteristics that diverged from the Neolithic practices of the Balkans and Central Europe. These local inhabitants were predominantly hunter-gatherers with probable (yet to be validated) limited experience in a specific form of agriculture and herding,[15] alongside the use of polished stone axes and pottery.[16] They settled vast territories in Eastern Europe, stretching from the Dniester River's catchment area to the Don and Volga Rivers.[17]

The Neolithisation in this region remains insufficiently studied despite a long history of research.[18] One of the reasons for this is the distinctiveness of local archaeological traditions, in particular their own special set of terms. In particular, the very concept of the Neolithic is often understood only by the presence of certain innovative elements of material culture rather than the complete establishment of the Neolithic way of life. Ceramic ware is often considered the defining feature of the Neolithic period.[19] And sometimes even the characteristics of the knapped stone assemblages.[20] Therefore, studies of Neolithisation often focus on the spread of some ceramic styles rather than on the diffusion of cultivated plants and domestic animals. The corresponding dissonance, when the term 'Neolithic' has two senses, makes it difficult to understand the results of Eastern European archaeologists and distorts the local tradition's reception of pan-European explanatory models.[21]

In this text, we propose to designate as 'Neolithic' only those groups that practised agriculture and cattle breeding. Groups that had ceramic technology but primarily engaged in fishing, hunting, and gathering – often labelled as 'Neolithic' in local archaeological traditions – will be referred to as 'para-Neolithic' hereafter. This clear terminological distinction will allow for better systematisation of the data, making the material culture differences between early farmers and ceramic-using foragers more apparent.

Why not simply refer to the latter as 'Mesolithic'? Doing so would confuse Eastern European readers, as the term 'Mesolithic' is traditionally reserved for the well-known predecessors of the ceramic and agricultural spread in this region. The para-Neolithic is not a separate and distinct archaeological period like the Neolithic or

15 Endo et al. 2022; Motuzaite Matuzeviciute 2020.

16 Telegin 1985b; 1987.

17 Dolbunova et al. 2023.

18 Tovkailo 2020.

19 Kolpakov et al. 2023.

20 Man'ko 2007; Zaliznyak 1998.

21 Man'ko; Telizhenko 2016; Zaliznyak 2017.

Mesolithic. Instead, in the context of Eastern Europe during the sixth to fifth millennium BCE, the Neolithic and para-Neolithic refer to two groups of roughly contemporaneous communities: one primarily engaged in agriculture and animal husbandry, and the other did not.

Do para-Neolithic groups represent 'transitional societies' between the Mesolithic and Neolithic communities 'on the way to the Neolithic'?[22] Not necessarily. It is premature and often erroneous to assert this for all para-Neolithic communities.

Along with the term 'para-Neolithic', it has been suggested that the term 'sub-Neolithic' should refer to a roughly similar range of phenomena.[23] However, the concept of 'sub-Neolithic' implies that the changes observed in hunter-gatherer communities, which distinguish them from earlier Mesolithic hunter-gatherers, were driven by contact with Neolithic groups.[24] In our opinion, this thesis is debatable and requires additional evidence. Therefore, we will use the more neutral term 'para-Neolithic'.

Several methodological tools allow us to see the archaeology of the first farmers and their contemporaries in southern Eastern Europe in a new light. They include:

1. post-depositional criticism armed with a microstratigraphic approach to the sites;
2. serial radiocarbon dating to complement and verify the typological seriation;
3. deconstruction of traditional ethnically-concerned archaeological taxonomies.[25]

These methodological tools have been known for a long time. Nevertheless, the peculiarities of the national archaeological traditions make them still novel here when applied in combination.

Therefore, the microstratigraphical approach, detecting cultural layer disturbances, later admixtures, and non-synchronous structures, combined with flotation and water-sieving, proved a powerful tool. Namely, until not long ago, the synchronisation of many phenomena relied on the detection of their characteristic things in the same contexts. Concerning the Neolithic, these contexts often were only cultural layers and not some features. The 'microstratigraphic critique' demonstrates that these synchronies are questionable due to contamination of the cultural layers with later materials. Moreover, the definition of archaeological groupings could be erroneous because of the mixing of entirely different types of phenomena since

22 Haskevych et al. 2020; Zvelebil, Lillie 2000.

23 Haskevych et al. 2019.

24 Nowak 2007.

25 Kohl 1998.

it relied on sites yielding systematic disturbances of cultural layers in certain natural conditions and not on archaeological reality.[26]

Thus, a microstratigraphic approach to excavations, even of well-known sites, seems productive. It allowed us to identify differences that the first excavators did not notice and to detect new cultural layers and stratigraphic units at some sites. In particular, two 'long sequences', Kamyana Mohyla 1 and Melnychna Krucha, were studied this way (together with N. Kotova, W. Tinner, and E. Nielsen). At both sites, the stratigraphic sequence was confirmed by palaeopedological analysis and 3-D analysis of the finds' point cloud. Properly dated sites constitute a reference that can be used to solve problems of the chronology of some archaeological phenomena of a larger scale.

When a site's stratigraphy is clarified and understood at the microstratigraphic level, sampling for radiocarbon dating becomes meaningful. We understand what we are dating (in most cases). The new radiocarbon dates were obtained using accelerated mass spectrometry (AMS) in the laboratories of Bern and Poznan. This method provides minor standard deviations than most conventional dates available for the study area. During the author's MSCA project and related inquiries, the radiocarbon database was expanded by 45 new dates.

The dates were then processed using calibration and statistical techniques based on the Bayesian algorithm in the OxCal software.[27] Calibration is the transition from a sample's radioactive carbon content to the sample's position on a time scale.[28] The now widely accepted Intcal20 curve makes it possible to accurately shift to calibrated dates within the Holocene.[29]

Bayesian statistics offers a straightforward, probabilistic approach to blending various types of evidence in estimating prehistorical event dates and explicitly expressing the uncertainties in these estimations. This methodology allows us to factor in the interconnections among samples when calibrating a set of connected dates. An obvious application of this type of modelling is the implementation of stratigraphic information on the order of stratigraphic units. This allows the dating of the lower unit to be used as a *terminus post quem* for the upper unit, and so on.[30] Also, it is natural to test typo-chronological schemes when the order of phenomena established by the latter is used as a hypothesis to order relevant radiocarbon dates.[31] Thus, the validity of the

26 Sorokin 2006.

27 Bronk Ramsey 1995; 1998; 2009; Bronk Ramsey, Lee 2013.

28 Buck et al. 1991.

29 Reimer et al. 2020.

30 Bronk Ramsey 2009.

31 Diachenko et al. 2024.

resulting model corresponds to the validity of the typo-chronological scheme. For this purpose, the built-in functions Boundary, Sequence, Phase and several others are used in OxCal software.[32]

All new radiocarbon dates were obtained from fragments of bones and all results are conventional radiocarbon ages.[33] Here and thereafter, we differentiate clearly between calibrated 14C dates (cited 'calBCE') and estimates interpolated from 14C dates, typological seriation and stratigraphies (cited 'BCE').

An archaeological culture is an amorphous classificatory unit, which is meant to imply both temporal longevity and spatial coherence of some similar items in the archaeological record.[34] The complete dominance of the cultural-historical approach in local archaeological traditions has led to an understanding of archaeology as a 'science of cultures', with 'culture' often having a distinct ethnic meaning.[35] However, archaeological culture is only a tool, a unit of classification, important insofar as it is useful for the purpose of research.[36] Therefore, one of the techniques constantly used in this work is the 'deconstruction' of the well-known archaeological cultures of the region, attempting to see the archaeological reality behind the classification grid. A logical move to prehistoric reality requires seeing beyond the classificatory frameworks and understanding the actual duration and limits of human societies under question.

The Carpathian-Dnieper region lies in the temperate climate zone of the Northern Hemisphere. Within its borders, three physical and geographical zones can be seen: forest, forest-steppe and steppe, and in the Carpathians, there is a high-altitude zone. The region's physical and geographical zones vary markedly from west to east (primarily regarding climate, soil, and vegetation). Summers are long, sunny, hot, and arid. Autumn is warm and rainy in the second half. Winters are short, mild, and snowy. Spring comes early. Due to a sharp rise in air temperature, moisture evaporates quickly from the soil.[37] Chernozem is the region's predominant soil type, encompassing over 65% of the land. This soil variety boasts an abundance of nutrients and exceptional fertility, making it the preferred choice for Neolithic farmers across many regions.[38]

32 Bronk Ramsey, Lee 2013.

33 Stuiver, Polach 1977.

34 Childe 1929, v-vi.

35 Kohl 1998.

36 Shanks, Tilley 1992.

37 Marynych 1990.

38 Kiosak, Matviishyna 2023.

The book's structure is organised according to the archaeological classification of the studied phenomena. Chapter 1 discusses the current chronology of the Mesolithic in the region, using the 'long sequences' from Kamyana Mohyla 1 and Melnychna Krucha as reference case studies. Chapter 2 addresses the para-Neolithic, focusing on the spread of the first ceramics in the region and the formation of para-Neolithic communities. This chapter also touches upon the deconstruction of certain typological concepts, such as the 'Buh-Dniester culture'. Chapter 3 presents the latest data on the chronology of agricultural dispersals in the Carpathian-Dnieper region. Chapter 4 employs a microregional approach, concentrating on a small region of the Southern Buh River valley **[fig. 1: A]**. This chapter aims to elucidate the spatial aspects of agricultural dispersals and their probable relationship to the spatial patterns of the local population.

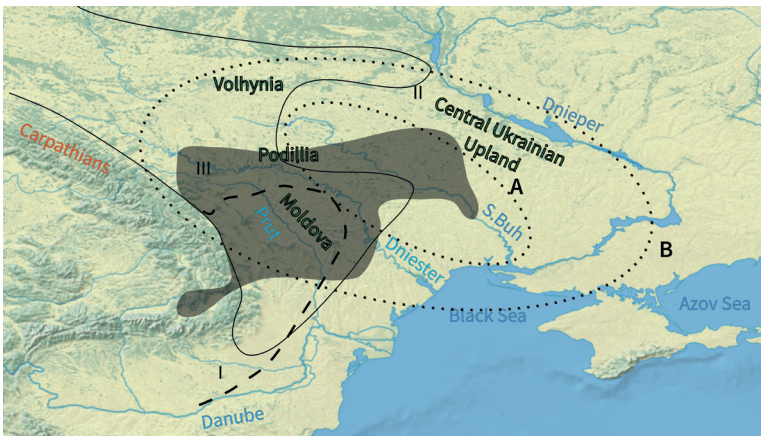

Figure 1 A – focus micro-region (Chapter 4), Southern Buh region; B – the study region, Carpathian-Dnieper region. Distribution areas of the following cultural aspects: I – Criș; II – LBK; III – Early Trypillia. Map by the Author, Topo: Natural Earth

1 Who's Indigenous Here? Disentangling 'Mesolithic Prelude'

Summary 1.1 The Issue of 'Mesolithic Heritage'. – 1.2 The Current Typo-Chronological Schemesand Their Flaws. – 1.3 New Stratigraphic Sequences and Radiocarbon Dates. – 1.4 The Mesolithic Sequence Reconstructed?. – 1.5 'Mesolithic Heritage' Revised. – 1.6 Conclusion.

The search for a 'Mesolithic heritage' in Neolithic communities has recently received a new impetus from palaeogenetic studies.[1] However, Neolithic migrants could only interact with those Mesolithic groups that existed at the time of their arrival in a particular region.[2] This requirement of simultaneity is the necessary minimum for the assertion of interaction. Consistent application of this requirement has made it possible to refute certain hypothetical episodes of interaction.[3]

Sadly, the Mesolithic chronology in the south of Eastern Europe requires considerable work to revise it in its current state. In the region, the archaeological periodisation is based almost exclusively on typological seriation and only to a small extent on stratigraphic and

1 Bramanti et al. 2009; Mathieson et al. 2018; Szécsényi-Nagy et al. 2015.

2 Perrin, Manen 2021.

3 Biagi et al. 1993.

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isotopic dating data.[4] Serial radiocarbon dating casts doubt on several formerly generally accepted statements, which were not based on any robust chronological frame.[5] The full picture is still emerging. Only certain episodes have been dated and firmly placed on the chronological scale.[6] This section is devoted to an examination of these episodes and a consideration of their significance in the context of the Neolithisation of the region.

First, we will reformulate the problem of the Meso-Neolithic interface in the light of the region's peculiarities (§ 1.1), then briefly review the existing (as formulated by the classics of Ukrainian Mesolithic studies)[7] framework of periods and cultures (§ 1.2). After that, we will introduce new information on the Mesolithic chronology obtained thanks to the serial dating of stratigraphic sequences recently studied, including the sites excavated under the supervision or with the participation of the author (§ 1.3) and try to summarise this information in the context of other sites (§ 1.4). Finally, the last subsection (§ 1.5) is devoted to a view of the Mesolithic 'heritage' from the perspective of Neolithic flint industries. What exactly is Mesolithic about the latter?

1.1 The Issue of 'Mesolithic Heritage'

Local hunter-gatherers have played a significant role in the Neolithisation of the south of Eastern Europe according to almost every author who has ever touched on this topic.[8] This role ranged up to the autochthonous domestication of certain animals in the study area: pigs[9] or bovids.[10] Nowadays, these autochthonous constructions lack sufficient evidence, and some of them have been directly refuted.[11] According to the consensus opinion, the lithic inventories of Neolithic communities usually contained certain elements from the industries of their Mesolithic predecessors, which suggested a certain continuity of population in different regions, a Mesolithic substrate, or at least intensive contacts between early farmers and local Mesolithic groups.[12]

4 Zaliznyak 2020.

5 Biagi et al. 2007; Motuzaite Matuzeviciute et al. 2015.

6 Kiosak 2019b.

7 Stanko 1982; Telegin 1982; Zaliznyak 2020.

8 Anthony 2007.

9 Stoliar 1959.

10 Danilenko 1986; Stanko et al. 1999.

11 Shnirelman 1989.

12 Dergachev, Dolukhanov 2007.

A long tradition sanctified a vision of Neolithisation, in which local Mesolithic populations remained in place for thousands of years and transformed into new Neolithic communities through the adoption of agriculture and pastoralism.[13] Upon their arrival, the new-coming early farmers came into contact with the indigenous groups and the latter modified their ways of life. In particular, it was proposed that the formation of the 'Neolithic Buh-Dniester culture' should be viewed as 'a two-way process in which the local Mesolithic traditions were fused (hybridised) with the traditions of more 'progressive' newcomers from the Balkan-Danubian tribes, with the dominance of the latter'.[14] Namely, 'the carriers of syncretic lithic inventories of Hrebenyky – Kukrek type'[15] were supposed to have been affected by the Neolithisation in this case. Then, in the early Neolithic period the influence of 'Western Neolithic cultures' suggested to 'have expanded eastwards over the entire right bank region (of the Dnieper) and ultimately further to the east of the Dnieper itself, in particular exerting an influence on the population of the Mesolithic Kukrek culture, which would have resulted in the emergence of the Neolithic Surskyi culture, Early Neolithic sites of the Matveev-Kurgan type and the Rakushechny Yar cultures'.[16] The discussion focused around the ways and timing of Neolithisation. Indeed, the 'Balkan' vision outlined above was opposed by supporters of the 'Circum-Caspian', 'Caucasian'[17] and 'maritime'[18] routes. However, the very nature of the process – through the reception of elements of a new way of life by the local hunter-gatherer population – has never been questioned in Soviet and post-Soviet historiography.

This approach found consonance in the works of the 'neo-autochthonous' direction of Neolithic archaeology. Specifically it was suggested that local 'ceramic' groups were 'hunter-gatherers in the availability phase', and the 'Buh-Dniester culture' was a 'transitional society'.[19] Several authors have reconstructed the networks of contacts, sometimes hundreds and thousands of kilometres long, between hunter-gatherers and early farmers.[20] 'The Buh-Dniester culture' was perceived as a local variant of the Criş culture,[21] as its

13 Krychevskyi 1941; Tovkailo 2020.

14 Tovkailo 2020, 113.

15 Zaliznyak 2020, 105.

16 Tovkailo 2020, 114; Zaliznyak 2006; Zaliznyak et al. 2013.

17 Danilenko 1969; Gorelik et al. 2016; Kotova 2003; Man'ko 2007.

18 Gaskevych 2011; Kotova 2009; Kotova et al. 2021.

19 Zvelebil, Lillie 2000.

20 Gorelik et al. 2016; Reingruber 2016.

21 Monah, Monah 2002.

'barbaric periphery'.[22] However, neither the local origin of the 'Neolithic population' nor the diffusion of agriculture and cattle breeding mainly by reception were subject to critical discussion. Considering this problem, it should be borne in mind that several recent discoveries have changed Ukrainian Neolithic studies[23] in such a way that a number of statements that looked quite acceptable until recently now have only anecdotal value. For example, the term 'Neolithic' has long been used to refer to both early farmers and their predecessors and contemporaries who used ceramics, but there is a clear lack of evidence of the acquaintance of the latter with agriculture and cattle breeding.[24] In this book we use the term 'para-Neolithic' to denominate them (see the next section for a more detailed discussion). Accordingly, the interaction of Mesolithic groups with early farmers and the interrelation of the Mesolithic and para-Neolithic are separate problems.[25]

This question is very controversial and is directly related to the discussion about the time and ways in which the first ceramics appeared in the Eurasian steppe and forest-steppe (see also chapter 2).[26] If we assume, as many do,[27] that hunter-gatherer ceramics appeared under the influence of early farmers, then the idea that early farmers could only interact with para-Neolithic groups loses any meaningful component – because hunter-gatherer communities became para-Neolithic thanks to the contact with early farmers. However, the available archaeological sources, particularly the corpus of radiocarbon dates, suggest a more complex course of history, with an independent process of para-Neolithic formation in the south of Eastern Europe.[28] This is supported by the distinctive originality of the oldest ceramics in the region.[29] Such ceramics spread independently of agriculture, animal husbandry, and other components of the Neolithic way of life. It is a phenomenon of hunter-gatherer societies.[30] The way it spread – demographic diffusion or the spread of an innovation – is a separate and not fully understood problem.

The clear separation of the Mesolithic and para-Neolithic that we propose in this work helps to distinguish these two groups of sites.

22 Zaliznyak 1998.

23 Zaliznyak 2017.

24 Benecke 1997; Endo et al. 2022; Motuzaite Matuzeviciute 2020.

25 Kiosak 2016b.

26 Dolbunova et al. 2023; Kuzmin 2002; Piezonka 2015.

27 Kotova et al. 2021; Tovkailo 2020.

28 Dolbunova et al. 2023.

29 Danilenko 1969.

30 Piezonka 2015.

This distinction will serve to put this problem more sharply: were the first hunter-gatherers with ceramics really local people? Or were they part of a migration that took place in the bowels of hunter-gatherer societies before Neolithisation? It is unconscious racism to assume that all hunter-gatherers are endlessly local groups without their own dynamic history.

The distinction between early farmers and hunter-gatherers with pottery in the region of study, first fully realised by D.Y. Telegin,[31] has in fact been neglected quite often. Several statements on the significant role of local hunter-gatherers in the Neolithisation of the region were actually based on a comparison of Mesolithic and para-Neolithic assemblages, not Neolithic ones. Bearing this in mind, we will try to build a list of hunter-gatherer communities (both pottery-making and not) that could have interacted with early farmers. Then, we will consider the evidence of interaction and new ideas about the chronological position of the actors, in an attempt to narrow down the list of probable agents.

1.2 The Current Typo-Chronological Schemes and Their Flaws

This paragraph intends to represent the current typo-chronological schemes for the Mesolithic of the region in question in the state in which they had existed prior to the research conducted in the book. The author tries to abstain from critique in this paragraph (§ 1.2) and reserves it for further discussion.

The period immediately preceding the emergence of early agricultural societies in the region of study has usually been divided by researchers into two parts.[32] The first part (eleventh-eight millennia BCE, Early Mesolithic) was rooted in the depths of the Palaeolithic period. The second (Late Mesolithic) was a precursor to Neolithisation. L.L. Zalizniak proposed to call the spread of the Late Mesolithic Protoneolithisation.[33] This dual division initially reflected the Western European concepts of Azilian and Tardenoisian, and later the First and the Second Mesolithic.

The Early Mesolithic period was initially associated with two groups of sites: Tsarynka and Bilolissia.[34] However, recent evidence has solidly established that the Tsarynka sites existed during the

31 Telegin 1985b.

32 Danilenko 1969; Kozlowski, Kozlowski 1979; Păunescu 1970; Stanko 1967; 2007; Stanko, Kiosak 2007; Telegin 1982; Zaliznyak 1998; 2020.

33 Zaliznyak 1998.

34 Stanko 1982.

Allerød period[35] as has been suspected for some time.[36] Some radiocarbon dates from Tsarynka-type sites (Osokorivka, Leontijivka, Rogalyk etc.) fall within this period **[fig. 3]**. The sole excavated site from the Bilolissia group, Bilolissia itself, yielded a radiocarbon date from the Preboreal age (Ki-10886; 8,900 ± 160; 9,255-7,815 calBCE **[fig. 3]**). It is worth noting that the spatial layout of the Bilolissia site is intricate enough to suggest the presence of multiple episodes in the site's history.[37] Furthermore, surface collection also include some artefacts belonging to the Epigravettian tradition. Thus, the early Mesolithic of southern Ukraine and Moldova as it was defined in the early 1980s was mostly re-attributed to Final Palaeolithic. This left a certain space that has not yet been filled. There is a gap in the chronological time frame.

V.N. Stanko supposed that due to evident similarities between the latest Epigravettian of Eastern Europe and the Kukrek techno-complex of the Boreal-Atlantic periods, there should be a 'missing link' – yet-to-be-found Early Mesolithic sites of Epigravettian tradition in the north Pontic region.[38] In this case, the Mesolithic origin in southern Ukraine should conform to J.K. Kozłowski's Model 1[39] – with the persistence of the Epigravettian tradition during Holocene. One might hypothesise that such sites did exist and have probably even been already discovered but have remained unrecognised within the general bulk of Kukrek and Kukrekoid sites. They certainly existed on the Crimean steppe and are represented by the site of Vyshenne 1 (lower layer), excavated by O.O. Yanevich. It is characterised by conical cores for microblades, end-scrapers on large flakes, multiple burins on flakes, and an 'archaic Gravettoid point'.[40] It represents Kukrek's early stage according to Yanevich's (1987) periodisation but in fact, it is different enough to be treated as a separate, post-Epigravettian cultural variant of the north Pontic Early Mesolithic.

Another Early Mesolithic variant was defined by O.O. Yanevich based on finds from the middle layer of the Shpan-Koba rock shelter **[fig. 2: 7]**. It is called the Shpan culture and the knapped stone artefacts are characterised by oblique points *à piquant triedre* and elongated triangles. This cultural variant is dated to the late Preboreal–early Boreal (GIN-6276, 9,150 ± 150 BP, 8,800-7,940 calBCE). It is

35 Biagi et al. 2007; Gorelik 2005; Olenkovskiy 2010.

36 Zaliznyak 1998.

37 Kiosak 2019b; Stanko, Kiosak 2007.

38 Stanko, Kiosak 2007.

39 Kozlowski, Nowak 2008, 106.

40 Yanevich 1987.

known mostly in the mountains of Crimea but O.O. Yanevich and D.Ju. Nuzhnyj also observed its traces in the steppe of the north Pontic region.[41] However, early Mesolithic sites in southern Ukraine and Moldova are very scarce and their chronology is questionable.

The advent of the Late Mesolithic is marked by a notable change in lithic technology, namely the predominance of a very regular bladelet (7-12 mm wide laminar products) production technique[42] resembling the distant western phenomenon of Montbani style technology[43] and the emergence of geometric microliths, mostly in trapezoid form. There are more than a hundred Late Mesolithic sites in the steppe region between the Carpathians, the Podillian Upland, the Ukrainian Crystallic Shield upland, the Dnieper Valley, and the Black Sea's north coast. In Ukraine and Moldova, they are traditionally subdivided into two large techno-typological 'blocks': geometric (containing geometric microliths) and non-geometric (with other types of projectiles) assemblages.[44]

The 'geometric block' **[fig. 4 left]** is represented by assemblages that contain 'flat' one-sided prismatic cores, multiple fragments of regular bladelets and blades with parallel edges and negatives of previous detachments, end-scrapers on small flakes, very often of circular and semi-circular types, and few burins (usually less than 1% of the tools). The geometric microliths comprise almost exclusively trapezes. Single lunates have been found but mostly either as surface material or in other 'dubious' contexts. The 'geometric block' is represented by the Hrebenyky culture.[45] The 'Hrebenyky culture' is open to various interpretations in terms of its extent: it can be seen as being of limited extent when the Hrebenyky distribution area is considered as confined by the Ingulets river in the east;[46] of 'wide' extent, when the culture incorporates sites to the east of the Dnieper River;[47] and of 'maximum' extent when 'Hrebenyky' is understood as a cultural-historical entity encompassing several archaeological 'cultures'.[48] However, there is a consensus on the structural position of the Hrebenyky culture. It is a Late Mesolithic cultural entity, equivalent to the Tardenoisian

41 Nuzhnij 1998.

42 Stanko 1982; Telegin 1982.

43 Rozoy 1968.

44 Covalenco 2017; Smyntyna 2007; Stanko, Kiosak 2010; Telegin 1982; Zaliznyak 2005; 2006; 2020.

45 Kozlowski, Kozlowski 1979; Stanko 1967.

46 Telegin 1982, 92.

47 Stanko, Kiosak 2010; Zaliznyak 2005.

48 Man'ko; Chkhatarashvili 2023.

and Castelnovian of Western Europe[49] (contra)[50] or the Darkvetian of Georgia.[51] In the Ukrainian and Moldavian Mesolithic archaeology, the only notable exception is the chronological scheme of I.V. and G.V. Sapozhnikovs.[52] Here the Hrebenyky starts from the very beginning of the Holocene, after which it is replaced by a non-geometric industry ('Kukrek') and later returns to form a 'syncretic' culture combining the characteristics of both geometric and non-geometric entities.

The 'non-geometric block' **[fig. 4 right]** is represented by the sites, usually united under the heading 'Kukrek culture'. They are characterised by microlithic, (often 'pencil-like') cores, fragments of microblades (less than 7 mm wide), bladelets and blades, end-scrapers on large flakes, simple, double and multiple burins on blades and flakes, and retouched fragments of blades with ventral trimming ('Kukrek inserts'). The microliths take the form of backed points, backed points with a truncation ('Abuzova Balka points'), as well as oblique points.[53] This culture finds no parallel in the cultural sequences of Southern and Western Europe. The consensus concept of the Kukrek culture, which is traditionally accepted nowadays, but which will be refined by this book, is as follows. The first Kukrek phase dates most probably to the Early Mesolithic,[54] while the 'classical' Kukrek sites are attributed to the Late Mesolithic.[55] Later, its elements are supposed to be incorporated within quite a few succeeding Neolithic (para-Neolithic in this book's terminology) cultures.[56] The latter author suggested that some cultures retained a Kukrek-like lithic inventory until the advent of the Chalcolithic period. Thus, the Kukrek concept is too vague, stretched in time and space, and needs to be refined and 'regionalised' by identifying the characteristics of Kukrek artefacts that would have had a limited distribution in time and/or space.

In the current literature,[57] the Kukrek cultural and historical community appears as an extremely long-lived (about 6,000 years of history) and widespread phenomenon in the territorial sense. At the same time, until recently, none of the sites with a distinct Kukrek inventory had an unambiguous chronology based on a coherent series of radiocarbon dates. Most Kukrek sites are represented by

49 Stanko 1982; Zaliznyak 1998.

50 Biagi 2016.

51 Man'ko; Chkhatarashvili 2023.

52 Sapozhnikov, Sapozhnikova 2011.

53 Telegin 1982, 98-119.

54 Yanevich 1987.

55 Stanko 1967; Telegin 1982.

56 Zaliznyak 1998; 2020.

57 Zaliznyak 2020.

surface finds (Bubynka, Abuzova Balka, Kinetspil, Gura Camencii 6, Varvareuca 9, Trapivka). The Kukrek materials were known from the well-documented excavations of Kukrek, Domchi-Kaya, Ihren 8, Sahaidak 1, and Kamyana Mohyla 1.[58]

But every radiocarbon-dated site has yielded both early (ninth-eighth millennium BCE) dates along with the dates of seventh millennium BCE.[59] Several excavated Kukrek sites are evidently inhomogenous, containing materials of many cultures and epochs (Dobrianka 3, Balin-Kosh, Myrne, Zaliznychne, Frumuşica, Katarzhyno 1).[60] In the next paragraph, I introduce two Kukrek assemblages, excavated and dated recently, which have considerably changed our understanding of this phenomenon.

So far, three Hrebenyky sites have been excavated: Myrne, Hirzheve, Sarateni **[fig. 2: 9, 17]**. Each of them had some kind of post-depositional damage and cannot be considered as a reference, which greatly complicates both the separation of Hrebenyky material from mixed assemblages and the consideration of the typological and statistical composition of most collections. An in-depth analysis of individual collections allowed some authors to raise the question of the cultural and chronological division of the 'geometric' aspect of the Late Mesolithic of the Northwest Black Sea region, looking for so called Final Mesolithic sites.[61] However, these subdivisions are rather based on the supposition of homogeneity of the analysed assemblages, which may be far from being true. Characteristic products of the Hrebenyky and Kukrek sites have been repeatedly found in the same complexes. For example, in 1969-76, they were found in different assemblages at one excavated site, Myrne.[62] The site of Zaliznychne has recently been added to the list of sites with 'syncretic' complexes.[63] S. Covalenco has shown that some Kukrekoid features can even be found in the assemblage, gathered from the surface of the eponymous site Hrebenyky.[64] Therefore, the current characterisation of the Hrebenyky culture is rather an 'ideal type', a set of products that systematically occur together in contexts mostly damaged by taphonomic processes.

How can we interpret this situation of coexistence of two cultural aspects on the same territory? Several interpretations have been

58 Stanko, Grigorieva 1977, 39; Telegin 1982; Yanevich 1987.

59 Man'ko 2015; Telegin 1990; 2002.

60 Kiosak, Pistruil 2013; Man'ko 2015; Smyntyna 2015; Stepanenko 1977; Zaliznyak et al. 2013.

61 Covalenco 2017.

62 Stanko 1982; Stanko, Kiosak 2010.

63 Smyntyna 2015.

64 Covalenco 2003.

proposed. V.N. Stanko believed that the Hrebenyky and Kukrek (Anetivka according to V.N. Stanko) were synchronous cultural groups that interacted with each other leading to the creation of a syncretic industry – a reflection of a syncretic society that combined the bearers of both flintworking traditions.[65] On the other hand, A.N. Sorokin believed that products of different origins were mixed as a result of post-depositional processes, and that the Kukrek and Hrebenyky did not exist simultaneously (at least, there is no evidence for this).[66] D.Y. Nuzhnyi and O.O. Yanevych suggested that the Hrebenyky and Kukrek groups had different economic strategies and therefore could have coexisted in the same ecological zone.[67]

L.L. Zalizniak tended to limit the existence of the Hrebenyky community to the Atlantic chronozone and linked its origin to the influence of Neolithic communities in the Balkans.[68] His Kukrek culture lasted much longer (from the Early Holocene) and covered a much larger territory. The Kukrek migrations and interaction with the Proto-Neolithic Hrebenyky led to the Neolithisation of the Right Bank of Ukraine.[69] I.V. and G.V. Sapozhnikovs attributed the 'Hrebenyky proper' complexes to the Early Mesolithic, with the 'intermediate type' complexes reflecting the interaction between Hrebenyky and Kukrek, and the Kukrek proper existing at the very end of the Mesolithic, in fact, already in the Aceramic Neolithic.[70] V.O. Manko developed the ideas of L. Domanska about the Caucasian roots of the Kukrek complexes[71] into a coherent concept of the Middle Eastern origin of this complex. He suggests that the Kukrek culture originated from the M'lefaat of the Middle East and lasted until the Late Neolithic in Ukraine.[72]

Thus, ancient migrations in opposite directions, as well as the concepts of autochthonous population development and contacts between different 'cultures', were reconstructed on an insufficient and flawed basis. The way forward, in our opinion, is to abstract from the concepts of typological development and instead search for reliable stratigraphic contexts supported by radiocarbon dating. In this way, it will be possible to create 'territories of clarity', established facts of the existence of a certain type of lithic complexes at a certain time in a certain region. Only then can generalisations be attempted on the basis of these facts.

65 Stanko 1982, 115-16.

66 Sorokin 2006.

67 Yanevich, Nuzhnyj 1987.

68 Zaliznyak 1998; 2020.

69 Zaliznyak 2005; 2006; 2020; Zaliznyak et al. 2013.

70 Sapozhnikov, Sapozhnikova 2011.

71 Domanska 1987.

72 Man'ko 2015.

1.3 New Stratigraphic Sequences and Radiocarbon Dates

The steppe of southern Eastern Europe is virtually devoid of sites with stratified Mesolithic and Neolithic layers. This circumstance has been cited as an obstacle to the development of evidence-based periodisation schemes for the region.[73] The only significant exceptions are the caves of the Crimean Mountains with long sequences of deposits.[74] However, the material culture of the Crimean Mountains is too peculiar to solve the problem of the relative chronology of sites in the steppe and forest-steppe zones. Recently, thanks to international cooperation projects, two long stratified Mesolithic-Neolithic sequences have been investigated in the west and east of the northern Black Sea steppe, namely at Melnychna Krucha and Kamyana Mohyla 1 **[fig. 2: 13-14]**. It is noteworthy that both sites have been known since the 1930s but were not fully understood at the time.[75] A microstratigraphic approach to excavations with 3-D recording of most finds allowed us to clearly define the archaeological sequence, and serial radiocarbon dating determined the age of the stratigraphic units. The palaeopedological analysis revealed the history of sediment formation at the sites. Thus, the new materials obtained with a known chronological position, both in absolute and relative terms, enable us to take a fresh look at the hunter-gatherers of the steppes of southern Eastern Europe before the eve of the Neolithic.

Melnychna Krucha is a multilayered site with finds dating from the Mesolithic to the Middle Ages.[76] It is located in a floodplain on the northern bank of the Southern Buh, near the village of Sabatynivka, Kirovohrad region, Ukraine some 210 km southwest of the Dnieper River. The site was discovered by S.I. Chub in 1930 and repeatedly excavated from 1931 to 1949.[77] V.M. Danilenko interpreted this site as a reference settlement of the Buh-Dniester culture, with its two stages: the early one, confirmed by the recovery of Pechera-style ceramic and 'archaic' flint tools of the Kukrek type, and the later one, with Savran pottery and 'geometric' lithic assemblage. My investigations of 2012, 2016-18 covered 160 square metres and revealed a complex stratigraphic sequence.[78]

The soil sequence was studied by Zh.M. Matviishyna.[79] She defined three consecutive soils in the section (eastern wall of square 6) **[fig. 5]**.

73 Sapozhnikov, Sapozhnikova 2011; Stanko, Svezhentsev 1988.

74 Cohen 1993; Yanevich 2019.

75 Bader 1950; Kozubovsky 1933.

76 Gaskevych 2012.

77 Gaskevych, Kiosak 2011.

78 Kiosak 2019a.

79 Kiosak, Matviishyna 2023.

Depth is cited from the surface above profile not from conventional zero like elsewhere. She kindly provided the author with the description of soil sequence, which I permit myself to cite in a shortened version translated in English:

"**Upper soil (0.0-0.85 m)**:
- **Hd (0.0-0.05 m)**: Light grey, loose, dusty-sandy light loam with some root traces.
- **Hk (0.05-0.4 m)**: Light to dark grey humus horizon with a light brownish shade, loose, grainy crumbly, dusty-sandy light loam. It contains grass roots and animal burrows filled with grey material.
- **Hpk (0.4-0.7 m)**: Pale yellow, light-grey horizon, which is looser and lighter in colour than the horizon above. It has a grainy powdery structure, dusty-sandy loam with many animal burrows.
- **Phk (Pk of upper soil) (0.7-0.85 m)**: Visibly lighter in colour than the horizon above, it is light grey to pale yellow, loose, crumbly, sandy-dusty light loam with animal burrows. It is clearly discernible as a lighter horizon in the sequence.

Middle soil (0.85-1.7 m):
- Hk (0.85-1.1 m): Pale yellow-grey, visibly darker than the horizon above. It is well-humusised, loose, grainy crumbly, with clear structure, dusty light loam.
- Hpk (1.1-1.4 m): Humus transitional horizon, pale yellow-grey, lighter in colour than the horizon above, loose, crumbly, grainy powdery, dusty light loam.
- P(h)k (1.4-1.6 m): Greyish pale yellow, lighter in colour than the horizon above, with uneven colouring, loose with tongues of humus and spots of carbonates.
- Pk (1,6-1,7 m): Light pale yellow, sandy dusty with a high sand content, light loam, crumbly with pale and grey animal burrows.

Lower soil (1.7-2.1 m):
- **Hpk (gl) (1.7-1.9 m)**: Humus horizon with interchanging layers of grey and brownish-grey stripes 5-7 cm wide. The higher layer is loose, sandy dusty, light loam, which contains shell fragments and small pebbles. The layers are divided by rusty-brown lines indicating a periodic hydromorphic regime.
- **Phkgl (1.9-2.1 m)**: horizon is similar to the one above, but is lighter by colour and contains more sand
- **Pk (2.1-2.15 m)**: Pale yellow grey sandy loam, continues under the bottom of the excavation pit".

The upper and middle soil layers developed in subaerial conditions, whereas the lower soil originated within a consistently damp

environment, likely subject to occasional flooding. The distinct boundary between the middle and lower soils probably signifies an episode of erosion.

The accumulations of archaeological finds somewhat overlap each other though are quite clearly discernible both stratigraphically and horizontally **[fig. 6]**. Stratigraphic unit (SU) 1a was found in the modern topsoil. It contained scattered Late Bronze Age and Iron Age potsherds and bones, while in the eastern zone of the excavation SU1b contained Eneolithic potsherds, dispersed lithic tools and animal bones, supposedly of this age. Stratigraphic unit SU2 was found in yellow loam within the middle soil (horizons Pk and P(h)k) beneath an almost sterile layer. It consisted of a dense scatter of bones and decortication fragments and flakes of several nodules of yellow-wax flint as well as eight potsherds. Despite the paucity of pottery in the excavation trench, this unit should be correlated with the local pottery-bearing groups of the so-called 'Buh-Dniester culture'.

Animal bones found in SU2 are from wild species, particularly *Cervus elaphus* and *Sus scrofa*. To establish the chronological framework for SU2, we selected two animal bone samples along with two small antler chips from T-shaped axes for radiocarbon dating. The analysis yielded dates ranging from 5977 to 5651 calBCE (2σ), as presented in **Supplementary Table 1-2** (from now on ST).

Three dates obtained from this layer (BE-7638, 6985 ± 22 BP; BE-7641, 6986 ± 24 BP; BE-7637, 6980 ± 24 BP) exhibit remarkable consistency and can be combined within the time range of 5834 to 5727 calBCE (2σ). The fourth date (BE-7640, 6812 ± 24 BP) falls slightly younger, between 5736 and 5651 calBCE (2σ) **[fig. 7]**.

Stratigraphic unit SU3 consisted of a layer of flint artefacts and fragmented bones dispersed in greyish loam of the lower soil (horizon Hpk (gl)). It also contained an increased percentage of plates from freshwater tortoise shells, bird bones, fish vertebrae, and small mammal bones. The assemblage is very microlithic with several micronuclei, end-scrapers on the flakes, and an isosceles trapeze. It resembles the sites associated with the 'Kukrek cultural tradition', a term introduced to describe a cultural complex succeeding the earlier Kukrek complex.[80] Recent findings increasingly support the notion that the 'Kukrek cultural tradition' can be attributed to the Late Mesolithic period.[81]

SU3 at Melnychna Krucha did not yield any fragment of pottery, any trace of cultivated plants, or any bone of domestic animals. Four radiocarbon dates (BE-10308, 7436 ± 23 BP; BE-7639, 7404 ± 23 BP) for SU3 place it within the time range of 6380 to 6230 calBCE, falling

80 Gaskevych 2005.

81 Gaskevych 2014; Kiosak 2019a.

well within the same time frame of 6366-6240 calBCE (2σ, when combined) [fig. 7] [ST 1-2].

The lowest layer (SU4) was found in a green-grey sandy conglomerate of the lower soil (Phkgl horizon). It formed a 'carpet-like' level with isolated finds of aurochs bones and flint tools. The finds include conical nuclei for small blades and microblades, multiple burins on flakes, a blade fragment with ventral processing and dorsal retouch ('Kukrek inserts') and a point with partial steep retouch, forming a distal sharp tip and a notch at the opposite end near the bulb of the blade [fig. 6].

It finds close parallels in the Kukrek technocomplex sites. Three bones were selected from this horizon for radiocarbon dating (BE-7636, 8368 ± 23 BP; BE-7635, 8311 ± 24 BP; BE-10309, 8344 ± 23 BP). They yielded calibrated ages of: 7520-7315 calBCE (2σ) [ST 1-2], or, if combined: 7485-7356 calBCE (2σ) (hereafter, we used the R_Combine function from OxCal) [fig. 7].

According to the data obtained, SU4 is dated to *circa* 7500-7300 BCE, so the Kukrek population settled the Southern Buh valley during the Early Holocene.

Thus, there are 11 AMS dates for Melnychna Krucha [ST 1-2]. This dating series, divided into three stratigraphic units, seems insufficient. Each of the units deserves additional dating. However, all dates are consistent with the stratigraphic order and expectations based on typological analogies. The Melnychna Krucha sequence is a 'long' sequence and it covers the transition between Mesolithic (SU3) and para-Neolithic (SU2). From chronological point of view this transition happened during or immediately after the 8200 calBP event. The paleoclimate event itself corresponds to the gap in radiocarbon dates between SU3 and SU2 [fig. 7], spanning the duration of the event. Specifically, the Mesolithic finds from the upper horizon of the lower soil (SU3) were dated immediately prior to the 8200 calBP event, while para-Neolithic artefacts from the lowermost horizon of the middle soil (SU2) were dated to the timeslot immediately after the above-mentioned event. This boundary also marks a pause in soil formation activities, during which organic materials significantly diminished, giving way to the formation of a yellowish layer of dust and sand at the base of the middle soil horizon. Thus, it is likely that erosion resulted from the effects of the 8200 calBP event. It may explain a lack of anthropogenic sediments of this age at the site. This lack could have been caused by erosional events, a lower intensity of human habitation in the region in general, or by a shift in the subsistence patterns, when the Southern Buh lowland lost its attractiveness to local inhabitants. Regardless of the exact cause, it is clear that the 8200 calBP event is reflected in the finds from Melnychna Krucha and Mesolithic assemblage precedes it, while para-Neolithic – postdates the event.

The stratified site of *Kamyana Mohyla 1* was discovered by V.M. Danilenko in the 1930s. It is located in front of a natural sandstone

mound (Kamyana Mohyla), on which many examples of rock art have been discovered.[82] The site is located in the floodplain of the Molochna River, more precisely, on a triangular promontory on the bank of the old Sekiz River bed, near the village of Myrne, Melitopol district, Zaporizhzhia region. This terrace-like elevation was formed in the Holocene, from alluvial deposits brought by the river to its bend, and loams moved downhill from the nearby Red Mountain. Together, these two sources of soil material resulted in relatively rapid sedimentation and the formation of a long soil sequence from the Early Holocene to the present day – up to 4 m of sediments in some areas.

In 2011-19, a joint Ukrainian-Swiss expedition (led by W. Tinner, N. Kotova, and the author) re-opened the site.

According to the palaeopedological analysis carried out by Zh.M. Matviishyna, four stages of soil development can be distinguished in the soil-section: 2 upper soils, separated by a loess-like layer with bone artefacts, and layered subaquatic soils at the base of the section **[fig. 8]**. She kindly provided the author with the description of soil sequence, which I permit myself to cite in a shortened version translated in English:

- Hd – 0.0-0.05 m – turf horizon
- Hk1 – 0.05-0.6 m – upper humus horizon – dark grey to black, loose, sandy-dusty light loam
- Hk2 – 0.6-1.0 m – the second humus horizon from the surface – the darkest and most humified in the section, dark grey to black, darker than the overlying one, loose, sandy-dusty light loam
- Hpk – 1.0-1.3 m – humus-transitional horizon – grey, humus, lightening to pale grey with depth, loose, granular-clumpy, dusty light loam
- Phk – 1.3-1.5 m – transitional horizon – sharply distinguished by lighter fawn-light grey, rather a uniform colour, and carbonate saturation, loose, lumpy-crumbly, sandy-dusty light loam
- Pk – 1.5-1.6 m – carbonate illuvium – the lightest in the section is a pale light grey loess-like material with carbonates concentrated in solid and floury forms above a denser mass of underlying soil.

The Phk and Pk horizons are perceived as a single horizon, which has a lighter mechanical composition, a loess-like appearance, and is located between two biogenic-accumulative soil horizons.

The soil under the loess-like layer has the following genetic horizons:

- Hk(p) – 1.6-1.8 m – humus, partially transitional to the overlying loess-like loam horizon.

82 Gladilin 1966; Radchenko, Kiosak 2022; Radchenko et al. 2020.

- Hk – 1.8-2.05 m – humus-transitional horizon, the darkest in the profile of this soil, greyish-dark chestnut, loose, heavier in particle size distribution – close to medium sandy-dusty loamizon, brownish-brownish-grey.
- Phk – 2.05-2.2 m – the lower humus-transitional carbonate horizon is greyish-light, the lightest in the section, uniformly coloured, with many wormholes and burrows filled with chestnut, mixed and dark material. It is a loose, sandy-dusty light loam, boiling with 10% hydrochloric acid solution.
- Pk – 2.2-2.25m – carbonate illuvium, which is distinguished rather conditionally, according to the light-purple material.

The underlying material, in the interval of 2.25-3.2 m, is a layer of floodplain alluvial soil formed because of periodic flooding. These sediments retain traces of the hydromorphic regime (expressed in layering and signs of gleying processes).

Thus, the following stages of soil types formation can be traced in the time interval from roughly 8700-8400 calBCE (9300 BP) to the present **[fig. 8]**:

1. layer at a depth of 2.8-3.2 m – lacustrine-alluvial deposits;
2. 2.25-2.8 m – floodplain-alluvial soil-pedosediment with traces of a hydromorphic regime and alternating periods of waterlogging and drainage, with gradual intensification of soil formation processes in the sediments, after deepening of the riverbed and stabilisation of soil development in a subaerial soil formation regime; carbonation of sediments is probably related to diagenesis processes;
3. 2.05-2.25 m – loess-like layer, genesis of which is probably related to the formation in conditions of some cooling and activation of sediment accumulation processes (aeolian or aeolian-deluvial);
4. 1.6-2.05 m – dark chestnut saline soil (Haplic Kastanozem Chromic) with a cultural layer in the upper part of the profile and possibly displaced above Azov-Dnieper culture artefacts – conditions of steppe landscapes of the southern steppe zone with a temperate climate;
5. 1.4-1.6 m – loess-like layer indicative of a temperate climate with relative cooling and increased accumulation of aeolian material;
6. 0.6-1.4 m – typical chernozem (Voronic Chernozem) with active development of biogenic-accumulative processes that led to the formation of a thick humus horizon – steppe conditions under a temperate climate, with improved moisture level and sufficient thermal regime compared to the underlying dark chestnut soil;

7. 0.0-0.6 m – modern chernozem, which was formed under active development of humus-accumulative processes. This soil is the upper part of the soil in the interval of 0.0-1.6 m, which modern soil scientists would define as a meadow chernozem deep humus soil (Haplic Chernozem) with the second humus horizon.

The lower part of the archaeological sequence (which corresponds to the Mesolithic and para-Neolithic) was established based on numerous materials from Trench 2 **[fig. 9]**. However, in Trench 2, the upper layer of sediments is missing, having been removed by construction equipment. The higher layers were preserved in Trench 1, but here the layers are not saturated at all, and the correlation of individual horizons with certain archaeological phenomena can be questioned. In Trench 2 the materials of the Azov-Dnieper culture lay at a depth of about 180-200 cm, in the middle horizon of the castanosem.[83] They form the layer D (jointly with some Eneolithic finds tramped from above in Trench 2).

Layer C lies below, in the transition horizon between the castonozem and the lower soil. It exhibits a distinctive 'striped' arrangement of artefacts, namely it consists of separate scatters of finds, discernible both in depth and in plan, interspersed among the extensive sequences of Layer D, which notably contain a multitude of para-Neolithic potsherds, and Layer B which is devoid of potsherds. Interestingly, the deepest and most ancient potsherds, exhibiting the stylistic attributes of the Surskyi culture, were unearthed at depths comparable to certain portions of Layer C within the excavation area.[84] This observation aligns with the depths of Surskyi potsherds from the earlier excavations.[85] Since several contradictory dates have been obtained from this depth **[fig. 8]**, we believe that each of the scatters of layer C merits a separate dating.

The radiocarbon-dated scatter of finds from Layer C in sq. 1-12 of Trench 2 yielded small, pyramidal nuclei with regular faceting. The assemblage is very microlithic, and three metric standards of blades were attested: microblades, bladelets and small blades **[fig. 9]**. For the manufacture of end-scrapers, flakes were widely used, so the percentage of circular and sub-circular end-scrapers is increased. Kukrek-type inserts lost their classical appearance. The trimming can be found on a number of morphologically unstable types of blanks – technical flakes, irregular blades, even lamellar flakes. There were fragments of backed points and backed bladelets.

83 Kotova et al. 2017b, 33.

84 Kotova et al. 2017b, 33-4.

85 Telegin 1990.

There was a scalene trapeze in Trench 1,[86] which could be associated with layer C.

Below this, in the upper part of the lacustrine alluvial sediments, layer B was found, comprising numerous lithic artefacts dispersed throughout (over 600 items in the squares 1-12 of trench 2), accompanied by at least two distinct fireplaces and shell middens scattered at varying depths.[87] It is plausible that these scatters may represent discrete phases of human occupation at this site, potentially enabling classification as distinct sub-horizons within Layer B once further excavation expands the surveyed area. Notably, this layer remains remarkably well-preserved, yielding a wealth of organic specimens, including animal bones and shells. Most chipped stone artefacts are not patinated or damaged, and several have been refitted.[88]

Two slender, pencil-like cores,[89] can be defined according to Telegin's criteria.[90] These cores are subconical with a single orthognathic platform and a regular pattern of microblade scars. In Layer B, both cores display consistent patterns of microblade scars all around. Additionally, the presence of blades and technical flakes suggests the exploitation of cores of other types. The predominant group consists of narrow blanks, ranging from 3 to 9 mm in width, which accounts for 58% of the assemblage. Following this, medium-wide lamellar products, measuring 9 to 12 mm in width, represent 23% of the assemblage, and blades, measuring 12 to 19 mm in width, are observed in 19% of cases. A natural clustering pattern indicates a preference for knapping off narrow blanks, although wider blanks were also systematically produced, likely intended for different technological purposes.

The tool assemblage includes notched or denticulate blades and bladelets, retouched blades and flakes, and Kukrek inserts, a category exclusively recognised by Soviet and post-Soviet researchers **[fig. 9]**. Kukrek inserts are defined as fragments of blades featuring retouch and ventral trimming,[91] with the credit for their initial definition going to G.A. Bonch-Osmolovsky. Danilenko interpreted some of these inserts as 'cutters' (prorezyvateli) used for incising grooves in bone, antler, and wooden hafts.[92] The function of these tools was defined by G.V. Sapozhnikova, who, analysing 103 inserts from the Kukrek site, established that they were intentionally produced through notching

86 Kotova et al. 2017b, fig. 11: 4.

87 Kiosak et al. 2022, fig. 4.

88 Kiosak et al. 2022, fig. 13.

89 Kiosak et al. 2022, fig. 10: 21-22.

90 Telegin 1976, 24-5.

91 Kiosak et al. 2022, fig. 9.

92 Danilenko 1969.

and subsequent fracturing of laminar blanks. The flat ventral trimming on these inserts resulted from their use as knives for planing of hard wood and bone.[93] Similar results were obtained by B. Voytek[94] on three Kukrek inserts from the Dobrianka 3 site in Central Ukraine. In the case of end-scrapers, they are primarily simple end-scrapers done on large flakes. Burins are represented by four distinctive groups: double/multiple burins made on blades, dihedral burins, multiple (Kukrek) burins on flakes,[95] and simple burins on flakes. Points were made by oblique truncation of microblades.

Layer B is separated from the overlying archaeological strata by a less saturated intermediary layer, measuring ca. 10-15 cm in thickness. Furthermore, it is separated from the underlying horizons by a sterile layer ca. 20 cm thick. Layer B is rich in freshwater shells, in stark contrast to the sedimentary layers situated above it. There is a 15-20 cm thick sterile gap below it, and then, there are several horizons with Early Mesolithic finds that merge into layer A.

Many radiocarbon dating attempts were made on the Kamyana Mohyla 1 site. Initial efforts, conducted before the resumption of fieldwork in 2011, relied on conventional dates provided by the Kyiv radiocarbon facility.[96] These early attempts revealed the site's complex history but failed to build a concrete chronology. Relevant materials from recent excavations were dated using the AMS method in the Poznan laboratory and the LARA facility at Bern University (jointly with N. Kotova, W. Tinner and S. Szidat).

Layer A of Kamyana Mohyla 1, which underlies Layer B, yielded several hearths, shell middens, and pits. The earliest date (BE-21069, 9482 ± 32 BP) comes from a depth of 178 cm from the conditional zero of Trench 2. Here, the lowest horizon with chipped stone artefacts and bone fragments was found in the very wet sediments (due to the high level of underground water), exposed over a small area (due to necessity of investigation of over 2 m of saturated archaeological layers above it). This lowermost horizon is covered by sterile sediment, some 30-40 cm thick. The date BE-21069 gives us a *terminus post quem* (9116-8635 calBCE) for the chronology of layer A. Six dates were obtained from layer A obtained on animal bones and charcoal. Four dates cluster around 8650-8500 calBCE. The charcoal date Poz-61519, 8810 ± 50 BP is an outlier (**model 1-2**,**ST 1-3**). However, analysis in OxCal showed that, in fact, the calibration of this date leads to two solutions: 8204-8032 calBCE (22.4%) and 8020-7713 calBCE (72.1%). While the latter is clearly inconsistent with the rest

93 Sapozhnikov, Sapozhnikova 2011.

94 Biagi, Kiosak 2010.

95 Telegin 1976.

96 Kotova 2003; 2004; Telegin 1990.

of the dating, the former follows another rather late date BE-26733, 9134 ± 13 BP, 8418-8283 calBCE (2σ).

Non-modelled dates place Layer A's existence between 8704-8283 calBCE (2σ), while Bayesian modelling with OxCal software (see **[model 1-3]** **[ST 1-3]** **[fig. 10]**) limited this range to 8694-8204 calBC (2σ). The lithic assemblage in this layer is characterised by a poor typology with a low proportion of formal tools.[97]

Therefore, the time span for the formation of Layer B should postdate 8200 BCE. Layer B was dated using a date from Trench 1 and six dates from Trench 2. In fact, there are two dates from Trench 1 at a depth comparable to Layer B; however, the younger date originates from a different sedimentological context due to variations in local topography **[fig. 10: B]**. The earlier date (Poz-51419, 8730 ± 50) corresponds to 7944-7600 calBCE (2σ), while the later date (Poz-51304, 7980 ± 40 BP) falls within 7047-6700 calBCE (2σ). In the squares 1-6 of Trench 2 a slender horizon was observed between Layer B and Layer C. This horizon (labelled C/B) was dated by a date Poz-51296, 7810 ± 70 BP. The date Poz-51296 (7810+80 BP) aligns well with the date Poz-51304 (7980 ± 40 BP) from Trench 1, as well as with the conventional date Ki-7668 (8020 ± 70 BP), indicating an early seventh-millennium BCE habitation on the surface of Layer B. Horizon C/B could have existed in other parts of the site, but it remains undetected there so far. When treated as a separate phase C/B between layers B and C, it yields a modelled calibrated date of 7034-6540 calBCE.

Layer B's dates from Trench 2 were derived from animal bones (3 items) and charcoal from hearths (3 items). Most of the dates fall within 8160-7198 calBCE (2σ), or 7951-7339 calBCE (2σ) when modelled **[model 1-2 and 1-3]** **[ST 1-3]**. We believe that most of the cultural deposits in Layer B were formed during this time period. A comparable date exists in the conventional dataset **[ST 1-3]** **[fig. 10]**, specifically, the date Ki-7669 (7936-7381 calBCE, 2σ). The dates Poz-51306 and BE-20556 appear to be outliers and likely correspond to the lower Layer A (as indicated by General Outlier model of OxCal, see **[model 1-2]** **[ST 1-3]**). Immobile objects, such as hearths, were securely dated by 14C to the first half to middle of the eighth millennium BCE.

Some lenses in Layer C were dated using radiocarbon method. Specifically, a hearth in square 14 at a depth of 48-60 cm yielded a 14C date of 6430-6230 calBCE (2σ), while a charcoal scatter in square 17 (at a depth of 76 cm) produced two similar dates, ranging from 6380 to 6084 calBCE (2σ). Comparable dates were obtained in previous attempts to date the site using conventional radiocarbon analysis **[ST 1-3]** **[fig. 10]**, including dates Ki-7667, Ki-4226, and Ki-4022 (expressed as 6370-5791 calBCE, 2σ).

97 Kotova et al. 2017b.

The rich layer D brought a variety of flint tools: long blades, including those with convergent semi-steep retouching, fan-shaped end-scrapers, trapezes, etc. Sherds of pottery from the Azov-Dnieper culture come from this layer. It obtained a single AMS date BE-21066, 6171 ± 27 BP. It calibrates to 5213-5030 calBCE (2σ). Three more legacy dates are attributed to the same timeslot, namely Ki-4023-25. They encompass the time-range 5474-4839 calBCE (2σ). However, one should note that the above mentioned legacy dates Ki-7667, Ki-4226, and Ki-4022 came from the same depth as indicated by the archival documentation.[98] When modelled, the age of layer D spans the period 5472-4950 calBCE, 2σ **[fig. 10]**.

Thus, 'classic' Kukrek assemblages were found to date to the eighth millennium BCE at two above-mentioned sites. They clearly belong to the Early/Middle and not the Late Mesolithic period and, thus, 'classic' Kukrek elements cannot be considered as evidence of a Mesolithic 'heritage' in any Neolithic complexes. Somewhat different materials of the Kukrek cultural tradition were found in the layers between the Classic Kukrek layers and stratigraphic units with para-Neolithic ceramics at Melnychna Krucha and Kamyana Mohyla 1. They date from the second half of the seventh millennium BCE, but still belong to the Late Mesolithic period and are unlikely to have witnessed any Neolithisation or 'ceramisation' of the region. Between them and the first evidence of domesticated plants and animals, or the use of pottery, there is a rather significant time gap, which also included the '8200 cal BP' climate event.

98 Kiosak et al. 2022; Telegin 1990.

1.4 The Mesolithic Sequence Reconstructed?

The observations on the stratigraphies of Melnychna Krucha and Kamyana Mohyla 1 should be confronted with other dated stratified sites attributed to the Kukrek.

The comparable lithic assemblage was uncovered at the site of Ihren 8 **[fig. 2: 5]**, located in the Dnieper valley.[99] However, it is worth noting that the extensive collection from Ihren 8 likely contains materials from various chronological periods and cultural aspects.[100] The dating of the Ihren 8 site has yielded somewhat contradictory results, despite most samples being taken from complexes, which were interpreted as pit-dwellings. The largest and most consistent series of dates, obtained from various laboratories in Kyiv, Groningen, Oxford, and Berlin, and derived from different types of datable materials such as bones, shells, and charcoal, falls within the first half of the eighth millennium BCE.[101] However, currently, there exist two valid viewpoints regarding the chronology of the Ihren 8 site:

1. The first interpretation posits that Ihren 8 primarily represents a settlement of the early Neolithic (pottery-bearing) Surskyi culture, and dates from the late seventh to early sixth millennium BCE.[102]
2. An alternative perspective suggests that the primary habitation at Ihren 8 corresponds to a late Mesolithic site from the Boreal period, dating from the late eighth to the first half of the seventh millennium BP, prior to calibration.[103]

The dating of Ihren 8 presents a challenge as the excavations were primarily conducted within spatially separated complexes, making it difficult to establish a consistent stratigraphic order. The layers within one complex do not necessarily correspond to the layers in another, further complicating the matter. Moreover, it is worth noting that some potsherds were found in the lowermost layers of certain 'pit-dwellings', particularly 'pit-dwelling 8',[104] which has implications for the homogeneity of this assemblage. As a result, the chronology of Ihren 8 must be determined on a complex-by-complex basis.[105]

99 Telegin 2002; Zaliznyak 2005; 2018.

100 Biagi, Kiosak 2010; Miller 1935.

101 Biagi, Kiosak 2010.

102 Man'ko 2005.

103 Biagi, Kiosak 2010; Stupak et al. 2022; Zaliznyak 2005; 2018.

104 Man'ko 2005.

105 Kiosak et al. 2023d.

Among the 'pit-dwellings', namely, at least one date has been obtained for dwellings 1, 2, 3, 4, 5, 7, 8, and 10 [ST 1-4]. Unfortunately, the radiocarbon chronologies of pits 3, 5, and 7 are exclusively based on the analysis of shells of freshwater gastropods.[106] Considering the unknown reservoir effect for the Dnieper River,[107] these dates are essentially excluded from meaningful consideration.

'Pit-dwelling 8' stands out as the best-dated complex at the Ihren 8 site. It has yielded consistent two AMS dates on animal bones, resulting in a calibrated range of 8211-7829 calBCE, 2σ. Additionally, five dates on TOCC's of potsherds and a single date on fish bone[108] were obtained. The potsherd ages may lack precision due to methodological issues,[109] but the very presence of potsherds does suggest a later episode or episodes of human activity in the vicinity of 'pit-dwelling 8'. Although the dated fish bone might seem older due to an unknown offset related to the reservoir effect, it proves that there have been a separate episode of activity linked to the deposition of this fish bone, and it significantly post-dates the dating established through the analysis of animal bones and charcoal.

Pit-dwelling 1' in Ihren 8 obtained all three types of dates: charcoal, animal bones and freshwater gastropods. The date from the freshwater molluscs is not reliable as was discussed above, while the dates from the animal bone and charcoal can be combined, giving a time span of 7934-7596 cal BCE (2σ). In contrast, 'Pit-dwelling 2' was dated using freshwater shells and has only one AMS measurement for an animal bone, which is calibrated to 7942-7605 calBCE, 2σ.[110] The dates for 'pit-dwelling 4' in Ihren 8 were determined using animal bone and charcoal, and they can be calibrated to a time range of 7759-7588 calBCE, 2σ. The reported potsherd from the upper layer D1 of 'pit-dwelling 4' suggests a later episode of human activity in this context. It's possible that 'pit-dwellings' 1, 2, and 4 were roughly contemporaneous, or feature 4 may post-date features 1 and 2 [fig. 11].

'Pit-dwelling 10' was placed into the early sixth millenium BCE by dates obtained from animal bones in Kyiv radiocarbon facility. Therefore, to establish the exact chronology of this feature, cross-laboratory validation is necessary.[111]

These observations strongly suggest that the Ihren 8 site did not result from a single habitation episode but rather from a sequence of

106 Kiosak et al. 2023d.

107 Kotova 2018; Lillie et al. 2009.

108 Lillie et al. 2009.

109 Meadows 2020.

110 Kiosak et al. 2023d

111 Kiosak et al. 2023c.

Mesolithic activities. The earliest dates were yielded by 'pit-dwelling 8': the late ninth to early eighth millennium BCE. This was followed by 'pit-dwellings 1 and 2', which can be dated to around 7900-7800 BCE. 'Pit-dwelling 4' may partially overlap in time with these two pits but likely postdates them, dating to the second quarter of the eighth millennium BCE.[112]

The later habitation of Ihren 8 is evident, occurring, at the earliest, in the second half of the seventh millennium BCE, on the basis of the OxA date on fish bone. Additionally, episodes of activity during the sixth to fifth millennia BCE are indicated by the discovery of potsherds with distinctive decoration in 'pit-dwellings 4 and 8' **[fig. 11]**. As a result, the Mesolithic activity at the site can presently be divided into four chronological horizons: three related to 8200-7600 BCE and at least one notably more recent event.[113]

Several other Kukrek sites were dated using the radiometric method: the eponymous Kukrek, Vyshenne 1, Mys Triitsi (Trinity Cape) and Dobrianka 3 **[fig. 12]**. Kukrek is a two-layer archaeological site, located in the foothills of Crimean Mountains, on the right bank of the Zuia River. The site was excavated in 1926-27 by G. Bonch-Osmolovskyi, and later, in 1975-76 by Yu. Kolosov and D. Telegin. The excavation findings of G. Bonch-Osmolovskyi were processed and published by E. Vekilova, and, more recently by M. Zhylin.[114] The 1975-76 excavations established the stratigraphic sequence of the site. The Kukrek-type cultural layer lies in a clay-sand layer at a depth of 1.4-1.6 metres. The upper, Murzak-Koba (Late Mesolithic with trapezes and segments typical for Mountainous Crimea and rarely found outside it) layer lies above, in the pebble layer, at a depth of 0.8-0.9 metres. Between the two cultural layers there is a sterile interlayer 0.5-0.6 metres thick. The site provided three conventional radiometric dates performed on shells of freshwater molluscs. As O. Yanevich has demonstrated, the samples were selected from the sediments underlying the Kukrek cultural layer. Results diverged notably. The Kyiv date calibrates to the very beginning of the Holocene, while a pair of Berlin dates point to the late seventh millennium BCE **[ST 1-5]** **[fig. 12]**. Thus, the shells were probably deposited by a natural process and cannot be linked to human activity on-site.[115]

Dates were obtained from animal bones at the Kyiv Radiocarbon Laboratory.[116] The obtained dates for Vyshenne 1 make it a very early

112 Kiosak et al. 2023d.

113 Kiosak et al. 2023d.

114 Telegin 1982; 2002.

115 Yanevich 2019.

116 Telegin 2002.

site – 9312-8859 calBCE, 2σ.[117] Accordingly, Mys Triitsi is one of the latest sites, dated to 6821-6469 and 6445-6089 calBCE, 2σ by a pair of rather inconsistent dates **[fig. 12]**. Unfortunately, it is now known that the lack of carbon ultrafiltration in the dating of animal bones, even from the Holocene period, can lead to distortions in the age of samples due to contamination with modern carbon.[118] Accordingly, the chronology of these sites should be verified by cross-laboratory comparison.

A distinct complex with numerous implements of the Kukrek type was discovered at the site of Dobrianka 3, situated in Central Ukraine (Kirovohrad region). A certain amount of early ceramic ware (similar to the Skybyntsi, Sokiltsi and Pechera ware) was also collected here, and three samples of it were dated directly. In general, the main complex of the site is dated to the last quarter of the seventh millennium BCE,[119] although the site also yielded the items usually dated to the sixth millennium BCE, namely trapezes with dorsal surfaces flattened by invasive retouch (ukr: 'trapetsii zi struganoiu spynkoiu'),[120] and Savran-style ceramics,[121] and the authors of the excavation report believe that the dates obtained are too early for the chronology of the Buh-Dniester culture.[122] There is also a single Early Holocene radiocarbon date: OxA-17490, 9115 ± 45 BP.[123] This fits surprisingly well with the dates we have so far for the classic Kukrek implements, which closely resemble the finds from Dobrianka 3. The site also yielded a burial dated directly to the late seventh millenium BCE: OxA-222-33*, 7227 ± 40 BP.[124] Some efforts to date animal bones from the cultural layer of the site resulted in late dates of the late fourth – early second millenium BCE, compromising the integrity of the Dobrianka 3 cultural layer.[125] Moreover, Kyiv laboratory's dates on animal bones from Dobrianka 3 are heterogenous: two dates (Ki-11105 and 11104) can be combined into the timeslot 6419-6061 calBCE, 2σ while the Ki-11103 date is later, calibrated to 6089-5665 calBCE, 94.5%. Thus, the cultural layer of Dobrianka 3 is a palimpsest of many habitations, among which there was probably a 'classic' Kukrek episode in the late ninth millennium BCE as indicated by the OxA-17940 date **[ST 1-6]** **[fig. 13]**.

117 Yanevich 2019.

118 Higham et al. 2006; Szidat et al. 2017.

119 Zaliznyak, Man'ko 2005; Zaliznyak, Panchenko 2007; Zaliznyak et al. 2013.

120 Kotova, Tuboltsev 1996.

121 Tovkailo 2014.

122 Zaliznyak et al. 2013, 248-9.

123 Lillie et al. 2009.

124 Lillie et al. 2009.

125 Biagi et al. 2007.

Thus, the set of legacy dates does not add much to our understanding of the Kukrek lithic toolsets, probably extending their duration into the late tenth – early ninth millennium BCE (Vyshenne 1) as well as into seventh millennium BCE (Mys Triitsi). However, the lack of serial dating makes these observations questionable.

The concept of 'Kukrek' can be questioned as it stands right now.[126] V.M. Danilenko was among the first to propose that the distinctive typological features of Kukrek were rooted in technological necessity. Specifically, Kukrek technology was geared toward producing grooved bone points equipped with elongated bladelet inserts.[127] Grooved bone points became the necessity due to the hunting of large game in wide open spaces by Kukrek.[128]

Traditionally, it is believed that the pressure technique forms the foundation of Kukrek lithic technology.[129] However, the KM1 collection reveals that some target blanks were crafted using a different technique, resulting in relatively thick, short blades with somewhat irregular dorsal patterns. These blanks were essential for producing Kukrek inserts and double and multiple burins, likely created through various direct knapping techniques. On the other hand, pencil-like cores and their products, including microblades and narrow bladelets (up to 9 mm wide), were crafted using the pressure technique. This is evident from the extreme regularity of the products and the small size of the finalised cores, making pressure the most suitable method for their production.[130]

The question arises: Are we dealing with two distinct *chaînes opératoires*? The first reserved for thick and short blades, while the second aimed at producing regular pressure-flaked bladelets? The answer lies in the refitting of Kukrek cores, which is yet to be done. It appears that these cores were initially shaped through hammer strikes to obtain larger blades, which were subsequently reshaped for use with pressure to create regular microblades and bladelets, probably shaped into projectile points afterwards. E. Girya suggested that both techniques could have formed part of a single operative chain.[131]

A separate *chaîne opératoire* should be reserved for the knapping of 'Kukrek burins'. It's highly likely that at least some burins are, in fact, cores on flakes, with their target product being elongated flakes.[132]

126 Zaliznyak 2020.

127 Danilenko 1969.

128 Yanevich, Nuzhnyj 1987.

129 Yanevich, Nuzhnyj 1987.

130 Girya 1997; Kiosak 2019b; Zaliznyak 1998.

131 Girya 1997.

132 Kiosak et al. 2022.

The use of the pressure technique allowed Kukrek flint-knappers to maximise core utilisation. Massive flakes were employed in the production of secondary flakes, with both approaches aiming to economise on raw materials. This need may result from the relatively high mobility of the Kukrek population.

The defining aspect of the Kukrek phenomenon differs fundamentally from that of other Mesolithic cultures in Ukraine. While the latter are typically defined on the basis of microlithic projectile point typology, the distinctiveness of Kukrek is sought in other functional tools. The shapes of these tools partly result from use-wear (as seen in Kukrek inserts)[133] or from the technological peculiarities of 'secondary' core knapping (as observed in Kukrek burins).[134] The Kukrek cultural community, as defined by Telegin, includes variants with different microlithic projectile point assemblages, possibly indicating different cultural affiliations.[135] Moreover, sites labelled as 'Kukrek' sometimes exhibit radically different typological compositions in their lithic inventories. Some characteristic Kukrek traits are often isolated from the broader Kukrek complex, and such sites are labelled 'Kukrekoid'. This term, however, lacks a clear definition, leading to a potential dilution of the original concept of Kukrek. Several phenomena that differ from the 'classic' Kukrek in chronology, distribution, and techno-morphological characteristics have been labelled as Kukrekoid. However, the perceived similarities often hold little significance. For instance, as demonstrated by D. Haskevych, the conical cores of the Buh-Dniester para-Neolithic only superficially resemble those of Kukrek. They were produced within a different technological context and served distinct technological purposes.[136]

Layer B of Kamyana Mohyla 1 and SU4 of Melnychna Krucha bear striking similarities to sites from the second stage of the Kukrek in Crimea,[137] namely with the assemblages of Kukrek, Domchi-Kaia, and Ivanivka **[fig. 14]**:

1. Conical cores frequently exhibit fine patterns of lamellar detachments around their perimeters.
2. Burins outnumber end-scrapers.
3. There are double burins on blades as well as multi-facetted burins on flakes.
4. End-scrapers are typically located at the ends of blanks, with few circular and subcircular end-scraper types.

133 Biagi, Kiosak 2010; Sapozhnikov, Sapozhnikova 2011.

134 Kiosak et al. 2022.

135 Telegin 1982, 114-15.

136 Gaskevych 2005.

137 Yanevich 1987.

5. Kukrek inserts are crafted on blade fragments, that are wide and massive. They often represent the most abundant type in the assemblage.
6. Oblique points can be found in the microlithic assemblages.
7. Geometric microliths are rare and atypical. Some trapezes reported from the Kukrek sites are, in fact, double truncations, being too long to be considered as geometric microliths.[138]

The Early Mesolithic assemblages in Layer A of the Kamyana Mohyla 1 site is earlier than the 'classic' Kukrek industry found in Layer B. The distinction between these two periods is well-established through their stratigraphic positions and radiocarbon analysis. The lithic assemblage of layer A is characterised by a relatively simple typological composition. In contrast, the 'classic' Kukrek complexes in Layer B constitute a highly uniform group in terms of lithic typology and technology, featuring the characteristics mentioned above. Radiocarbon dates suggest their development occurred between 7800 and 6700 BCE. A different type of industry emerges during the Late Mesolithic. It bears resemblance to the 'classic' Kukrek through the presence of conical cores, multiple burins, Kukrek inserts, and non-geometric microliths formed by a combination of backed sides and truncated ends. However, there are significant differences:

1. Bladelet and microblade cores, despite being called conical, are often not worked all around their perimeter. They are rather flattened, worked from one side only.
2. There is a higher proportion of microblades, especially in the category of microlithic tools (less than 2.5 cm in any dimension).
3. Kukrek inserts are crafted on bladelets, not on blades as before, and they are less regular and more atypical, essentially classified as pseudo-inserts.[139]
4. End-scrapers are more abundant than burins.
5. Many end-scrapers are of microlithic size, often circular or subcircular in form, and found at the end of bladelet fragments.
6. Some microlithic isosceles trapezes are part of these assemblages.
7. Non-geometric microliths typically take the form of backed points.[140]

138 Kiosak et al. 2022.

139 As termed by Telegin 1982.

140 Kiosak et al. 2022.

D. Haskevych referred to these complexes as the 'Kukrek cultural tradition', particularly in the context of the Buh-Dniester para-Neolithic.[141] Recent studies suggest that the 'Kukrek cultural tradition' thrived even before the arrival of pottery in the Southern Buh region at Melnychna Krucha, in SU3.[142] O. Yanevich recognised such assemblages and designated them as the 'third stage of Kukrek culture'. These are found in Crimea at sites like Olexiivska Zasukha, Frontove 1, Frontove 3, Dolynka, and Martynivka, some of which yielded para-Neolithic pottery alongside lithic complexes of the 'Kukrek cultural tradition'.[143]

Evidently, materials from both the 'classic' Kukrek and the 'Kukrek cultural tradition' were mixed by post-depositional processes at the Ihren 8 site. At the Melnychna Krucha site, the 'classic' Kukrek stratigraphic unit (SU4) was overlaid by sediments containing implements of the 'Kukrek cultural tradition' (SU3, dated to 6380-6230 years calBCE). Additionally, Layer C of the Kamyana Mohyla 1 site yielded scatters of lithic tools and fragmented bones related to the 'Kukrek cultural tradition'. The assemblages from the above-mentioned sites bear some resemblance (albeit to a lesser extent) to Kukrek-like sites in the Dnieper Rapids region. However, certain Dnieper Rapids sites are already associated with the Early Neolithic (or para-Neolithic in terminology of this book) Surskyi culture.[144] Therefore, the definition of the lithic assemblage of the Surskyi culture as 'Kukrek-related' or 'Kukrekoid'[145] can be questioned.

In summary, there are two distinct cultural aspects within the broader Kukrek concept: the 'classic' Kukrek (or Kukrek *sensu stricto*) and the 'Kukrek cultural tradition' **[fig. 14]**.[146] While these two aspects do not encompass the full spectrum of variability within the complexes labelled as 'Kukrek', they represent two relatively homogeneous units with clear chronological boundaries. The 'classic' Kukrek existed primarily during the eighth millennium BCE, while the 'Kukrek cultural tradition' immediately preceded the ceramisation of the region in the late seventh millennium BCE. It is probable that the Kukrek cultural tradition sites existed in the valleys of the Southern Buh and Molochna rivers prior to '8200 calBP' palaeoclimatic event, while the ceramic-bearing groups spread there, later, after this event in the early sixth millennium BCE, as it is observed

141 Gaskevych 2005.

142 Kiosak et al. 2021b.

143 Yanevich 1987; 2019.

144 Kotova, Tuboltsev 1996, 2013.

145 Tovkailo 2020.

146 Kiosak et al. 2022; Kiosak et al. 2023d.

in the long sequences of Melnychna Krucha and Kamyana Mohyla 1. The evidence to the contrary is considerable (Dobrianka 3, sites of the 'Early Buh-Dniester' culture, sites of the Dnieper Rapids), however the hypothesis of early ceramisation is mostly based on the taphonomically compromised assemblages resulting from 'palimpsest' sites and the 'direct' dates obtained from potsherds, totalling their organic content, which cannot yield any reliable result.[147]

However, it is only half of the story. The other half comprises the development of the lithic industries with regular lamellar technology and the set of microliths dominated by trapezes. These sites yielded dates, which can be classified into two different timeslots: to the eighth millennium BCE and the second half of the seventh millennium BCE. Let's review the former group of sites, including the sites of Laspi 7 and Myrne **[figs 2: 16; 9]**. The site of Laspi 7 (southern coast of Crimea) was inhabited by trapezes' makers between 7740-7580 calBCE.[148]

Myrne is a complex site, comprehensively studied and published in a standard way by V.N. Stanko.[149] This site consists of a central weakly saturated zone with over 20 separate scatters of chipped stones and fragmented bones around it. The assemblages can be classified into those of Hrebenyky and those of Kukrek components. The dating of this site is based on stratigraphic observations (according to pollen analysis, the cultural layer underlies a layer deposited under moist conditions of Atlantic chronozone), typo-chronological constructions, and radiocarbon dating. The latter indicates the existence of the site in the second half of the eighth millennium BCE,[150] namely, the site yielded four bones that date to 7590-7170 calBCE. Another charcoal (?) date was obtained using the conventional approach in the late 1980s.[151] When published, it was considered as possibly 'too young' **[ST 1-7]** **[fig. 15]**.

A.M. Sorokin has put forward serious criticisms of Myrne's taphonomy. According to him, the presence of a significant amount of finds in the upper layers that overlapped the cultural layer indicates significant bioturbation at the site.[152] The bioturbation and soil processes certainly took place at the site, yet the cultural layer of Myrne appears to be much better preserved than the cultural layers of most known Stone Age sites in the steppe zone.

147 Dolbunova et al. 2023; Meadows 2020.

148 Biagi, Kiosak 2010; Telegin 1982.

149 Stanko 1982.

150 Biagi, Kiosak 2010; Stanko 1982.

151 Stanko, Svezhentsev 1988.

152 Stanko 1967.

In the second half of the seventh millennium BCE (another period of radiocarbon date concentration **[fig. 16]**), the development of both 'geometric' and 'non-geometric' complexes continued **[fig. 17]**. Let's review the sites with radiocarbon dates referring to this period.

The lower layers of the Soroca sites, dated to this time by radiocarbon dates on charcoal, yielded a series of unilateral prismatic nuclei, and numerous fragments of regular bladelets and trapezes. According to L.L. Zalizniak (1998), the lower layers of the sites on the Dniester – Soroca 1 and 2 – are not much different from Hrebenyky **[fig. 2: 18]**.[153] Indeed, they represent a vivid manifestation of the Late Mesolithic industry with trapezes, just like Hrebenyky. However, there are also good reasons to suspect differences in knapping techniques between these two aspects of the 'geometric' Mesolithic, primarily the different appearance of the prismatic nuclei, noted on many occasions.

Hirzheve **[fig. 2: 17]** is a site investigated by V.N. Stanko in 1962-66 (under the general supervision of P.I. Boryskovskyi.[154] Shortly after the discovery, the cultural layer was significantly damaged by ploughing for forest planting. Among the materials from the site, there are Eneolithic and para-Neolithic finds.[155] A clear division between the Mesolithic and later complexes is hardly possible.

In the late 1980s, the St. Petersburg radiocarbon facility obtained the following date from bone: Le-1703 7050 ± 60 BP (6032-5789 calBCE) **[ST 1-7]**. Later on, in 2004-05, V. Man'ko obtained a pair of dates in Kyiv laboratory: on animal bone and on total organic content of a potsherd.[156] When calibrated, the dates span the period 6466-5812 calBCE. It is possible that some of the Hirzheve finds can also be linked to the second half of the seventh millennium BCE. At least, the earliest date on an animal bone from Hirzheve indicate certain human activity on the site within this timeslot.

Sarateni was investigated under the direction of N.A. Chetraru and excavated by S.I. Covalenco in 1994. The cultural layer of the site was significantly damaged by ploughing and should be considered as redeposited.[157] The available radiocarbon dates were performed on the total organic content of the potsherds from the cultural layer of the site and are not related to the dating of the main Mesolithic lithic assemblage.

The site of Ziankivtsi 2 **[fig. 2: 19]** is situated on the Southern Buh in the Vinnytsia region of Ukraine. It was excavated by V.M. Danilenko.

153 Zaliznyak 1998.

154 Stanko 1967; Stanko, Kiosak 2010.

155 Kiosak, Pistruil 2013.

156 Man'ko 2006, 19.

157 Covalenco 2017.

The lower layer of the site was defined as a 'pre-ceramic' Neolithic by the excavator[158] but this definition was quickly revised to simply Mesolithic.[159] The finds from this site were only briefly described: deer bones, *Unio* shells, fragments of bone points and deer antler products, numerous nuclei, microlithic end-scrapers on flakes, several trapezes, etc. were found here.[160] Nowadays, there is a common consensus that this complex represents the same type of industry as the lower layers of the Soroca 1 and 2 sites: it is 'geometric' but we do not know really much about it. The lower layer of Ziankivtsi 2 obtained a single radiocarbon date on animal bone from Kyiv radiocarbon facility (Ki-6694, 7540 ± 65 BP) **[ST 1-7]** and, thus, it requires cross-laboratory comparison in order to clarify its chronology.

Several other excavated sites **[fig. 21: squares 1-7]** Zaliznychne,[161] Katarzhyno 1,[162] Zakharivka 1,[163] Karpove yielded Hrebenyky materials alongside artefacts of other attributions and cannot be placed on the chronological scale with any certainty.

On the other hand, a large group of radiocarbon dates fell into the same timeslot (the second half of seventh millennium BCE) without being related to the well-defined complexes of material culture.

The Mesolithic cemeteries of the Dnieper Rapids region yielded a series of dates falling into this timespan **[fig. 16]**.[164] It is worth noting that they were previously attributed to Neolithic and the discovery of their Mesolithic age has not yet been fully appreciated. In particular, the archaeological record of Surskyi Neolithic (para-Neolithic in terminology of this book) culture has lost most of the burial complexes once attributed to it. Unfortunately, their chronology can be distorted by the reservoir effect.[165] Moreover, it is difficult to correlate their burial goods with any assemblages from residential contexts.

The Mesolithic cemetery on the Gard site yielded a radiocarbon date: Ki-14796, 7640 ± 90 BP.[166] The burial from Dobrianka 3 site was also dated to this timeslot as were two animal bones' samples from the cultural layer of this site (see discussion above).[167] Some

158 Danilenko 1969.

159 Telegin 1977.

160 Danilenko 1969, 90.

161 Smyntyna 2007; 2015.

162 Kiosak, Pistruil 2013.

163 Kiosak, Kotova 2020.

164 Lillie et al. 2020a.

165 Kotova 2018; Lillie et al. 2009.

166 Tovkailo 2014.

167 Lillie et al. 2009; Zaliznyak et al. 2013.

sites of the Buh-Dniester para-Neolithic provided radiocarbon dates on animal bones that fall into the second half of the seventh millennium BCE. While some authors argued that these dates are related to 'Neolithic' habitations, Dmytro Haskevych posed a hypothesis of unrecognised Mesolithic stratigraphic units in these sites.[168] Some confirmative evidence for this hypothesis has been found at Baz'kiv Ostriv and Pechera 1,[169] while it remains speculative in relation to other sites. The underlying Mesolithic layer has no Kukrek components in Baz'kiv Ostriv.[170]

Thus, today we are far from reconstructing the Mesolithic sequence for southern Ukraine and Moldova. Certain episodes of human activity have been dated, but typo-chronological schemes remain unconfirmed by serial radiometric dating. Classic Kukrek sites date to the eighth millennium BCE; accordingly, *Kukrek sensu stricto* elements cannot be considered evidence of Mesolithic influence on Neolithic groups. A number of sites and several burial grounds dating immediately prior to the '8200 calBP' climatic event have been identified in the region. Some sites yielded flint assemblages with regular blade techniques and numerous trapezes, while a developed backed bladelets industry with few trapezes characterises others.[171] The nature of these differences is currently difficult to determine. Could they be due to the different places of the sites in the cycle of mobility or to different economic strategies? Unfortunately, these and other intriguing questions remain unanswered. What we do know is that there is a clear boundary – namely, the climatic event of '8200 calBP' – between the Mesolithic of the seventh millennium BCE and the first ceramic complexes, at least in the cases of Melnychna Krucha and Kamyana Mohyla.

1.5 'Mesolithic Heritage' Revised

Having this chronological picture in mind, we can narrow down the list of possible 'Mesolithic elements' in the Neolithic lithic assemblages.

First of all, we should note that cross-cultural comparisons between Mesolithic and Neolithic often overlook the distinctive socio-economic organisation of the communities being compared. Therefore, even the most promising innovations 'seen' in a foreign cultural context could not be adopted by virtue of their technological

168 Gaskevych 2014, 10.

169 Haskevych et al. 2020, 189.

170 Haskevych et al. 2020.

171 Stanko 1982, 115; Telegin 1982, 118.

advantages alone.[172] A process of social acceptance of an innovation was needed, it had to be adapted to a pre-existing technological context. Finally, under new conditions, it could acquire a completely different social meaning, semiotic load and set of social and signifying functions. For the most part, these issues are ignored in studies of Mesolithic influences on early farming communities.

The chronological considerations which were expressed above suggest that many items purportedly attributed to the Mesolithic heritage should not be categorised as such. For instance, implements like Kukrek pencil-like cores, typical Kukrek inserts, and multi-facetted burins on blades are indicative of the technological *milieu* of the eighth millennium BCE. Therefore, they should not be considered as evidence of a 'Mesolithic influence' in Neolithic lithic assemblages. If comparable items were discovered at Neolithic sites, it would be more appropriate to formulate a case-specific explanation based on their unique technological context, rather than resorting to a blanket interpretation of 'Mesolithic borrowing'.

The reception of Mesolithic culture elements is traditionally assumed for the whole duration of Neolithic and even early stages of Eneolithic on the basis of: 1. regularly faceted (including pencil-shaped) nuclei for bladelets and microblades and 2. trapezoidal geometric microliths.[173] And indeed, they are known in the 'geometric' Late Mesolithic sites of the region: both in Hrebenyky and in Soroca-type sites.

However, trapezes and slender regular bladelets are known in almost every Neolithic culture till the middle Trypillia (around the late fifth – early fourth millennium BCE) in the Carpathian-Dnieper region, and in each of them they are regarded as evidence of Mesolithic influence. Both pressure-flaking techniques and geometric microliths are also known in the Near East, *Heimatland* for most Neolithic cultures of Southeastern Europe, and may have entered Europe together with other innovative elements of Neolithic way of life.[174] They were certainly known and exploited by the knappers of the Criş-Starcevo, Dudeşti, Boian, and the Lower Danube cultures with fluted pottery **[fig. 18]**.[175] "At least in the region between the Carpathian mountains and the Dniester River, there is no reason to assume new contacts with Mesolithic groups for each of the Neolithic cultures with trapezes."[176] Probably, the ability to make geometric microliths came from the previous quite Neolithic communities, without

172 Roux 1999; 2017.

173 Danilenko 1969; Păunescu 1970; Turcanu 2009; Zaliznyak 2020.

174 Connolly 1999; Tringham 1973; Zaliznyak 1998.

175 Mateiciucova 2008; Păunescu 1970; Turcanu 2009.

176 Kiosak 2016.

the immediate need to find surviving groups of hunter-gatherers to learn from them how to equip arrows of archers from early agricultural communities.

Thus, trapezes in a microlithic set of a Neolithic site cannot be treated as a trace of 'Mesolithic tradition' without additional argumentation. The technique of microlith production is much more informative. Unfortunately, there are few materials for its reconstruction in the Neolithic – early Eneolithic communities of the region. It is known that the microburin technique is not characteristic of the LBK of Central Europe.[177] Its presence in settlements of the Buh-Dniester para-Neolithic is doubtful.[178] In the latter every find of a microburin is accompanied by rhomboidal points, morphologically similar to early Trypillian points and, in almost all cases, by early Trypillian ceramics.[179] Thus, it is possible that microburins and rhomboid points done in microburin technique belong to the early Trypillian material complex and not to the hunter-gatherers' assemblages. Morphological studies on the trapezes' typology fail short because of the lack of well-defined complexes without later admixtures.

The technique of laminar and lamellar production with pressure is often attributed to such Mesolithic traces, while there are good reasons to doubt this interpretation. Interestingly, in Ukrainian historiography, it is the pressure method of production that is attributed to the 'Mesolithic heritage', while in Central European scholarship, knapping by indirect percussion is more likely to be associated with the Late Mesolithic, and pressure is attributed to the features brought by early farmers.[180]

However, the pressure technique was first reliably recorded in the Late Palaeolithic.[181] It was used to remove blades from massive lamellar blanks after the formation of an impact platform by truncation at the Rocher-de-la-Caille site in Madeleine, France. The production of blades using the pressure technique was recorded in the Early Holocene of northern Finland at the Sujala site.[182] A number of authors, summarising the available data, tend to write about the appearance of blade production with pressure in the Circumbaltic zone during the ninth millennium BCE as a result of the migration of 'post-Swiderian' hunters from the east, from the East European Plain. The latter brought with them a pressure blade technology

177 Kaczanowska 1980.

178 Gaskevych 2003.

179 Kiosak 2019b.

180 Allard 2004; Mateiciucova 2008.

181 Pelegrin et al. 1995.

182 Rankama, Kankaanpää 2008; Rankama, Kankaanpää 2011.

based on conical nuclei.[183] Dmytro Stupak has demonstrated that the post-Swiderian groups of northern Ukraine also used this technique.[184]

The Late Mesolithic of Europe is marked by the spread of an innovative technical complex – long, thin and regular blades and geometric microliths in the form of trapezes.[185] The modern technological approach has made it possible to show that apparently homogeneous industries actually originated from two different technological contexts: 'Mediterranean' based on a combination of pressure and indirect percussion[186] and 'Northern' based exclusively on punch knapping.[187]

The origin of this technological phenomenon of Late Mesolithic blade and trapeze industries has been sought in different parts of the world. A number of researchers insisted on an autochthonous origin in southwestern France or northeastern Italy or even Belgium. Other authors have sought migratory explanations: from the northern world of deer hunters,[188] the Crimea and the Caucasus,[189] the Middle East,[190] and North Africa.[191]

The technique of pressure is well documented in the Middle East at early agricultural sites,[192] in particular on the Anatolian plateau from the ninth millennium BCE.[193] The first farmers of Europe certainly had it in their technical *repertoire*.[194] This technique was recorded in a variety of Early Neolithic contexts that spread across Europe with the Neolithic.[195] That is why I. Mateiciucova connected its appearance in the LBK materials of Central Europe with the 'Mediterranean' impulse.[196]

In the southern Eastern Europe, the first evidence of pressure-made blades from conical nuclei can be associated with Kukrek-type industries and the eighth millennium BCE. Moreover, the miniature conical nuclei of the Myrne site (7400-7200 BCE) were most likely worked by

183 Sørensen et al. 2013.

184 Stupak 2006.

185 Biagi, Starnini 2016.

186 Binder et al. 2012; Perrin et al. 2009.

187 Allard 2007.

188 Barbaza 1999.

189 Biagi 2016; Domanska 1987.

190 Gehlen 2010.

191 Marchand, Perrin 2017.

192 Inizian 2012; Nishiaki 2000.

193 Binder 2008.

194 Binder, Perlés 1990; Pelegrin 2012b.

195 Domboroczki et al. 2010; Kozlowski, Nowak 2008.

196 Mateiciucova 2008.

pressure.[197] There is also poorer dated evidence for an earlier age of this technique here and in related regions, primarily in the Dnieper Rapids region and Crimea.[198] Subsequently, the pressure technique is often recorded in the sites of early agricultural cultures of the region and is usually interpreted as evidence of the Mesolithic 'heritage'. However, in the southern Eastern Europe, when specific cases of pressure laminar production can be linked to Mesolithic and Neolithic 'roots', an in-depth analysis of the knapping technology is required, which is not limited to stating the regularity of the edges of blades and bladelets. In cases of such analysis, Mesolithic 'traces' are often not confirmed,[199] although due to the small number of cases studied, it would be a careless and hasty statement to assert the Mesolithic origin of the pressure laminar production in the materials of Neolithic cultures of the region under study.

The formation of raw material exchange networks, despite their presence in the *Heimatland* of early farmers in Anatolia and the Levant, is often seen as dependent on migrants' contacts with the local population – mobile hunter-gatherer groups.[200] Although information about deposits of high-quality raw materials and relations over their control may have united hunter-gatherers and early farmers, it is worth emphasising that the supply of materials to sedentary and mobile populations radically differed from an organisational point of view.[201]

The usual background for the search for traces of the Mesolithic 'heritage' is the traditional cultural-historical approach, when the ancient pottery makers are presented as blind slaves to tradition, reproducing a certain set of products for thousands of years simply following cultural norms. In contrast, I suppose that the Neolithic knappers had their own agency, trying to adapt their skill to a situation they encountered on their life trajectory.[202] From the perspective of this approach, such cases of long-term constancy are anomalous and require a separate explanation. Traditional prescriptions are fulfilled through social mechanisms that keep explicit and unspoken rules in place.[203] The restrictions imposed by society never deprive a person of complete freedom of action. Rather, they form the 'rules

197 Kiosak 2019b.

198 Yanevich 2019; Zaliznyak 2020.

199 Kiosak 2016a.

200 Allard 2004; Gronenborn 1998; Mateiciucova 2008.

201 Zimmermann 1995.

202 Allard 2004; Allard, Denis 2015; Bickle, Whittle 2013; Kiosak 2019a; Rolland, Dibble 1990.

203 Weedman Arthur 2010.

of the game', define the field on which social interaction between actors takes place, and structure and reproduce social relations.[204]

Thus, Neolithic flintknappers should be viewed as 'thoughtful craftsmen' who possessed a certain technological *repertoire*, a set of techniques and methods that were implemented depending on the needs and circumstances of the action. This approach calls into question the evolutionary significance of the knapping technique. The development of the flint industries is often perceived as a completely evolutionary process – a movement from the simple to the complex, where more complex techniques have innovative advantages over simpler ones and, upon their appearance, completely or mostly replace their predecessors simply due to their greater efficiency. In fact, the long coexistence of a wide variety of knapping techniques does not support this view. There are numerous cases when a certain technique functions in a living culture after its appearance and then is lost, and 're-discovered'. Therefore, we must assume that the technological *repertoire* of early farmers of the southern Eastern Europe included a variety of knapping techniques that were implemented depending on the need. Given the high efficiency of the punch knapping and pressure techniques,[205] a craftsman could easily satisfy the need for blades for his household in a relatively short period of time.

1.6 Conclusion

Modern radiocarbon date series indicate that early farmers could only have interacted with para-Neolithic fishers, hunters and gatherers, and not with their Mesolithic predecessors. The transition between Mesolithic and para-Neolithic could have happened several centuries earlier than the actual Neolithisation of the region. In this context, the exclusive attribution of certain technical components of the material culture of early farmers to the 'Mesolithic heritage' is more than dubious. Several elements of supposed 'Mesolithic heritage' should not be treated as such. Specifically, Kukrek implements, such as Kukrek pencil-like cores, typical Kukrek inserts, and multi-facetted burins on blades, belong to the technological context of the eighth millennium BCE and cannot be evidence of a 'Mesolithic influence' in Neolithic lithic assemblages. Some items are interpreted as 'Mesolithic' in an overly straightforward way, namely trapezes and evidence for pressure-based laminar production. These technological features existed in a number of Neolithic cultures and could be an organic 'Neolithic' component of the lithic toolsets of the early farmers.

204 Hodder 1982.

205 Pelegrin 1994; 2006; 2012a; 2012b.

Figures

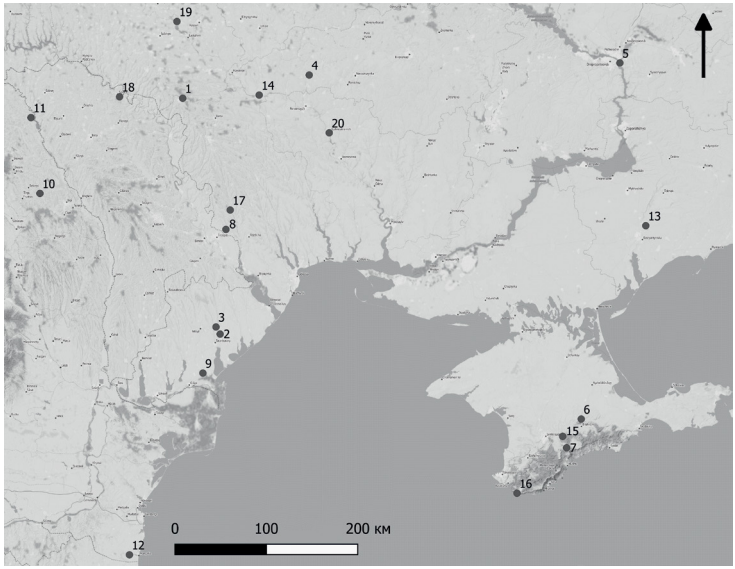

Figure 2 Relevant hunter-gatherer sites in the Carpathian-Danube region and surrounding areas. 1. Tsarynka (Tsarinka); 2. Bilolissia (Belolesie); 3. Cilighider; 4 . Dobrianka III; 5 . Ihren 8 (Igren); 6. Vyshenne 1; 7. Shpan-Koba; 8. Hrebenyky (Grebeniki); 9. Myrne (Mirnoe); 10. Erbiceni; 11. Ripiceni-Izvor; 12. Albești; 13. Kamyana Mohyla 1; 14. Melnychna Krucha; 15. Kukrek; 16. Laspi 7; 17. Hirzheve (Girzhevo); 18. Soroca 2; 19. Ziankivtsi 2; 20. Gard. Map by the Author

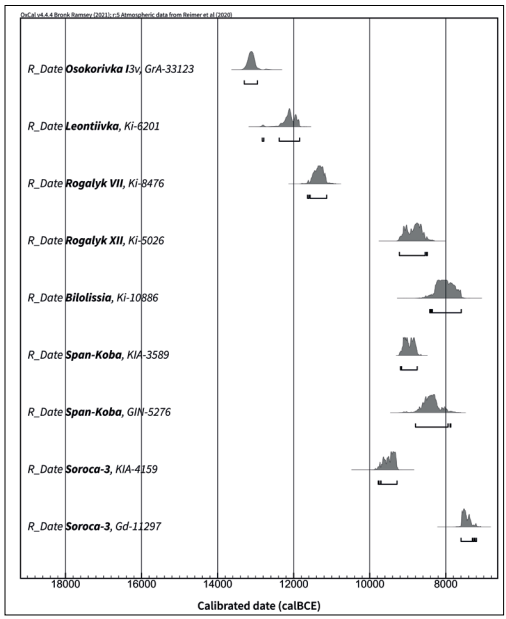

Figure 3
Legacy dates for the Early Mesolithic in southern Ukraine and Moldova. **ST 1-1**.
Done in OxCal by the Author (here and thereafter OxCal 4.4.4 by Bronk Ramsey 2021, calibration curve IntCal20 by Reimer et al. 2020)

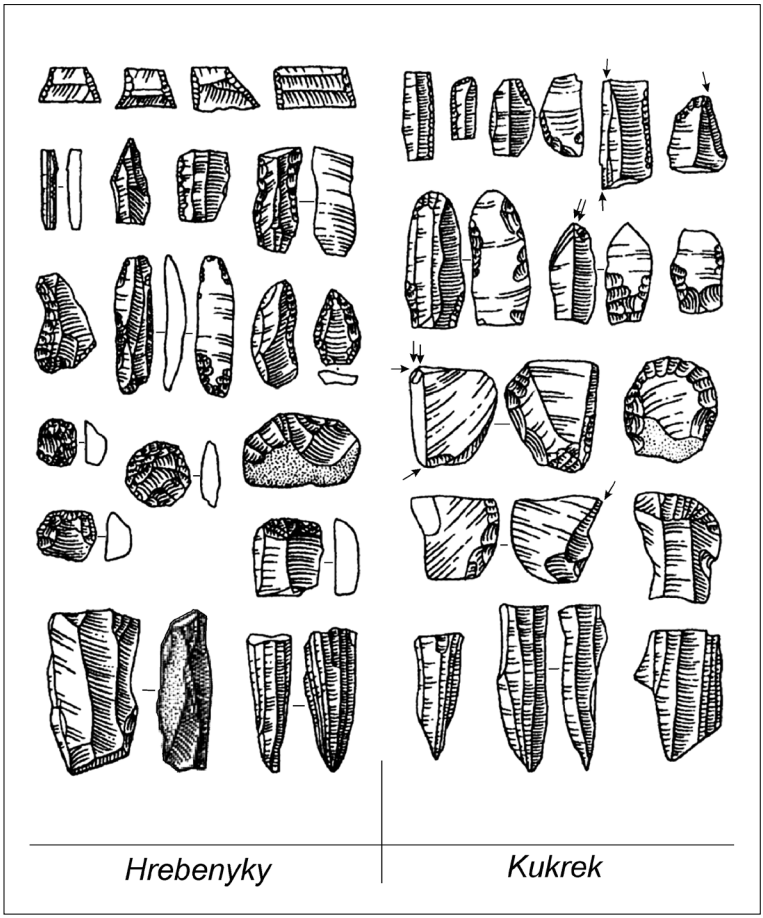

Figure 4 Kukrek versus Hrebenyky tool types as seen by Stanko 1972 with changes

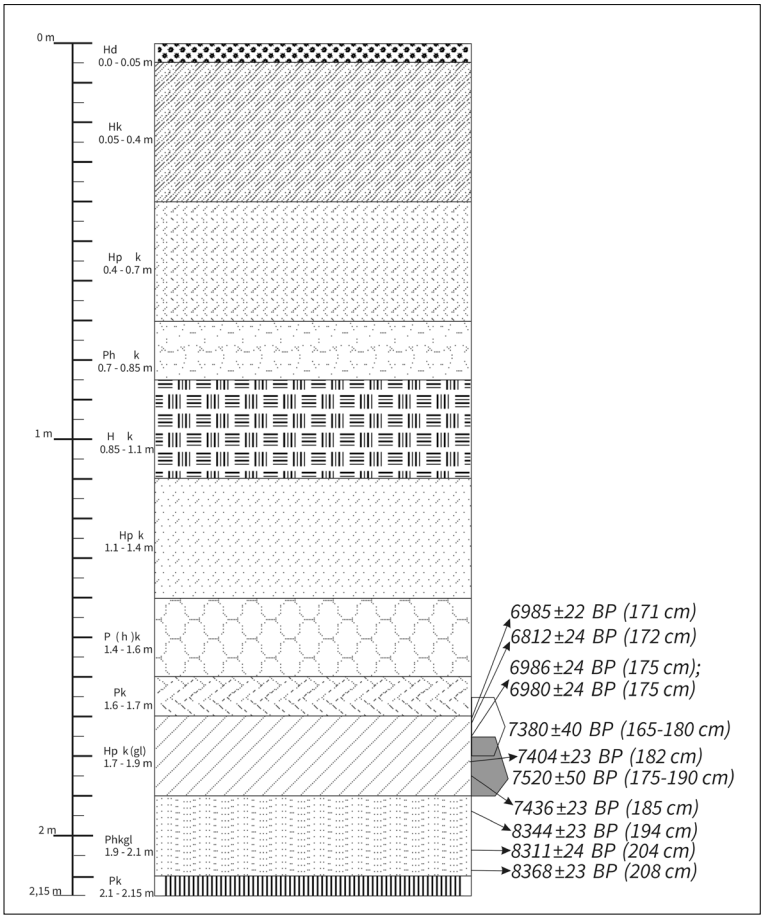

Figure 5 The schematic soil sequence of Melnychna Krucha with the position of radiocarbon-dated samples. Drawing by the Author after description by Zh. Matviishyna

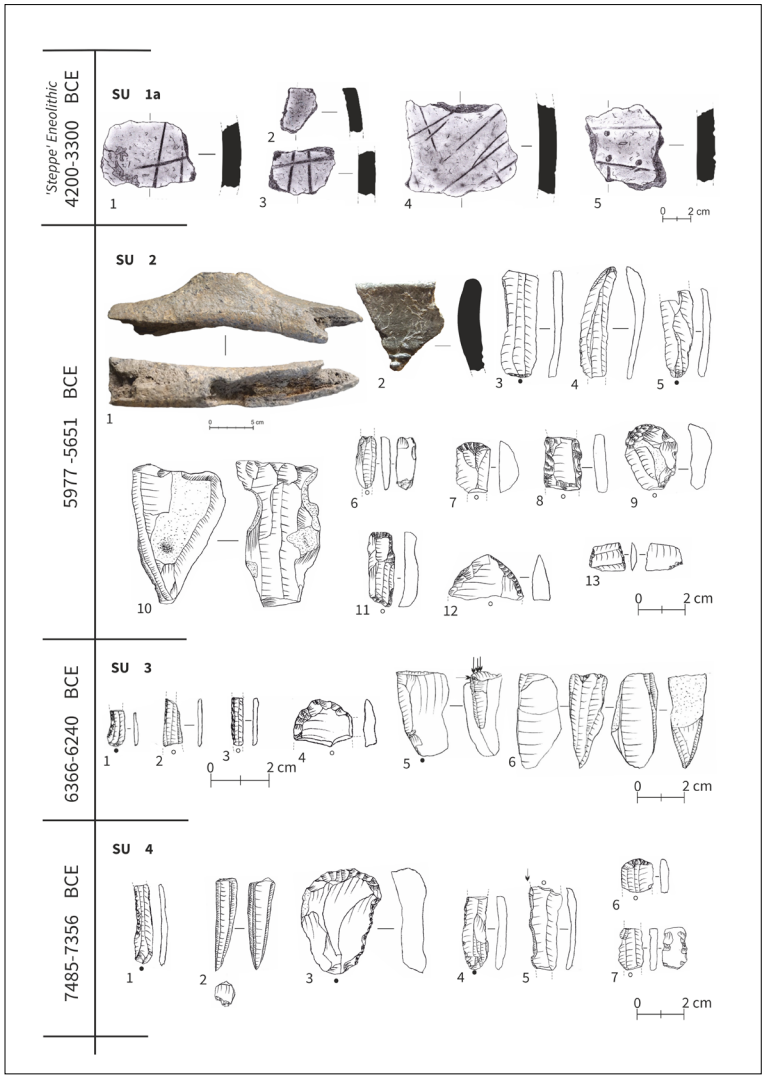

Figure 6 The archaeological sequence of Melnychna Krucha. Drawing by the Author

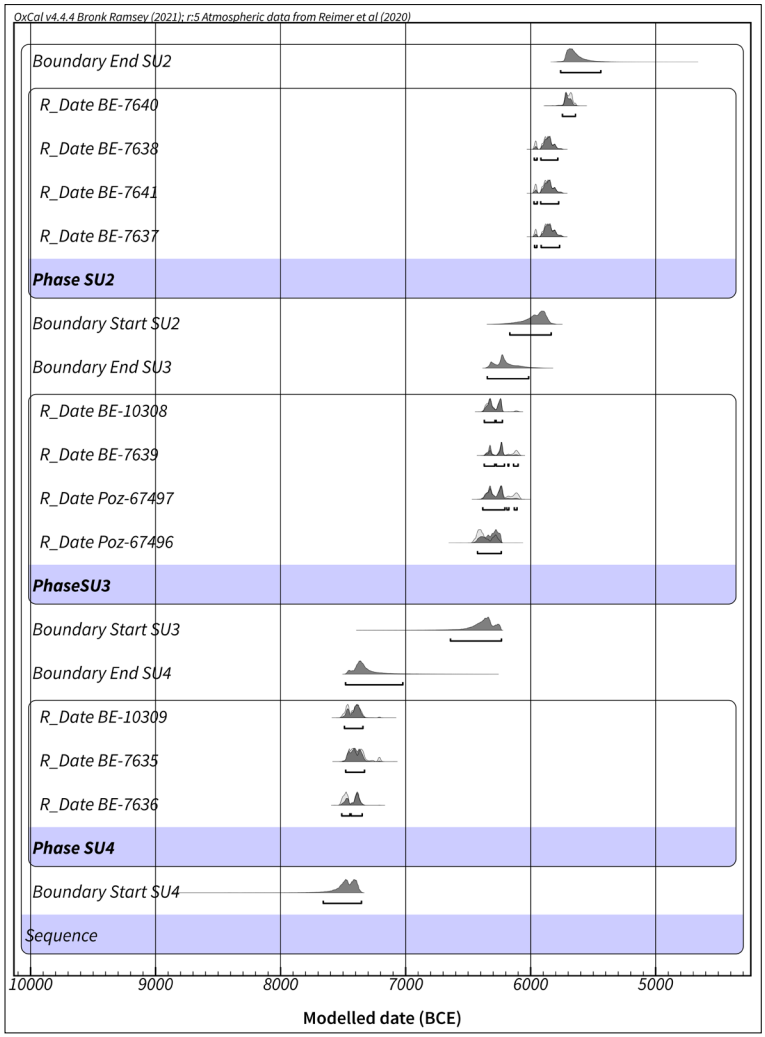

Figure 7 Modelled radiocarbon dates for Melnychna Krucha. **ST 1-2**. Done in OxCal by the Author

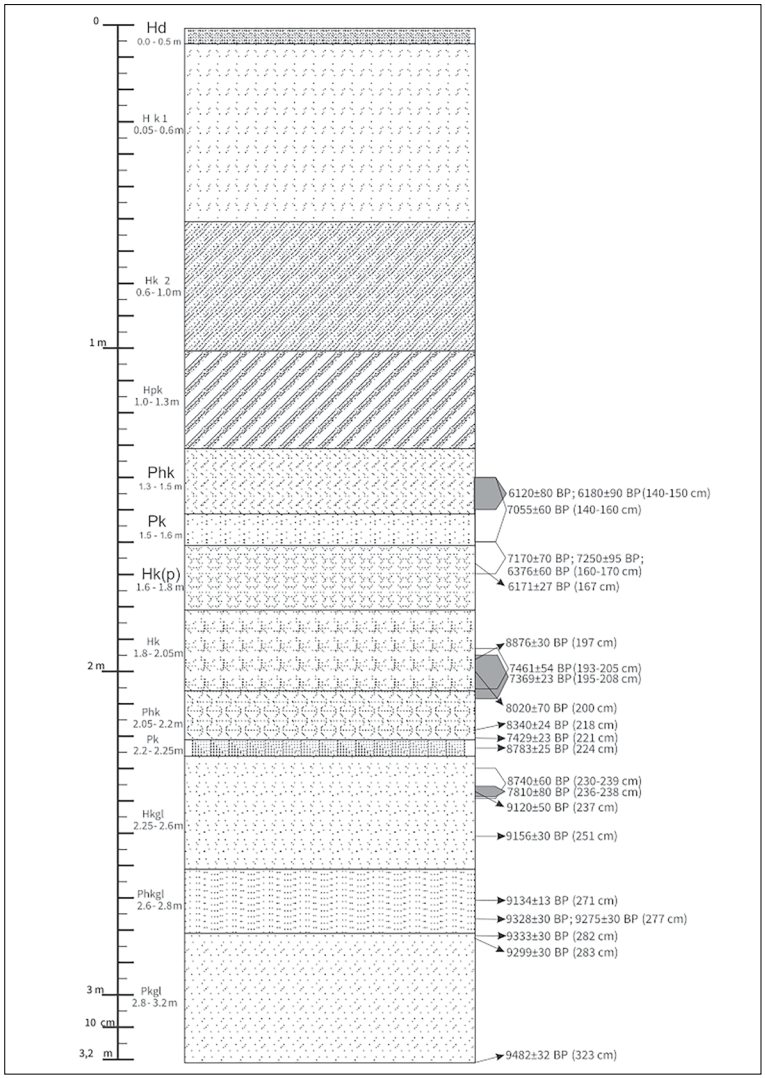

Figure 8 The schematic soil sequence of Kamyana Mohyla 1 with the relative position of radiocarbon-dated samples. Description of soil sequence: see text. Elaborated by the Author after the description of Zh. Matviishyna, with radiocarbon dates kindly provided by W. Tinner, S. Szidat and N. Kotova

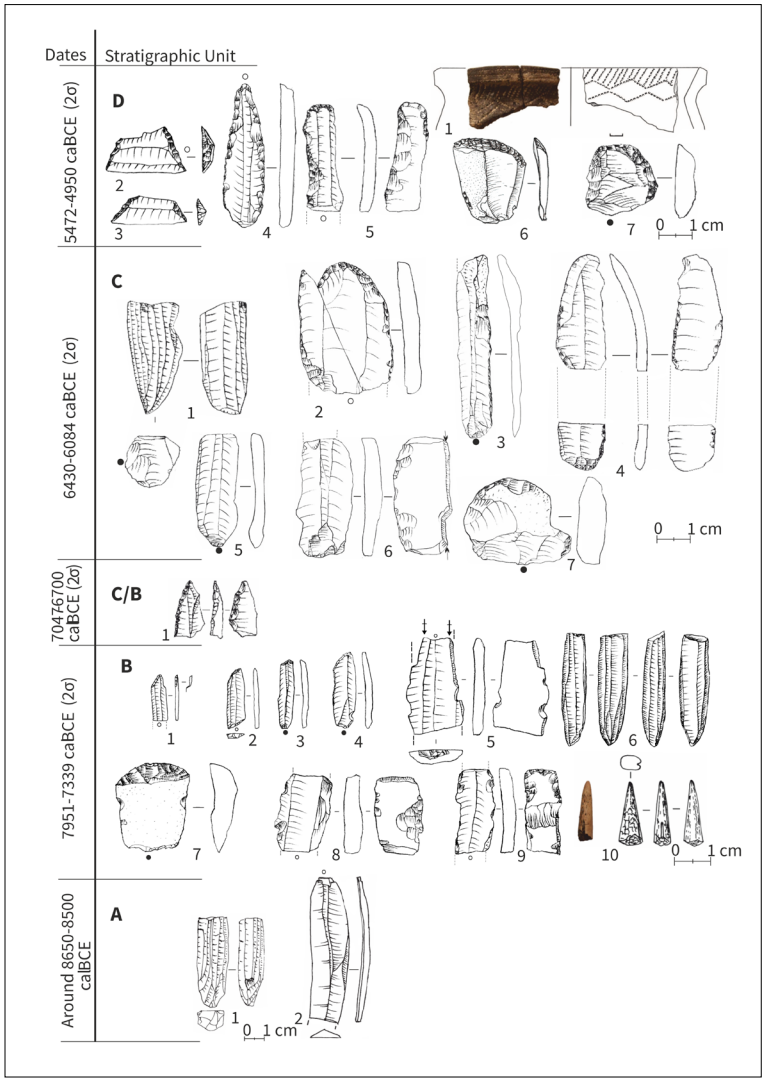

Figure 9 The archaeological sequence of Trench 2 of Kamyana Mohyla 1. D1, 6 after Kotova et al. 2017, B10 after Kiosak et al. 2022. Drawing by the Author

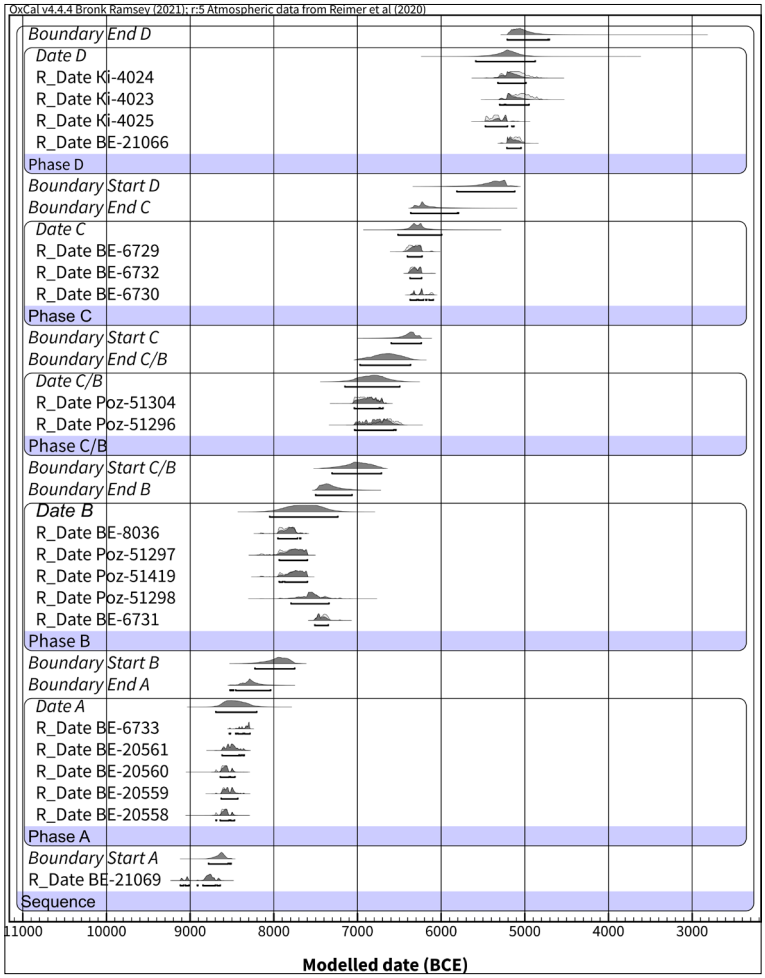

Figure 10 Modelled radiocarbon dates for Kamyana Mohyla 1. **ST 1-3**. Model 1-2. Done in OxCal by the Author

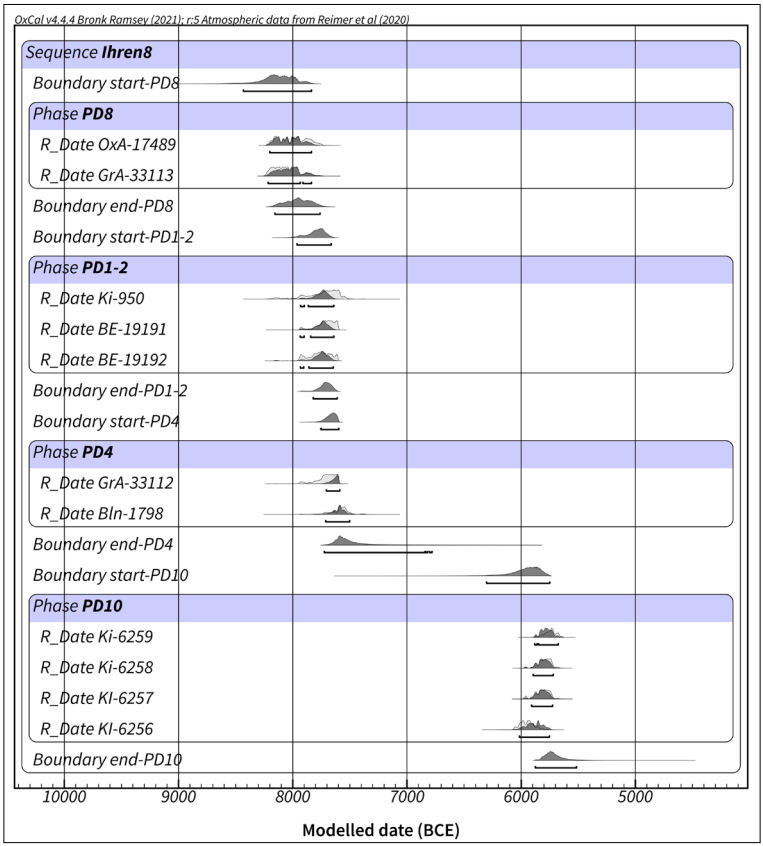

Figure 11 The modelled sequence of Ihren 8. **ST 1-4**. Model 1-4. Done in OxCal by the Author

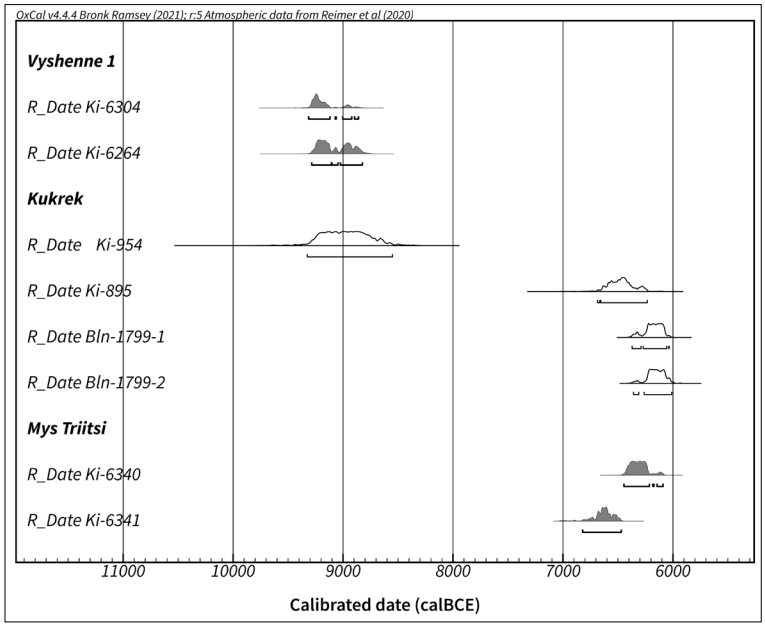

Figure 12 The legacy dates for Kukrek sites in the Southern Ukraine and Moldova. Grey: dates from animal bones; white: dates from shells of freshwater molluscs. **ST 1-5**. Done in OxCal by the Author

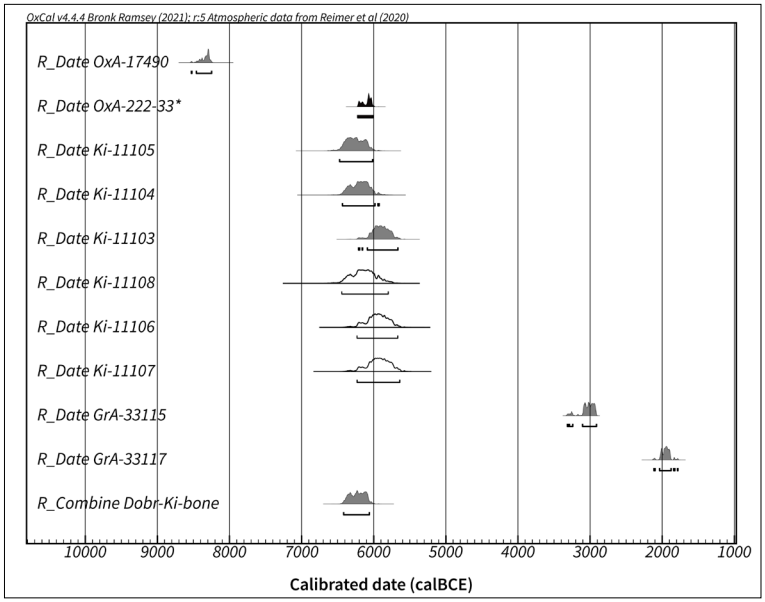

Figure 13 Dobrianka 3. The radiocarbon dates: grey: animal bones; black: human bone; white: potsherds. Dobr-Ki-bone: the combination of dates Ki-11105 and Ki-11104. **ST 1-6**. Done in OxCal by the Author

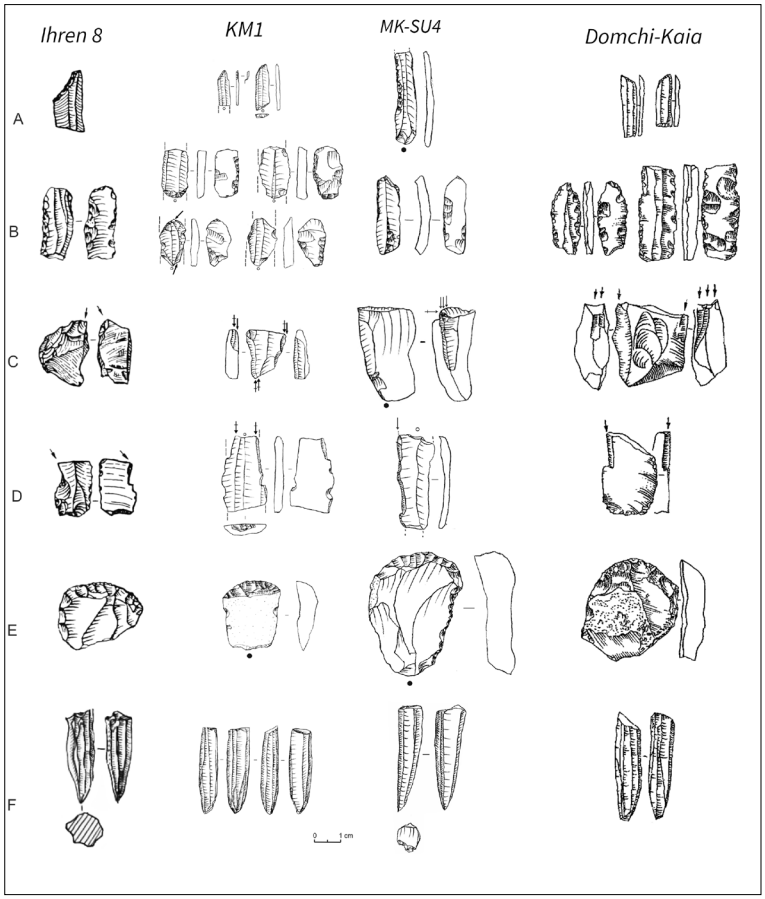

Figure 14 Comparison of the lithic assemblages of *Kukrek sensu stricto*. After Kiosak et al. 2023 with modifications. A. obliquely truncated bladelets (in case of MK-SU4 – its proximal fragment); B: so called 'Kukrek inserts'; C: 'Kukrek burins' (multiple burins on flakes); D. simple burins on blades (in case of KM1 – double burin); E: end-scrapers on flakes; F. pencil-like cores. KM1 – Kamyana-Mohyla 1, MK-SU4 – Melnychna Krucha, stratigraphic unit 4

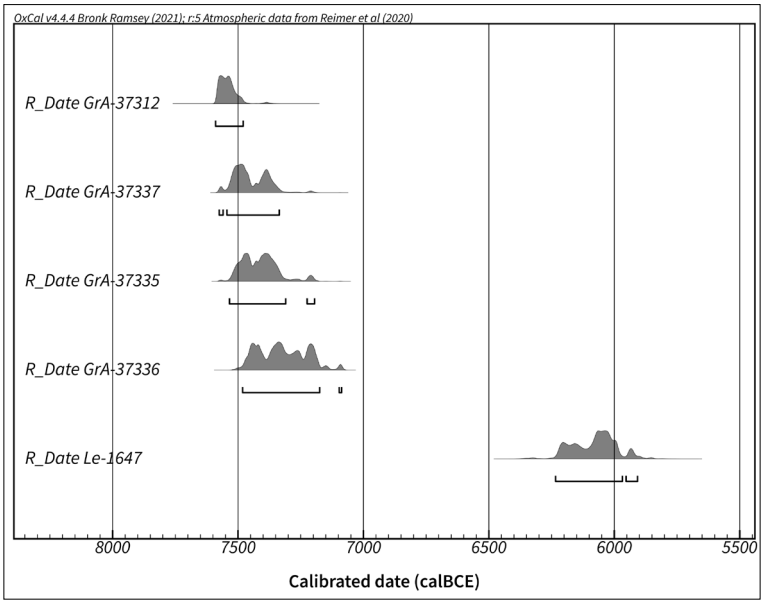

Figure 15 Myrne site. Radiocarbon dates. After Biagi, Kiosak 2010. Done in OxCal by the Author

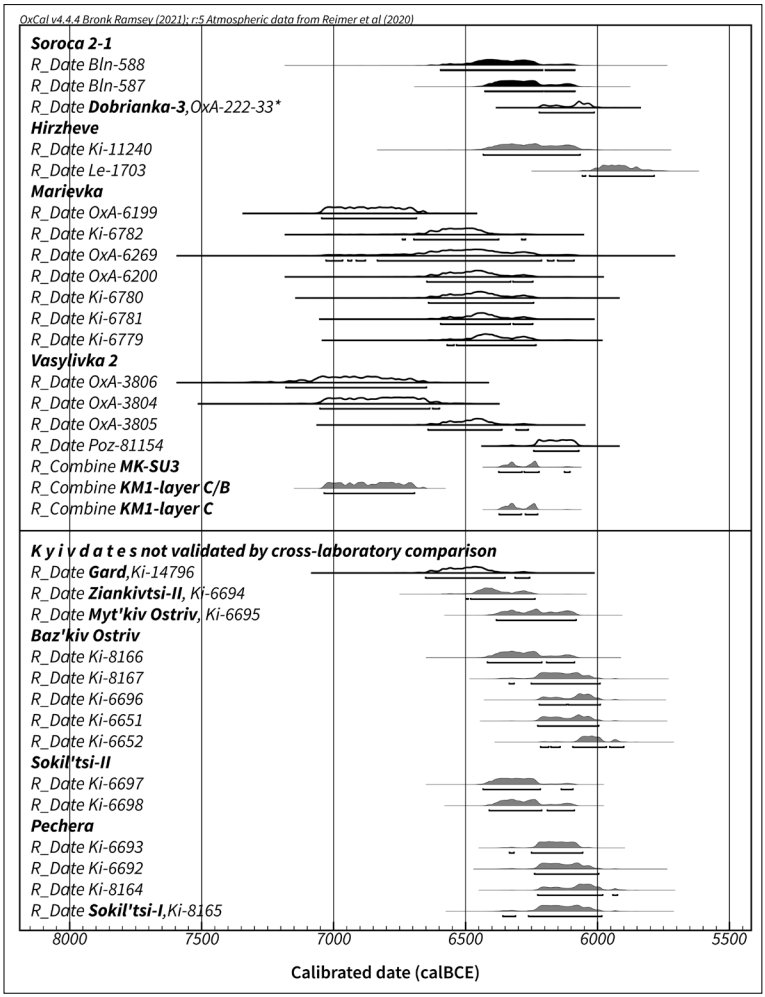

Figure 16 Radiocarbon dates for the sites of the seventh millennium BCE in the North Pontic region. Black: charcoal; grey: animal bones; empty: human bones. MK – Melnychna Krucha, KM1 – Kamyana Mohyla 1. **ST 1-7**. Done in OxCal by the Author

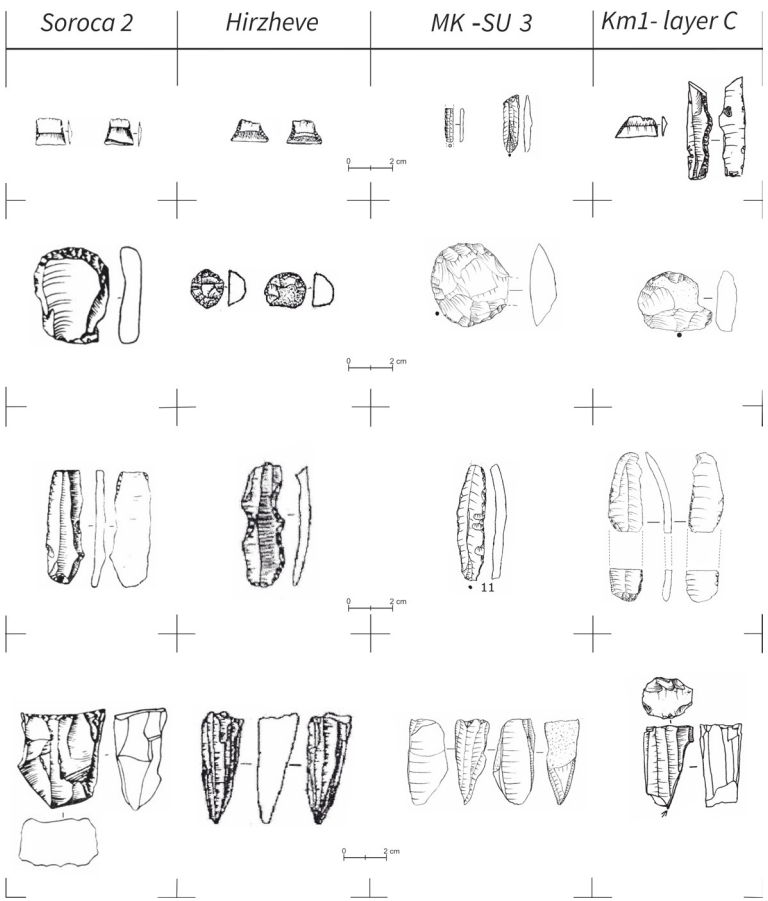

Figure 17 The comparison of lithic complexes of the second half of the seventh millennium BCE from the Northern Pontic region. Soroca 2: after Marchevich 1974; Hirzheve: after Stanko, Kiosak 2010; MK-SU3, Melnychna Krucha SU3: after Kiosak 2019; KM1, Kamyana Mohyla 1 – layer C: after Kotova et al. 2017. Collage by the Author

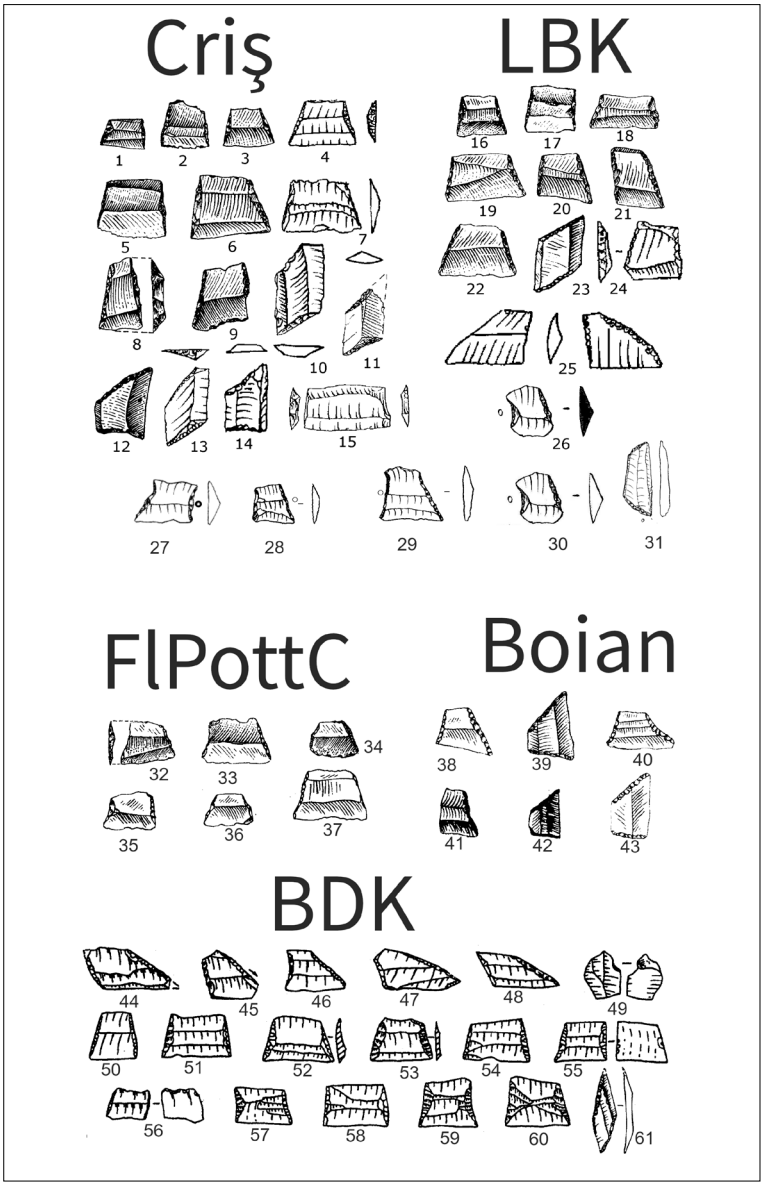

Figure 18 Geometrical microliths of Neolithic from Carpathian-Danubian region and trapezes from Kamyane-Zavallia (after Kiosak 2016 with modifications). Cris: Criş culture (1-15), including Sacarovca group (4, 7, 11, 13-15); LBK: LinearBandkeramik Culture (16-31); FlPotC: Fluted Pottery Cultures (Dudeşti [32-34], Vinca-Tordoş [35-37]); Boian: Boian culture (38-43); BDK: Buh-Dniester para-Neolithic (44-61). 1-3, 5-6, 8: Cuina Turcului-Dubova; 4-7, 10-11, 13-15: Sacarovca; 9: Balş; 12; Trestiana: 16-17; Bereşti: 18-22; Traian-Dialui-Fîntînilor: 23; Glăvenești Vechi: 24; Chișchereni V: 25; Dănceni I: 26-31; Kamyane-Zavallia: 32, 34; Dudeşti: 233; Dragceanu: 38-40; Cleanov Fiera: 41-43; Cernica: 42; Giuleşti-Bucureşti: 44-49; Gard 3 (44 – micro-burin): 50-60; Gard: 4, 61; Soroca: 5. According to: Păunescu 1970; Dergacev and Larina 2015; Larina 1999; Markevich 1974; Tovkailo 2005; Kiosak 2019. Collage by the Author

Supplementary Tables

ST 1-1 Radiocarbon dates intended for Early Mesolithic in the region between Carpathians and Dnieper. Some are evidently Final Paleolithic

Site Name	Provenance	Lab. Number	Date BP	SD	Cultural aspect	Material	CalBC (1 sigma)	CalBC (2 sigmas)	Reference
Dobryanka-3	cultural layer	OxA-17490	9115	45	Unknown	bone	8420-8272	8454-8252	Lillie et al. 2009
Soroca-3	cultural layer	KIA-4159	9950	70	Unknown	Tooth (horse)	9650–9300	9758-9279	Wechler 2001
Soroca-3	cultural layer	Gd-11297	8430	90	Unknown	Unio shell	7580–7370	7602-7192	Wechler 2001
Osokorivka I 3v	3v	GrA-33123	12640	50	Tsarynka	bone	13193.5-13034	13298.5-12949.5	Biagi et al. 2007
Leontiivka	cultural layer	Ki-6201	12150	90	Tsarynka	bone	12223-11864.5	12826-11843	Olenkovskyi 2010
Rogalyk VII	cultural layer	Ki-8476	11400	140	Epigravettian	bone	11463.5-11214.5	11633.5-11129.5	Olenkovskyi 2010
Rogalyk XII	cultural layer	Ki-5026	9470	110	Tsarynka	bone	9119-8622	9219.5-8485.5	Olenkovskyi 2010
Bilolissia	cultural layer	Ki-10886	8900	160	Bilolissia	bone	8255-7813	8420-7592	Man'ko 2006
Span-Koba	cultural layer	KIA-3589	9560	50	Span-Koba	bone	9121.5-8807	9189.5-8751.5	Yanevich 2019
Span-Koba	cultural layer	GIN-5276	9150	150	Span-Koba	bone	8610-8236	8796.5-7866	Yanevich 2019

ST 1-2 Radiocarbon dates for the site of Melnychna Krucha

Site name	Provenance	Lab. no.	Date BP	SD	Cultural aspect	Material	CalBC (1 sigma)	CalBC (2 sigmas)	Reference
Melnychna Krucha	SU4	BE-7636	8368	23		bone	7478-7360	7496-7339	Kiosak et al. 2021
Melnychna Krucha	SU4	BE-7635	8311	24		bone	7456-7353	7486-7322	Kiosak et al. 2021
Melnychna Krucha	SU4	BE-10309	8344	23		bone	7452-7343	7480-7310	Kiosak et al. 2021
Melnychna Krucha	SU3	Poz-67496	7520	50		bone	7452-7343	7480-7310	Kiosak et al. 2021
Melnychna Krucha	SU3	Poz-67497	7380	40		Angiosperm	6448-6361	6461-6252	Kiosak, Salavert 2018
Melnychna Krucha	SU3	BE-7639	7370	24		Ash charcoal	6356-6216	6380-6100	Kiosak, Salavert 2018
Melnychna Krucha	SU3	BE-10308	7404	23	Mesolithic	Bone	6334-6216	6361-6103	Kiosak et al. 2021
Melnychna Krucha	SU2	BE-7637	6980	24	Unknown	Bone	5980-5900	5990-5880	Kiosak et al. 2021
Melnychna Krucha	SU2	BE-7641	6986	24	Unknown	Bone	5872-5778	5888-5748	Kiosak et al. 2021
Melnychna Krucha	SU2	BE-7638	6985	22	Unknown	Antler	5773-5724	5835-5714	Kiosak et al. 2021
Melnychna Krucha	SU2	BE-7640	6812	24	Unknown	Bone	5762-5716	5806-5675	Kiosak et al. 2021
Melnychna Krucha	SU-R4	BE-10319	6008	21	Unknown	Bone	4880-4795	4930-4780	Kiosak et al. 2021

ST 1-3 Radiocarbon dates for the site of Kamyana Mohyla 1

Site name	Provenance	Lab. no.	Date BP	SD	Material	Telegin et al. 2000	CalBC (2 sigmas)	Reference
KM1	Tr. 2 - sq.17, depth 50-63 cm, fireplace, Layer C	BE-6730	7369	23	charcoal	6333-6094	6364-6083	Kiosak et al. 2022
KM1	Tr. 2 - sq.17, depth 76 cm, fireplace, Layer C	BE-6732	7429	23	charcoal	6367-6242	6378-6234	Kiosak et al. 2022
KM1	Tr. 2 - sq.14, depth 48-60 cm, fireplace, Layer C	BE-6729	7461	54	charcoal	6392-6251	6248-6229	Kiosak et al. 2022
KM1	Tr. 2 – sq.1, depth 91-93 cm, Layer B	Poz-51296	7810	80	animal bone	6767-6502	7029-6464	Kiosak et al. 2022
KM1	Tr. I – sq. 5, Depth 140 cm, Layer B	Poz-51304	7980	40	animal bone	7036-6825	7046-6699	Kotova et al. 2017
KM1	Tr. 2 - sq.13, depth 73 cm, charcoal scatter, Layer B	BE-6731	8340	24	charcoal	7478-7356	7504-7334	Kiosak et al. 2022
KM1	Tr. 2 - sq. 9, Layer B	Poz-51298	8510	110	charcoal	7705-7370	7935-7193	Kiosak et al. 2022
KM1	Tr. I - sq. 3, 140 cm, Layer B	Poz-51419	8730	50	bone of a large ungulate (bull or elk)	7815-7605	7942-7598	Kotova et al. 2017
KM1	Tr. 2 - sq. 6, depth 85-94 cm, fireplace, Layer B	Poz-51297	8740	60	charcoal	7936-7606	8164-7592	Kiosak et al. 2022
KM1	Tr. 2 - sq.15, Pit 1 , depth 79 cm, Layer B	BE-8036	8783	25	animal bone	7940-7758	8158-7718	Kiosak et al. 2022
KM1	Tr. 2 – sq. 4, depth 92 cm, Layer	Poz-51306	9120	50	animal bone	8419-8273	8534-8245	Kiosak et al. 2022
KM1	Tr. 1 - sq.9, depth 206 cm, Layer A, fireplace	Poz-61519	8810	50	charcoal	8161-7752	8203-7659	Kotova et al. 2017
KM1	Tr. 2 - sq.15, depth 126 cm, fireplace, Layer A	BE-6733	9134	13	charcoal	8329-8288	8416-8282	Kiosak et al. 2022
KM1	EP of 1983, depth 140-160 cm	Ki-7667	7055	60	animal bone	5994-5847	6057-5791	Kotova 2003
KM1	Ep of 1987, z=160-170 cm	Ki-4226	7170	70	animal bone	6082-5923	6220-5900	Telegin et al. 2000
KM1	Ep of 1987, z=160-170 cm	Ki-4022	7250	95	animal bone	6221-6027	6370-5919	Telegin et al. 2000
KM1	Ep of 1987, z=200 cm	Ki-7668	8020	70	unknown	7060-6822	7138-6686	Bezus'ko 2009
KM1	"Mesolithic Layer"	Ki-7669	8570	85	animal bone	7710-7525	7936-7381	Kotova 2003
KM1	Tr.2 - Sq. 30n, z-106	BE-20556	9156	30	animal bone	8418-8292	8530-8286	Kotova et al. sbm
KM1	Tr.2 – Sq. 30n, z-137	BE-20558	9333	30	animal bone	8630-8550	8704-8475	Kotova et al. sbm
KM1	Tr.2 – Sq.30n, z-138	BE-20559	9299	30	animal bone	8616-8485	8691-8359	Kotova et al. sbm
KM1	Tr.2 – Sq. 30op, z-132	BE-20560	9328	30	animal bone	8627-8550	8703-8471	Kotova et al. sbm
KM1	Tr.2 – Sq.19,z-132	BE-20561	9275	30	animal bone	8609-8456	8621-8351	Kotova et al. sbm
KM1	Tr.2 – Soil section, z-22	BE-21066	6171	27	animal bone	5206-5054	5213-5030	Kotova et al. sbm
KM1	Tr.2 – Soil section, z-52	BE-21068	8876	30	animal bone	8191-7955	8225-7853	Kotova et al. sbm
KM1	Tr.2 – Soil section, z-178	BE-21069	9482	32	animal bone	9042-8710	9115-8634	Kotova et al. sbm
KM1	Trench 1983	Ki-4025	6376	60		5469-5227	5474-5216	Telegin et al. 2000
KM1	Trench 1983	Ki-4023	6120	80		5206-4946	5295-4839	Telegin et al. 2000
KM1	Trench 1983	Ki-4024	6180	90		5284-5003	5320-4849	Telegin et al. 2000

ST 1-4 Radiocarbon dates for the site of Ihren 8

Site Name	Provenance	Lab. Number	Date BP	SD	Material	CalBC (1 sigma)	CalBC (2 sigmas)	Reference
Ihren' 8	Pit-dwellling 2	Bln-1797/2	9940	70	unident. Charcoal	9630-9330	9760-9280	Telegin 2002
Ihren' 8	Pit-dwelling 8	OxA-17489	8885	40	*Cervus* bone	8180-7970	8220-7840	Lillie et al. 2009
Ihren' 8	Pit-dwelling 8, lowermost layer	GrA-33113	8880	45	Mammal long bone flake	8202-7966	8232-7836	Biagi, Kiosak 2010
Ihren' 8	Pit-dwelling 4, lowermost layer	GrA-33112	8695	45	Mammal long bone flake	7733-7610	7934-7592	Biagi, Kiosak 2010
Ihren' 8	Pit-dwellling 1	Ki-950	8650	100	unident. Charcoal	7890-7600	8150-7500	Zaitseva et al. 2000
Ihren' 8	Pit-dwellling 4	Bln-1798	8550	80	unident. Charcoal	7670-7530	7780-7450	Telegin 2002
Ihren' 8	Pit-dwelling 8	OxA-17491	7640	90	Fish bone	6590-6431	6655-6264	Lillie et al. 2009
Ihren' 8	PD10	Ki-6259	6860	45	Bone	5792-5670	5841-5654	Telegin 2002
Ihren' 8	PD10	Ki-6258	6910	50	Bone	5836-5731	5967-5672	Telegin 2002
Ihren' 8	PD10	KI-6257	6930	50	Bone	5875-5739	5970-5720	Telegin 2002
Ihren' 8	PD10	KI-6256	7080	60	Bone	6016-5894	6067-5833	Telegin 2002
Ihren' 8	PD1	BE-19191	8712	37	Bone	7743-7605	7937-7595	Kiosak et al. 2023c
Ihren' 8	PD2	BE-19192	8740	37	Bone	7931-7609	7941-7603	Kiosak et al. 2023c
Ihren' 8	PD3	Ki-806	6930	130	freshwater shells	5977-5715	6058-5620	Telegin 2002
Ihren' 8	PD4	Ki-850	7300	130	freshwater shells	6338-6023	6427-5919	Telegin 2002
Ihren' 8	PD2	Ki-805	8080	210	freshwater shells	7320-6698	7531-6515	Telegin 2002
Ihren' 8	PD1	Ki-368	8860	470	freshwater shells	8701-7380	9320-6703	Telegin 2002
Ihren' 8	PD5	Ki-956	9290	110	freshwater shells	8695-8343	9039-8380	Telegin 2002
Ihren' 8	CL-D2	Bln-1707/1	8575	70	freshwater shells	7707-7530	7765-7485	Telegin 2002
Ihren' 8	CL-D2	Bln-1707/2	8940	65	freshwater shells	8248-7965	8285-7848	Telegin 2002
Ihren' 8	PD2	Bln-1797/1	8570	70	freshwater shells / charcoal	7706-7527	7753-7484	Telegin 2002
Ihren' 8	PD2	Bln-1797/2	9940	70	freshwater shells / charcoal	9653-9295	9749-9268	Telegin 2002
Ihren' 8	PD7	Ki-2171	6500	200	freshwater shells	5629-5219	5827-4995	Telegin 2002
Ihren' 8	Trench 8	Ki-2168	6520	95	freshwater shells	5606-5376	5629-5306	Telegin 2002
Ihren' 8	Sq21	Ki-2169	6650	200	freshwater shells	5739-5374	5981-5214	Telegin 2002
Ihren' 8	Sq3	Ki-2170	6820	120	freshwater shells	5837-5621	5978-5484	Telegin 2002
Ihren' 8	Trench 8	Ki-3034	6650	120	freshwater shells	5664-5477	5784-5364	Telegin 2002
Ihren' 8	PD10	Ki-3613	5650	80	freshwater shells	4576-4361	4679-4346	Telegin 2002
Ihren' 8	PD7	Ki-1206	7120	100	freshwater shells	6074-5850	6220-5789	Telegin 2002
Ihren' 8	Trench 4	Ki-1569	7850	100	freshwater shells	7024-6588	7038-6499	Telegin 2002
Ihren' 8	PD4, D1	Ki-11684	6500	140	Potsherd	5610-5330	5718-5131	Man'ko 2005
Ihren' 8	PD8, D	Ki-11682	6600	140	Potsherd	5656-5385	5772-5223	Man'ko 2005
Ihren' 8	PD8, E	Ki-11683	6700	140	Potsherd	5722-5481	5888-5372	Man'ko 2005
Ihren' 8	PD8, D2	Ki-11685	7050	140	Potsherd	6056-5784	6220-5668	Man'ko 2005

ST 1-5 Legacy dates for Kukrek sites

Site Name	Lab. Number	Date BP	SD	Cultural aspect	Material	CalBC (1 sigma)	CalBC (2 sigmas)	Reference
Vyshenne 1	Ki-6304	9740	60	Kukrek	bone	9287-9160	9312-8859	Yanevich 2019
Vyshenne 1	Ki-6264	9680	70	Kukrek	bone	9252-8871	9285-8823	Yanevich 2019
Kukrek	Ki-954	9600	150	Kukrek	freshwater shells	9221-8805	9324-8549	Yanevich 2019
Kukrek	Ki-895	7620	110	Kukrek	freshwater shells	6595-6385	6685-6233	Yanevich 2019
Kukrek	Bln-1799-1	7320	65	Kukrek	freshwater shells	6227-6086	6371-6034	Yanevich 2019
Kukrek	Bln-1799-2	7285	70	Kukrek	freshwater shells	6221-6074	6358-6011	Yanevich 2019
Mys Triitsi	Ki-6340	7450	70	Kukrek	bone	6390-6244	6445-6089	Yanevich 2019
Mys Triitsi	Ki-6341	7800	60	Kukrek	bone	6688-6513	6821-6469	Yanevich 2019

ST 1-6 Radiocarbon dates for the site of Dobrianka

Site Name	Provenance	Lab. Number	Date BP	SD	Cultural aspect	Material	CalBC (1 sigma)	CalBC (2 sigmas)	Reference
Dobrianka-3	cultural layer	**OxA-17490**	9115	45		animal bone	8420-8272	8454-8252	Lillie et al. 2009
Dobrianka-3	Burial	OxA-222-33*	7227	40	Mesolithic	Human bone	6202-6028	6210-6018	Lillie et al. 2009
Dobrianka-3	cultural layer	Ki-11105	7400	130		animal bone	6395-6090	6471-6015	Tovkailo 2020
Dobrianka-3	cultural layer	Ki-11104	7320	130		animal bone	6366-6061	6433-5925	Tovkailo 2020
Dobrianka-3	cultural layer	Ki-11103	7030	120		animal bone	6014-5787	6210-5664	Tovkailo 2020
Dobrianka-3	cultural layer	Ki-11108	7260	170	Savran	potsherd	6360-5983	6442-5797	Tovkailo 2020
Dobrianka-3	cultural layer	Ki-11106	7070	150	Savran	potsherd	6069-5782	6230-5666	Tovkailo 2020
Dobrianka-3	cultural layer	Ki-11107	7050	160	Savran	potsherd	6059-5761	6229-5638	Tovkailo 2020
Dobrianka-3	cultural layer	GrA-33115	4400	35		animal bone	3088-2926	3313-2909	Biagi et al. 2007
Dobrianka-3	cultural layer	GrA-33117	3595	35		animal bone	2014-1896	2114-1782	Biagi et al. 2007

ST 1-7 Radiocarbon dates for the Late Mesolithic

Site name	Provenance	Lab. no.	Date BP	SD	Cultural aspect	Material	CalBC (1 sigma)	CalBC (2 sigmas)	Reference
Myrne	Trench 1, sq. G24	GrA-37312	8475	45		Bone	7576-7524	7588-7487	Biagi, Kiosak 2010
Myrne	Trench III, sq. V1	GrA-37337	8385	45		Bone	7528-7372	7546-7342	Biagi, Kiosak 2010
Myrne	Trench II, sq. B5	GrA-37335	8350	45		Bone	7491-7356	7530-7310	Biagi, Kiosak 2010
Myrne	Trench I, sq. D22	GrA-37336	8280	45		Bone	7454-7193	7476-7180	Biagi, Kiosak 2010
Myrne	cultural layer	Le-1647	7200	80		nd	6206-6000	6234-5912	Stanko, Svezhentsev 1988
Mkrucha	*SU4*	*BE-7636*	*8368*	*23*		*bone*	*7478-7360*	*7496-7339*	Kiosak et al. 2021
MKrucha	*SU4*	*BE-7635*	*8311*	*24*		*bone*	*7456-7353*	*7486-7322*	Kiosak et al. 2021
MKrucha	*SU4*	*BE-10309*	*8344*	*23*		*bone*	*7452-7343*	*7480-7310*	Kiosak et al. 2021
MK	SU3	Poz-67496	7520	50		*bone*	*7452-7343*	*7480-7310*	Kiosak et al. 2021
MK	SU3	Poz-67497	7380	40		Angiosperm	6448-6361	6461-6252	Kiosak, Salavert 2018
MK	SU3	BE-7639	7370	24		Ash charcoal	6356-6216	6380-6100	Kiosak, Salavert 2018
MK	*SU3*	*BE-10308*	*7404*	*23*	*Mesolithic*	Bone	6334-6216	6361-6103	Kiosak et al. 2021
Gard	Cemetery	Ki-14796	7640	90	Mesolithic	Animal bone	6590-6431	6655-6264	Tovkailo 2014
Soroca-II.1	Cultural layer	Bln-588	7520	120	Mesolithic	Charcoal	6466-6246	6600-6200	Markevich 1974
Soroca-II.1	Cultural layer	Bln-587	7420	80	Mesolithic	Charcoal	6390-6228	6435-6097	Markevich 1974
Dobrianka-3	Burial	OxA-222-33*	7227	40	Mesolithic	Human bone	6202-6028	6210-6018	Lillie et al. 2009
Hirzheve	Cultural layer	Ki-11240	7390	100	Mesolithic	Bone	6392-6110	6435-6065	Man'ko 2006
Hirzheve	Cultural layer	Le-1703	7050	60	Mesolithic	?	6001-5885	6032-5789	Stanko, Svezhentsev 1988
Marievka	Burial 4	OxA-6199	7955	55	Mesolithic	Human bone	7028-6770	7045-6690	Lillie 1998
Marievka	Burial 10	OxA-6200	7620	100	Mesolithic	Human bone	6590-6406	6648-6251	Lillie 1998
Marievka	Burial 14	OxA-6269	7630	160	Mesolithic	Human bone	6648-6264	7027-6108	Lillie 1998
Marievka	Burial 4	Ki-6782	7680	90	Mesolithic	Human bone	6594.5-6441	6738-6272	Lillie, Budd 2020
Marievka	Burial 10	Ki-6779	7550	80	Mesolithic	Human bone	6469.5-6260.5	6568.5-6232.5	Lillie, Budd 2020
Marievka	Burial 10	Ki-6781	7585	80	Mesolithic	Human bone	6564.5-6271.5	6593-6244.5	Lillie, Budd 2020
Marievka	Burial 14	Ki-6780	7600	100	Mesolithic	Human bone	6586-6379	6639-6241.5	Lillie, Budd 2020
Vasylivka 2	6285-20	OxA-3804	7920	85	Mesolithic	Human bone	7028-6653.5	7050.5-6598	Lillie, Budd 2020
Vasylivka 2	6285-19	OxA-3805	7620	80	Mesolithic	Human bone	6569-6411	6641-6261.5	Lillie, Budd 2020
Vasylivka 2	6285-15	OxA-3806	8020	90	Mesolithic	Human bone	7063.5-6773	7179.5-6647.5	Lillie, Budd 2020
Vasylivka 2	6285-11	Poz-81154	7320	40	Mesolithic	Human bone	6225.5-6088	6240.5-6070	Lillie, Budd 2020
Zian'kivtsi-2	Lowermost cultural layer	Ki-6694	7540	65	Mesolithic	Bone	6465-6272	6494-6244	Kotova 2003
Mytkiv Ostriv	Depth 125 cm, lower layer	Ki-6695	7375	60	Pechera	Bone	6366-6119	6388-6090	Kotova 2003
Bazkiv Ostriv	Sq. B8, depth 80 cm	Ki-8166	7410	65	Pechera	Bone	6371-6230	6426-6100	Kotova 2003
Bazkiv Ostriv	Sq. Ya12, depth 80 cm	Ki-8167	7270	70	Pechera	Bone	6212-6072	6336-6004	Kotova 2003
Bazkiv Ostriv	Sq. G7, depth 80 cm	Ki-6696	7215	55	Pechera	Bone	6202-6016	6216-6002	Kotova 2003
Bazkiv Ostriv	depth 90 cm	Ki-6651	7235	60	Pechera	Bone	6206-6034	6224-6009	Kotova 2003
Bazkiv Ostriv	Sq. Yu7, depth 80 cm	Ki-6652	7160	55	Pechera	Bone	6070-5988	6207-5912	Kotova 2003
Sokiltsi-2	Lower layer	Ki-6697	7440	60	Pechera	Bone	6377-6250	6438-6214	Kotova 2003
Sokiltsi-2	Lower layer	Ki-6698	7405	55	Pechera	Bone	6362-6230	6416-6102	Kotova 2003
Pechera	Lower layer	Ki-6693	7305	50	Pechera	Bone	6221-6102	6328-6054	Kotova 2003
Pechera	Lower layer	Ki-6692	7260	65	Pechera	Bone	6211-6066	6240-6008	Kotova 2003
Pechera	Lower layer	Ki-8164	7205	70	Pechera	Bone	6204-6006	6227-5930	Kotova 2003
Sokiltsi-2	Complex 1	Ki-8165	7260	80	Pechera	Bone	6215-6060	6350-5988	Kotova 2003

Models

Model 1-1 Melnychna Krucha. Sequential phases

```
Plot()
  {
    Sequence()
    {
      Boundary("Start 1");
      Phase("1")
      {
        R_Date("BE-7636",8368,23);
        R_Date("BE-7635",8311,24);
        R_Date("BE-10309",8344,23);
      };
      Boundary("End 1");
      Boundary("Start 2");
      Phase("2")
      {
        R_Date("Poz-67496",7520,50);
        R_Date("Poz-67497",7380,40);
        R_Date("BE-7639",7370,24);
        R_Date("BE-10308",7404,23);
      };
      Boundary("End 2");
      Boundary("Start 3");
      Phase("3")
      {
        R_Date("BE-7637",6980,24);
        R_Date("BE-7641",6986,24);
        R_Date("BE-7638",6985,22);
        R_Date("BE-7640",6812,24);
      };
      Boundary("End 3");
    };
  };
```

Model 1-2 Kamyana Mohyla, Sequential phases, General Outlier model

```
Plot()
  {
    Outlier_Model("General",T(5),U(0,4),"t");
    Sequence()
    {
      R_Date("BE-21069",9482,32);
      Boundary("Start A");
      Phase("A")
      {
        R_Date("BE-20558",9333,30);
        R_Date("BE-20559",9299,30);
        R_Date("BE-20560",9328,30);
        R_Date("BE-20561",9275,30);
        R_Date("Poz-61519",8810,50)
        {
          Outlier("General",0.25);
        };
        R_Date("BE-6733",9134,13);
      };
      Boundary("End A");
      Boundary("Start B");
      Phase("B")
      {
        R_Date("BE-20556",9156,30)
        {
          Outlier("General",0.25);
        };
        R_Date("BE-6731",8340,24);
        R_Date("Poz-51298",8510,110);
        R_Date("Poz-51419",8730,50);
        R_Date("Poz-51297",8740,60);
        R_Date("BE-8036",8783,25);
        R_Date("Poz-51306",9120,50)
        {
          Outlier("General",0.25);
        };
      };
      Boundary("End B");
      Boundary("Start C/B");
      Phase("C/B")
      {
        R_Date("Poz-51296",7810,80);
        R_Date("Poz-51304",7980,40);
      };
      Boundary("End C/B");
      Boundary("Start C");
      Phase("C")
      {
        R_Date("BE-6730",7369,23);
```

```
        R_Date("BE-6732",7429,23);
        R_Date("BE-6729",7461,54);
      };
      Boundary("End C");
      Boundary("Start D");
      Phase("D")
      {
        R_Date("BE-21066",6171,27);
        R_Date("Ki-4025",6376,60);
        R_Date("Ki-4023",6120,80);
        R_Date("Ki-4024",6180,90);
      };
      Boundary("End D");
    };
};
```

Model 1-3 Kamyana Mohyla 1. Sequential model with outliers excluded

```
Plot()
{
  Sequence()
  {
    R_Date("BE-21069",9482,32);
    Boundary("Start A");
    Phase("A")
    {
      R_Date("BE-20558",9333,30);
      R_Date("BE-20559",9299,30);
      R_Date("BE-20560",9328,30);
      R_Date("BE-20561",9275,30);
      R_Date("BE-6733",9134,13);
      Date("Date A");
    };
    Boundary("End A");
    Boundary("Start B");
    Phase("B")
    {
      R_Date("BE-6731",8340,24);
      R_Date("Poz-51298",8510,110);
      R_Date("Poz-51419",8730,50);
      R_Date("Poz-51297",8740,60);
      R_Date("BE-8036",8783,25);
      Date("Date B");
    };
    Boundary("End B");
    Boundary("Start C/B");
    Phase("C/B")
    {
      R_Date("Poz-51296",7810,80);
      R_Date("Poz-51304",7980,40);
      Date("Date C/B");
    };
    Boundary("End C/B");
    Boundary("Start C");
    Phase("C")
    {
      R_Date("BE-6730",7369,23);
      R_Date("BE-6732",7429,23);
      R_Date("BE-6729",7461,54);
      Date ("Date C");
    };
    Boundary("End C");
    Boundary("Start D");
    Phase("D")
    {
      R_Date("BE-21066",6171,27);
      R_Date("Ki-4025",6376,60);
```

```
        R_Date("Ki-4023",6120,80);
        R_Date("Ki-4024",6180,90);
        Date ("Date D");
      };
      Boundary("End D");
    };
};
```

Model 1-4 Sequence of Ihren 8, sequential phases, dates on freshwater shells excluded

```
Plot()
  {
    Sequence("ihren")
    {
      Boundary("start-PD8");
      Phase("PD8")
      {
        R_Date("OxA-17489", 8845, 40);
        R_Date("GrA-33113", 8880, 45);
      };
      Boundary("end-PD8");
      Boundary("start-PD1-2");
      Phase("PD1-2")
      {
        R_Date("Ki-950", 8650, 100);
        R_Date("BE-19191", 8712, 37);
        R_Date("BE-19192", 8740, 37);
      };
      Boundary("end-PD1-2");
      Boundary("start-PD4");
      Phase("PD4")
      {
        R_Date("GrA-33112", 8695, 45);
        R_Date("Bln-1798", 8550, 80);
      };
      Boundary("end-PD4");
      Boundary("start-PD10");
      Phase("PD10")
      {
        R_Date("Ki-6259",6860,45);
        R_Date("Ki-6258",6910,50);
        R_Date("KI-6257",6930,50);
        R_Date("KI-6256",7080,60);
      };
      Boundary("end-PD10");
    };
  };
```

2 Ceramic Mesolithic, Sub-Neolithic, Para-Neolithic Hunter-Gatherers in Availability Phase: Searching for a Definition for the Obvious

Summary 2.1 The Current Typo-Chronological Schemes. – 2.2 Deconstructing 'Buh-Dniester Culture'. – 2.3 East of the Dnieper: Refining the Chronology of Pottery Hunter-Gatherers. – 2.4 The Problem of the Earliest Pottery in the North Pontic Steppes: A Brief Overview of the State-of-Art. – 2.5 Conclusion.

The Carpathian-Dnieper region spans a wide range of ecological zones, extending from the Black and Azov Sea's coastlines in the south to the steppe, forest-steppe, mixed and deciduous forests in the north, and up into alpine uplands in the Carpathians.[1] Consequently, it's logical to infer that the processes and timelines of Neolithisation differ significantly based on the specific ecological context. Over time, there appears to be a trend towards delayed agricultural colonisation in less fertile or more remote areas. Thus, we can expect the coexistence of Neolithic groups on already cultivated lands and hunter-gatherer groups on the yet unreached territories.

And, actually, seven thousand years ago, the Carpathian-Dnieper region can be subdivided between two social worlds: the world of early farmers and the world of fishermen, hunters, and gatherers.[2] The

1 Marynych 1990.

2 Lillie et al. 2020b; Telegin 1985b; Wechler 2001.

latter we propose to label as para-Neolithic. The societies of the early agricultural world had a common origin. For the first time in Europe, communities of this type emerged in Thessaly and gradually spread deeper into the Balkans and Central Europe, as well as along the Mediterranean coast.[3] This process, called 'Neolithisation', led to radical population changes in large parts of southern and central Europe.[4] Instead, groups of fishermen, hunters and gatherers were heterogeneous, with different economic strategies and probably different social structures.[5]

Early farmers based their economy on agriculture and animal husbandry. They lived a sedentary lifestyle in permanent settlements with permanent houses, structuring and developing the space around them.[6] Their ceramic complexes are mostly clearly divided into tableware and kitchenware, and the raw materials for decorations and tools were often obtained far from the place of use.[7] The social organisation of the early farmers was capable of holding together much larger groups of people than the average among fishermen, hunters and gatherers.[8] Early farmers shared a number of related religious belief systems, often centred on a fertility goddess.[9] Archaeological markers **[fig. 19]** of early farmers in general (but there are important exceptions) include flat-bottomed (sometimes painted) vessels, burial rites bent on their sides, anthropomorphic figurines, which correspond to the sharp- or round-bottomed vessels of fishermen, hunters, and gatherers, buried people stretched out on their backs, and ornaments made of deer, wild boar, bear teeth, etc.[10] Fishermen, hunters and gatherers led a mobile lifestyle.[11] Palaeogenetic studies show that even in terms of genetic makeup, early farmers and hunter-gatherers were mostly different.[12]

This section examines the realm of ceramic hunter-gatherers. Initially, we will examine the current understanding of their cultural diversity (§ 2.1), abstaining from critique for a while. Subsequently, we will cast doubt on its correspondence to past realities, using the

3 Aubán et al. 2015; Bentley et al. 2003; Biagi et al. 2005.

4 Ammerman, Cavalli-Sforza 1971; Mathieson et al. 2018.

5 Gehlen 2010; Gronenborn 1997; Nowak 2007; Zaliznyak 1998.

6 Lüning 1982.

7 Zimmermann 1995.

8 Müller 2016.

9 Hodder 2010.

10 Telegin 1985b.

11 Zaliznyak 2020.

12 Bramanti et al. 2009; Lipson et al. 2017.

well-examined Buh-Dniester culture as a case in point (§ 2.2). These observed patterns may be extrapolated to other regions and cultural aspects (§ 2.3). With the established chronology of sites, we can then draw generalisations about the early spread of ceramics (§ 2.4).

2.1 The Current Typo-Chronological Schemes

The dominance of the cultural-historical approach in local archaeologies has led to understanding the Neolithic of southern Eastern Europe as a mosaic of cultural aspects.[13] From my point of view, this typological grid masks the real state of research in the region. In many cases, a cultural aspect refers only to a characteristic style of ceramics, and there is a lack of reliable information about its correspondence to other elements of material culture. In the future, with the spread of modern research methods, many of the cultural groupings will have to be deconstructed. However, this large-scale task is beyond the scope of this work. In the following, we will try to deconstruct the 'Buh-Dniester culture' as an example of such an approach. Therefore, the following presentation of the cultural map of the para-Neolithic of Ukraine is intended to describe the existing terminology and record the state of research. The author does not aim at an accurate or complete description of these groups and asks the reader to refer to publicly available overviews.[14]

The southwestern part of Ukrainian, and Moldavian forest-steppe was an area of so-called 'Buh-Dniester culture'. Its sites were mostly found along the major rivers: the Southern Buh and Dniester **[figs 20-21]**. Some finds were reported further east – as far as the Prut River valley.[15] At the beginning of the 2010s, about 90 sites and two cemeteries were attributed to this culture.[16] The scatters of finds were interpreted as surface dwellings, while shallow pits of complex shapes filled with archaeological material were interpreted as semi-dugout dwellings.[17] The culture consisted of three to seven stages, the differences between which were quite significant.[18] Flat-bottomed and sharp-bottomed vessels with significant variations in decoration, tempers and the technology of their manufacture have

13 Motuzaite Matuzeviciute 2012; Tovkailo 2020.

14 Kotova 2003; Telegin 1987; Tovkailo 2020.

15 Markevich 1974.

16 Tovkailo 2020.

17 Danilenko 1969; Markevich 1974.

18 Danilenko 1969; Telegin 1977; Tringham 1973.

been recorded.[19] The flint inventory is also distinctive. Some sites yielded lithic assemblages similar to Kukrek, others to Hrebenyky.[20] The Balkan contacts of this culture were especially emphasised.[21]

The area of distribution of the so-called Surskyi (also Surska, Sura-Dnieper) culture is outlined in the most general terms.[22] Pottery of this characteristic appearance has often been found in multi-layered settlements in the Dnieper Rapids region **[fig. 20]**.[23] This is where the sites on Surskyi, Shulaiv, Strilcha Skelya, and other islands are located.[24] Many sites were excavated in the first half of the twentieth century and have questionable stratigraphy. Ceramics of this type have also been found quite far from this region[25] – on the Oril River (Yosypivka), on the Siverskyi Donets (Oleksandriia). It has long been known in the Azov region, in particular at the multi-layered site of Kamyana Mohyla 1.[26] The peculiar Surskyi ceramics have a pointed bottom, made of well-silted clay, sometimes with a temper of crushed shells. Linear incised compositions adorned these pots.[27] Some scatters of finds have been interpreted as dwellings or residential complexes. According to the descriptions, they have somewhat deepened lenses of darker soil saturated with anthropogenic remains – similar to the trampling floors of the Late Palaeolithic sites. Such sites are known on Surskyi and Shulaiv islands.[28] Often, stone vessels are also found at these sites, sometimes with engraved ornaments.[29] A characteristic feature is the variety of bone products, including fishing tools.[30]

The vast territories of forest-steppe and forests were settled by groups with comb-ornamented pottery **[fig. 20]**. D. Telegin united them into Dnieper-Donets culture.[31] This pottery was distributed in Polissia and Volhynia, in the Dnieper Valley, and on the Ukrainian left bank of Dnieper up to the middle reaches of the Siverskyi

19 Haskevych et al. 2020.
20 Gaskevych 2003; Kotova 2003.
21 Tovkailo 2014.
22 Tovkailo 2020.
23 Dobrovolskyi 1949.
24 Kotova 2015.
25 Telegin 1985b.
26 Danilenko 1952.
27 Kotova 2015.
28 Demchenko 2016.
29 Danilenko 1969.
30 Demchenko 2016.
31 Telegin 1968.

Donets. The pots are mostly with pointed bottoms, but there are also remains of flat-bottomed pots and bowls. Tempers in the ceramic paste included grass and sand. Flint axes and trapezes are often found. D. Telegin believed that this population left burial grounds of the Mariupol type.[32] However, there is convincing evidence that a significant part of these cemeteries is associated with groups with slightly different ceramics.[33] Nowadays, many regional styles of this pottery are defined, giving place to multiple cultures determined on the basis of characteristic styles.[34] The particular importance held Volhynian cultural aspect (often equalled to Nieman culture of Poland and Bielorussia)[35] and the Kyiv-Cherkassy aspect in the Middle Dnieper region.[36] They were suspected of participating in contacts with incoming early farmers,[37] but the evidence for interactions has yet to be criticised and validated with modern scientific approaches.

The Azov-Dnieper archaeological culture **[fig. 20]**, often associated with the Neolithic period,[38] holds a prominent position in Ukraine's historical timeline. This culture is marked by an abundance of finely adorned ceramic containers featuring flat bottoms and distinctive 'collar' rims, as well as established settlements and numerous burial sites.[39] Researchers conducted several rounds of dating on human remains found in cemeteries within the Dnieper Rapids region, linked to this cultural context.[40] However, the dates based on human bones are notably earlier than the dates done from deer teeth and other animal bones.[41] This discrepancy can be attributed to a freshwater reservoir effect.

One defining characteristic of this cultural group is the presence of flat-bottomed pots with 'collar rims' that feature a distinctive collar-like thickening, as well as rims that are both obliquely cut and thickened. The ceramic ware from this culture is predominantly adorned with patterns created through the impression of comb stamps. These patterns typically form horizontal rows separated by

32 Telegin, Potekhina 1987.

33 Kotova 2003.

34 Kotova 2003.

35 Okhrimenko 2009.

36 Kotova 2012.

37 Okhrimenko 2009; Tovkailo 2020.

38 Kotova 2003.

39 Kotova et al. 2021; Kotova 2003.

40 Lillie et al. 2020b.

41 Kotova 2018; Lillie et al. 2009.

zigzag or straight lines.[42] Lithic tools comprise fan-shaped endscrapers, 'knives' (blades with convergent semi-abrupt retouch), 'chisels' (*pièces esquillées*), and geometric microliths, typically trapezes, sometimes trapezes with a flat invasive retouch on dorsal surfaces.[43]

The burial customs of the Azov-Dnieper population have been extensively studied, particularly in the context of Mariupol-type burial sites.[44] Deceased individuals were interred in large cemeteries in closely spaced pits, creating long rows of burials. The bodies of the deceased were positioned lying on their backs.

The cultural picture drawn above reflects the previous stage of development of Ukrainian, Moldovan and Russian archaeology.[45] Today, the process of its criticism and reconstruction is already quite active, depending on new dating results, the use of other scientific methods and, above all, the refined excavation methodology.[46]

2.2 Deconstructing 'Buh-Dniester Culture'

'Buh-Dniester culture' is a theoretical construct created to characterise the Neolithic of south-western Ukraine and Moldova. V.M. Danilenko and V.I. Marchevici developed it between 1949 and 1974.[47] The term was coined in 1963. V.M. Danilenko saw 'Buh-Dniester' as an example of typical early farming culture covering the timespan from the appearance of domestic fauna and flora in the region till the beginning of the Eneolithic period.[48] The concept of 'Buh-Dniester culture' was eagerly accepted by the archaeologists in the Soviet Union and abroad.[49] Several authors recognised an important role of Buh-Dniester culture in the Neolithisation of Eastern Europe.[50]

In 1990s with the fall of the Iron Curtain, hard times came to the cultures with their limits corresponding to the modern-day state borders as was the case with the 'Buh-Dniester culture'.[51] Claims of very early agriculture and husbandry came under the scrutiny and,

42 Kotova 2015.

43 Kotova et al. 2021.

44 Telegin, Potekhina 1987.

45 Tovkailo 2020.

46 Dolbunova et al. 2023; Haskevych et al. 2019; Kiosak 2019a; Kiosak et al. 2023c; Kotova 2018; Man'ko 2007; Motuzaite Matuzeviciute et al. 2015.

47 Danilenko 1969; Markevich 1974.

48 Danilenko 1969.

49 Sulimirski 1970; Tringham 1971.

50 Comşa 1994; Kozlowski 1989, 136; Tringham 1973.

51 Kohl 1998.

generally, failed.[52] However, despite a notable share of criticism poured out on Buh-Dniester culture on this occasion, it is still perceived as an entity. This generalisation is thought to represents the sites of a certain period of prehistory from valleys of Dniester and Southern Buh rivers.[53] We will try to demonstrate that this is not the case. This section aims at deconstruction of 'Buh-Dniester culture' concept. Its heuristic value is exhausted at the moment. The demolition of the concept of a unified culture for early pottery-bearing groups of the region between the Carpathians and the Southern Buh river opens a new fruitful direction of research – namely, the search for the diversity of the material culture expressions which would surpass artificial limits of 'Buh-Dniester' culture.

Today, the concept of 'Buh-Dniester culture' has become the object of methodological criticism and systematic revision. As a result of recent discussions, several contradictory interpretations of the sites with early ceramics of the Southern Buh and Dniester valleys (late seventh – sixth millennia BCE) have crystallised. There are three leading solutions to the 'Buh-Dniester' problem.

Historically, the first of them was the vision of the 'Buh-Dniester culture' as an entirely early agricultural community associated with ways of the Neolithisation, which were different from a 'mainstream' dry-land dispersal into Balkans and Central Europe. This is how it was reconstructed by V. Danilenko (1969).[54] According to him, the Buh-Dniester culture covers the entire period, from the appearance of the first domesticated animals and plants to the spread of the Eneolithic Early Trypillian groups in the valleys of eponymous rivers. It was formed under the 'eastern' influence, arriving mainly via the circum-Caspian way, and only then underwent 'cultural consolidation' with the Balkan-Danube area of Körös-Starcevo. Hoe and stick farming and cattle breeding played a lesser role than hunting, but were the 'most progressive' branches of the economy.[55] A similar interpretation was proposed by V. Marchevici on the basis of rich materials from stratified settlements of the middle Dniester valley.[56]

At the current level of achievements of Ukrainian Neolithic studies, the concept of V. Danilenko – V. Marchevici was developed by N. Kotova.[57] Relying on the definitions of archaeozoologists and palaeobotanists and radiometric dating methods, N. Kotova suggested

52 Benecke 1997; Motuzaite Matuzeviciute 2020.

53 Tovkailo 2020.

54 Danilenko 1986.

55 Danilenko 1969, 159-61.

56 Markevich 1974.

57 Kotova 2003.

the early (as early as the seventh millennium BCE) appearance of cattle breeding and agriculture on the Southern Buh, along with the most ancient ceramics.[58] She connected the ceramics of the early Buh-Dniester styles with the oldest Neolithic horizons of the Inner Balkans and western Anatolia, seeing analogies in the East Thracian group of Maslidere sites and the Monochrome Neolithic of Bulgaria, the oldest layers of the Grivac and Blagotin settlements.[59] Such an early connection was supposed to be made possible thanks to certain maritime links before the distribution of Criş culture to the east of the Carpathians.[60] Some features of Buh-Dniester ceramics were explained by D. Haskevych by the maritime expansion of early agricultural cultures similar to the Mediterranean Impresso circle.[61]

Recently, the theory of extra-Balkan Neolithisation has received a powerful impetus from the works of A.F. Gorelik, A. Tsybriy and V. Tsybriy, who, although not directly dealing with materials from the region, provided convincing evidence of early Anatolian influence on the sites of the Northern Black Sea region.[62] V.O. Manko reconstructed the Final Palaeolithic and Mesolithic contact systems (cultural and historical communities) between the Middle East and the steppes of Ukraine.[63]

The second approach was to perceive the Buh-Dniester culture as an agricultural culture formed through the dry-land 'Balkan' path of Neolithisation. Namely, D. Telegin stated that LBK and Buh-Dniester cultures represented early farmers in the territory of Ukraine.[64] Perhaps, L.L. Zaliznyak developed this concept in the most detailed way. According to him, the Buh-Dniester culture is a 'barbaric manifestation of the Neolithic of the Danube region'[65] and was formed by the second (of four) waves of 'Balkan newcomers in the forest-steppe of Right-Bank Ukraine'.[66]

According to the third approach, the Buh-Dniester culture is a hunter-gatherer community, possibly under the strong influence of the Balkan-Danube world of early farmers. This possibility was first mentioned by R. Tringham, shortly after the publication of

58 Kotova 2004.

59 Kotova 2009, 170; Kotova 2015, 60-1.

60 Kotova et al. 2021.

61 Gaskevych 2011.

62 Gorelik et al. 2016.

63 Man'ko 2007; Man'ko 2015.

64 Telegin 1977, 88; Telegin 1985b, 114.

65 Monah, Monah 2002; Zaliznyak 1998, 232.

66 Zaliznyak et al. 2013.

V.M. Danilenko.[67] The idea of contact between hunter-gatherers of the Southern Buh and Dniester and early farmers of the Balkans has been fruitfully developed by a number of researchers.[68] M. Zvelebil and M. Lillie summarised these observations in the 'transitional society' model. According to them, the Buh-Dniester people are hunters in the 'availability phase' – in a state of interaction with early farmers, when they are already familiar with the achievements of the Neolithic Revolution, but continue their traditional way of life.[69] O. Larina and V.A. Dergachev developed a similar approach based on the materials of the region between rivers Dniester and Prut.[70] A. Reingruber reconstructed a network of contacts that connected early agricultural and hunter-gatherer communities in the Northwest Black Sea region.[71] Recently, in light of the latest refutations of the presence of imprints of parts of domestic plants on Buh-Dniester ceramics,[72] L.L. Zaliznyak seems to be inclined to this view.[73]

The debate between the proponents of different concepts was conducted along several main 'lines of argumentation'.

The core of the recent discussion on the Buh-Dniester culture was whether the 'Buh-Dniester' people had ever practised agriculture and husbandry. V.M. Danilenko was quite optimistic regarding this question. He published some evidence of husbandry (bones of domestic animals), and agricultural practices (blades with sickle gloss, hoe-like antler implements and grinding stones).[74] Later, his observations were reinforced by analysis of plant imprints on 'Buh-Dniester' potsherds. Three species of wheat and a single species of barley were found.[75] While Ukrainian and Moldovan archaeozoologists[76] mostly identified a certain number of bones from the Buh-Dniester sites as the remains of domestic animals (cattle, pigs, and sheep/goat), their Western European colleagues questioned this interpretation on the grounds of differences in morphometric approach.

Namely, during the 1990s, N. Beneke revised a number of faunal collections from excavations of the 1960s, and also studied materials

67 Tringham 1971, 96-101.

68 Dennell 1983; Dolukhanov 1979; Kozlowski 1989.

69 Zvelebil, Lillie 2000.

70 Dergaciov, Larina 2015; Larina 1994; Larina 2010.

71 Reingruber 2012.

72 Endo et al. 2022.

73 Zaliznyak 2017.

74 Danilenko 1969.

75 Kotova, Pashkevich 2003; Yanushevich 1989.

76 David 1996; David 1997; Zhuravlev, Kotova 1996.

from the 1996-97 works of the joint German-Moldavian expedition on the banks of Dniester river at the sites of Soroca-3, Tătăreuca Nouă 14 and 15. According to him, the 'old' assemblages completely lacked the remains of domestic animals, and the few bones of the latter from the new excavations did not come from sufficiently well-dated contexts. The presence of Eneolithic admixtures cannot be ruled out.[77] He concluded that 'no definitely domestic animal bones are known from a secure context for the re-studied Buh-Dniester materials'.[78] Accordingly, his work did not provide evidence for domestic animals in the Buh-Dniester economy. His results were recently reproduced when studying supposedly 'Neolithic' animal bones from the Dnieper Rapids region.[79]

The remains of cultivated plants have not been identified by flotation at Buh-Dniester sites, although, in fact, flotation was not used very often during excavations. However, every attempt resulted in a recovery of a variety of wild plants' remains while failing to uncover cultivated flora.[80] Similar results came from flotation attempts at other sites of para-Neolithic: Rakushechnyi Yar,[81] sites in Crimea and Eastern Ukraine.[82]

A considerable diversity of cultivated plant species was determined by the imprints of grains and spikelets on ceramics from Buh-Dniester sites.[83] However, there are grounds for doubt here as well. For example, the largest number of imprints was found on the materials of the settlement Sacarovca 1,[84] which, as is now known, does not belong to the Buh-Dniester, but is instead a site of the Criş culture.[85] Some sherds with abundant organic temper are often identified as evidence of Balkan influences or direct Balkan imports in the collections of other Buh-Dniester sites.[86] Therefore, the relevant imprints on these potsherds cannot be definitive proof that the inhabitants of the Southern Buh and Dniester valleys practised agriculture in the period in question or even used wheat and barley for food. Such conclusions require re-examining the sherds with imprints to verify their cultural attribution.[87]

77 Benecke 1997; Wechler 2001.

78 As cited by Wechler 2001.

79 Stupak et al. 2022.

80 Salavert et al. 2020.

81 Dolbunova et al. 2020.

82 Motuzaite Matuzeviciute 2020.

83 Kotova, Pashkevich 2003; Yanushevich 1989.

84 Yanushevich 1989, 609.

85 Larina 1994.

86 Danilenko 1969; Haskevych et al. 2020; Tovkailo 2004; Tovkailo 2014.

87 Kiosak 2016b, 137.

Recently, in the course of the joint research by Japanese and Ukrainian specialists, the imprints on the sherds were reviewed using the replica method followed by scanning electron microscopy. The new work did not confirm the presence of imprints of cultivated plants: some of them turned out to be non-indicative, while others were traces of wild flora.[88] Thus, re-evaluation of pericarp imprints on 'Buh-Dniester' potsherds failed to recover any secure evidence of plant cultivation.[89]

Thus, there is no evidence for the presence of domesticated animals and plants in the Buh-Dniester contexts today. The earliest finds of cultivated plants directly dated by radiocarbon were recovered from Linear Pottery Culture contexts of 53rd century BCE – much later than the expected onset of 'Buh-Dniester culture' in the region.[90] This critique required a re-shaping of our understanding of the 'Buh-Dniester' sites and strongly supports the view that inhabitants of these sites were hunter-gatherers (the third approach from the discussion above), while the evidence of their acquaintance with agriculture and herding is at best anecdotal at the moment.

Another line of critique proceeds with an argument of post-depositional transformations. Soon after V. Danilenko's excavations, his field observations were questioned. For example, D. Telegin, having studied the materials of excavations on Bazkiv and Mytkiv islands,[91] noted that it was impossible to divide the lower pack of sediments into several horizons, and, therefore, there were no stratigraphic arguments in favour of the existence of the Skybyntsi layer.[92] Modern researchers have gone further in their post-depositional critique of the classic 'Buh-Dniester' sites. N. Kotova, having studied collections and field documentation, concluded that the only genuinely stratified site is Bazkiv Ostriv, where two layers can be distinguished: upper and lower.[93]

D. Haskevych[94] has demonstrated that the excavation methodology and objective post-depositional processes, in many cases, made it impossible to distinguish separate layers on several 'Buh-Dniester' sites. In some cases, it has been convincingly demonstrated that V. Danilenko reconstructed the stratigraphy when the data were insufficient. For example, the Savran layer at Melnychna

88 Endo et al. 2017; Endo et al. 2019; Endo et al. 2022.

89 Endo et al. 2022.

90 Moskal-del Hoyo et al. 2023; Motuzaite Matuzeviciute, Telizhenko 2016.

91 Danilenko 1969.

92 Telegin 1977, 89.

93 Kotova 2003.

94 Gaskevych 2014.

Krucha was identified based on the materials of the 1938-39 surface collection.[95]

Attempts to verify the observations of the mid-twentieth century through new excavations have mostly falsified them. Most of the 'Buh-Dniester culture' sites have been flooded by the waters of the reservoirs, during the construction of which they were discovered and studied. Only Melnychna Krucha, Mykolyna Broiaka, Savran, and Pechera are suitable for study in the valley of the Southern Buh among 'Danilenko's sites'. Excavations of the Pechera site in 2008 (D.L. Haskevych, L. Cherniak, B. Józwiak) showed that as a result of post-depositional processes, finds of different periods were evenly mixed in the cultural deposits.[96]

Similarly, unsatisfactory results were obtained at the new works on the Dniester sites – Soroca 3[97] and Tsekinivka 1.[98] A detailed review of the stratigraphy of Bazkiv Ostriv also revealed the doubtfulness of attributing certain items to a specific complex. However, three layers were identified in terms of depth: Mesolithic and two Neolithic[99] (para-Neolithic in the terminology of this book). Contrary to published data, the Kukrek flint artefacts in the collection of the Bazkiv Ostriv turned out to be brought from another site due to imperfect field documentation and are not related to any of the three horizons of the site.

In this aspect, the search for 'pure', homogeneous accumulations of material among field documentation and collections of V. Danilenko's works looks promising. Such complexes are distinguished among the materials that previously seemed unpromising due to their 'small number' or 'unstratified' nature. D. Haskevych has identified relatively 'pure' contexts at the Hlynske I site, namely Complex 1 with ceramics of the Criş and Pechera aspects and a flint collection devoid of the Kukrek component.[100] However, this work is only at its beginning, and homogeneous para-Neolithic complexes from the Southern Buh valley can be counted on the fingers of one hand.

Another unsolved problem concerns the chronology of the sites attributed to the Buh-Dniester. The dating of the Buh-Dniester sites in 1969-74 was based on 'imports' and typological synchronisation.[101] The Pechera phase corresponded to the Criş-Körös-Starcevo culture

95 Gaskevych, Kiosak 2011.

96 Gaskevych 2013.

97 Wechler 2001; Wechler et al. 1998.

98 Haskevych 2018a.

99 Haskevych et al. 2020.

100 Haskevych 2017.

101 Danilenko 1969; Markevich 1974.

complex, the Samchyntsi phase to the LBK, and the later phases (Savran and Khmelnyk) were tied to the formation of the Early Trypillia. The few radiocarbon dates contradicted the broad dating proposed by V. Danilenko[102] but generally corresponded to the established development picture.[103]

During the 1990s, a series of radiocarbon conventional dates were obtained in the Kyiv laboratory. The samples were selected to represent different phases of the Buh-Dniester culture. As a result, the early period of the Buh-Dniester culture (pre-Samchyntsi) was attributed to the second half of the seventh millennium BCE, and the second (Samchyntsi-Savran) lasted during the first half to mid-sixth millennium BCE.[104]

L. Zalizniak and M. Tovkailo objected to the new chronology of the Buh-Dniester culture. According to them, the early Pechera stage is the result of interaction with the world of the Balkan early farmers of the Criș culture, and therefore, it cannot be dated earlier than the latter. Thus, the development of the Buh-Dniester culture should have been within the sixth millennium BCE.[105] These views aligned with radiocarbon dates, often obtained from charcoal, in laboratories in Berlin and Leningrad before 1991.[106]

D. Haskevich proposed a clear distinction between the 'new' and 'old' chronologies and pointed out that it is hardly methodologically correct to compare different sets of dates within the same analysis.[107] Although internally coherent and correctly reflecting the relative chronology of events,[108] these sets contradicted each other on an absolute chronological scale. According to the 'old' chronology, early Buh-Dniester sites existed within the range of 5880-5550 BCE, and later ones – 5610-4710 BCE.[109]

Nowadays, the chronology of the Buh-Dniester para-Neolithic should have been based on a solid radiocarbon dating database, but it is not the case so far. M. Tovkailo mentions 79 dates ,[110] and we can add eight more to his list **[ST 2-1]**. So, a total of 87 dates provide the chronology of these sites. However, when you start working with this database, it becomes evident that most dates are irrelevant. Some

102 Telegin 1977, 88.

103 Telegin 1987.

104 Burdo 2003; Kotova 2003; Kovaliukh et al. 2007.

105 Tovkailo 2004; Zaliznyak 2005.

106 Tovkailo 2014.

107 Gaskevych 2007.

108 Vinogradova, Kiosak 2010.

109 Gaskevych 2014.

110 Tovkailo 2020.

go far beyond the acceptable chronology of para-Neolithic sites – for example, the two dates for Soroca 3 or the Early Holocene date for Dobrianka 3.[111] In addition, many of the dates come from unknown contexts. Considering the numerous episodes of occupation of the sites on the banks of the Southern Buh and Dniester, any mention of only a cultural layer as a context for sampling is usually meaningless. It indicates that we do not know what was dated. In addition, Mesolithic layers were directly discovered by excavations at several Buh-Dniester sites (Melnychna Krucha, Gard).[112] At some sites, the probable presence of such layers was demonstrated quite strongly by analysis of field documentation (Pechera, Bazkiv Ostriv, Sokiltsi 2).[113] Moreover, most dates are conventional, and radiocarbon dating by AMS has been used only sporadically. Several series of AMS radiocarbon dates have been obtained for sites of the former Buh-Dniester culture.[114]

Furthermore, many of the dates originate from the Kyiv laboratory and were obtained between 1998 and 2008 – thus belonging to a series of dates that have been called into question by numerous instances of inconsistencies in cross-laboratory comparisons.[115] The Kyiv radiocarbon facility has generated a substantial volume of dates since the 1980s. In the early days, the initial Kyiv dates were combined with data from Berlin and Oxford to establish the first reliable absolute chronology schemes for the Ukrainian Neolithic period.[116] Since 1998, the Kyiv laboratory produced numerous dates for the Stone Age of Ukraine and neighbouring regions. These dates were met with mixed reception, with some researchers accepting and interpreting them[117] while others vehemently contested their validity.[118]

Recently, the results of the Kyiv laboratory from 1998-2008 **[fig. 22]** were compared with those of other laboratories (Oxford, Vienna, Poznan, Bern, etc) in dating eight settlements and six burials. The results indicate that 'there were no systematic discrepancies or errors associated with the 'questionable' series from this radiocarbon facility'.[119] However, "a cross-laboratory comparison seems

111 Gaskevych 2014.

112 Kiosak 2019a; Tovkailo 2014.

113 Gaskevych 2014; Haskevych 2018b.

114 Haskevych et al. 2019; Kiosak et al. 2021b.

115 Gaskevych 2007; Gaskevych 2013; Gaskevych 2014; Kiosak et al. 2023c; Rassamakin 2012; Shatilo 2021.

116 Telegin 1985a; Telegin 1987.

117 Burdo 2003; Kotova 2004; Vinogradova, Kiosak 2010.

118 Gaskevych 2007; Tovkailo 2004; Zaliznyak et al. 2013.

119 Kiosak et al. 2023c.

necessary in every conclusion drawn from the inquiries of the Kyiv facility done between 1998-2008".[120] Therefore, only those dates from the suspicious series (1998-2008) from Kyiv that have been verified to some extent by dates from other radiocarbon facilities will be used for further analysis.

Another factor to consider is the limited progress in directly dating pottery sherds between 1998 and 2008.[121] Over the last decade, several series of 'direct' dates for the organic content of Buh-Dniester pottery have been obtained, which seem to prove the antiquity of the first appearance of ceramic in the Carpathian-Dnieper region.[122] Many 'questionable' queries by the Kyiv laboratory were conducted on potsherds without differentiating the nature and source of organic components in the clay paste of archaeological potsherds (so-called total organic carbon content, TOCC).[123] This approach has faced criticism from various perspectives. Averaging the carbon content in organic remains of diverse origins can be highly misleading,[124] the reservoir effect can influence riverine and marine-derived tempers,[125] and it is challenging to exclude the 'old shell' effect in cases where intensive crushed shell temper is used.[126] Direct dates based on the organic content of potsherds were noted to diverge significantly when compared to dates from other materials.[127]

Recently, the Tokyo Laboratory **[fig. 22]** has tried to improve the methodology and eliminate some of the difficulties, namely by identifying contamination with 'old carbon',[128] but other shortcomings of such dating are challenging to account for them completely. In Eastern Europe, the earliest pottery was often crafted from river silts with a natural mixture of decomposed riverine plants. Such selection of raw material could lead to a noticeable reservoir effect.[129] Consequently, radiocarbon chronologies, including those based on Tokyo 'direct' dates on potsherds, often did not correspond to typochronologies in many cases.[130] A more constructive approach could involve

120 Kiosak et al. 2023c.

121 Kuznetsov, Mochalov 2017; Zaitseva et al. 2009.

122 Man'ko 2006; Zaitseva et al. 2009.

123 Meadows 2020.

124 Meadows 2020.

125 Boudin et al. 2009; Boudin et al. 2010.

126 Douka et al. 2010.

127 Kuznetsov, Mochalov 2017.

128 Endo et al. 2022; Haskevych et al. 2019.

129 Kotova 2018.

130 Haskevych et al. 2019.

comparative dating of the food crust and the organic temper from the same vessel, ideally supplemented by dating associated animal bones or other organic materials. Therefore, due to the limited advancement in direct pottery dating, some dates obtained from potsherds may be subject to doubt. For instance, a series of dates for Bazkiv Ostriv and Hirzheve could fall into this category.[131]

A comparison was carried out between Kyiv (1998-2008) and non-Kyiv (recent Kyiv determinations from 2009 onward included) sets of dates for para-Neolithic sites of the Southern Buh valley. In order to summarise datasets, we employed several approaches: direct summation (function Sum in OxCal) and Kernel Density estimates (KDE) models. KDE models produce smooth density estimates, which can help in visualising the distribution of radiocarbon dates without being overly influenced by individual data points or outliers. This smoothness aids in identifying patterns and trends in the dataset.[132] We used KDE-model rather than KDE-plot because the datasets are not constrained prior to modelling in any way **[ST 2-1] [model 2-1]**. The findings revealed a chronological gap of 200-400 years between these two datasets **[fig. 22]**. Kyiv' direct' dates on potsherds constantly yielded dates several centuries earlier than expected or defined by other relevant dates on other datable materials. Tokyo 'direct' dates on potsherds sometimes yielded reasonable results, but mostly, they were distorted by external carbon admixtures. Additionally, when an AMS set of dates was incorporated, they consistently yielded narrower chronological ranges **[fig. 22]**.

So, when these dubious dates (evident outliers, Kyiv dates of 1998-2008 not validated by cross-laboratory comparison, 'direct' dates on TOCC of potsherds) are excluded, the remaining dataset includes only 24 reliable dates **[fig. 23]**. When modelled with the Kernel Density Estimate tool of OxCal 4.4.4 software, they are clearly divided into two blocks, each of which forms one of the peaks of the plot: around 6000-5400 BCE and roughly 5050-4600 BCE **[fig. 23: B]**. These blocks are even more evident if we leave only bone and charcoal dates **[fig. 23: C]**. The period of lower density corresponds to the time when LBK groups expanded into the region. Several dates fall within this minimum on the KDE-model graph, so we cannot state the complete abandonment of the region by hunter-gatherers during this time. However, their presence is evidently less attested than before and afterwards.

The picture that emerges is entirely unexpected and does not fit well with the model of ceramic hunter-gatherers influenced by Balkan Neolithic cultures. The emergence of para-Neolithic groups in

131 Haskevych et al. 2019; Man'ko 2006.

132 Bronk Ramsey 2017.

the region somewhat precedes the spread of the Criş culture population **[fig. 23]** (see chapter 3 for a detailed discussion). At the same time, the spread of the LBK was accompanied by a decrease in the intensity of habitation at hunter-gatherer sites, followed by an increase when the LBK declined. Therefore, it would be surprising if these two significant chronological blocks of para-Neolithic sites did not have peculiarities in their material culture. Thus, we should expect the Buh-Dniester para-Neolithic to be divided into, at least, two cultural aspects: pre-LBK and post-LBK.

Let us consider in detail the dated sites of 'Buh-Dniester' para-Neolithic. The sites dated exclusively by 'direct' dates on potsherds or exclusively by 'Kyiv dates' of suspicious series are excluded from consideration.

The site of the Bazkiv Ostriv stood on the island of the Southern Buh River near the village of Skybyntsi, Vinnytsia region. It was excavated by V. Danilenko in 1959 on an area of over 300 m^2. The para-Neolithic finds formed several scatters of potsherds, lithic tools, animal bones and *Unio* mollusc shells.[133] V. Danilenko interpreted this site as stratified with layers of the Skybyntsi, Pechera and Samchyntsi phases of the 'Buh-Dniester culture'. N. Kotova re-analysed the preserved collection and identified two layers: early and late.[134]

Recently, a detailed analysis of the site's stratigraphy based on field documentation was carried out by D. Haskevych. Based on the analysis of the number of finds marked on the site's plan separately for several small zones identified within its boundaries, he assumed that the cultural layer of the site contained three horizons of increased concentration of finds – two with para-Neolithic ceramics and one with no ceramics, probably, Mesolithic.[135] Bazkiv Ostriv has 14 radiocarbon dates reported by now. Seven dates were made on animal bones and antlers in Kyiv laboratory, and six more are 'direct' dates on potsherds. A single date on charred residues attached to the potsherd validates one of the 'direct' dates. Each series of dates is somewhat unreliable, taken on its own, but when treated jointly, they cross-validate each other to a certain extent.

Five Kyiv dates of Bazkiv Ostriv **[fig. 24]** fell into the seventh millennium BCE and could belong to pre-ceramic Mesolithic habitation. Two latter dates reasonably correspond well with a single date done on the potsherd of a Skybyntsi phase vessel, indicating an episode of human activity at the site around 5650-5400 BCE. Two other dates were done on organic inclusions in the potsherd and the organic residue attached. They are the latest encompassing 5250-4850 BCE.

133 Danilenko 1969, 62-70.

134 Kotova 2003.

135 Haskevych 2018b.

Unfortunately, dates combine poorly. While their asynchrony is highly unlikely, this discrepancy indicates a methodological problem with this dating effort. D. Haskevych noted: 'Differences in the nature of the ceramics of the reconstructed horizons of the remaining zones were absent or were not recorded due to the loss of most of the finds'.[136] Instead, there was a significant mixing of materials that were attributed to different phases of 'Buh-Dniester culture'. Thus, despite significant progress in understanding the Bazkiv Ostriv chronology, we still cannot use its materials to substantiate a correlation between potsherds decorated in a certain style and other categories of material culture.

The sequence of Melnychna Krucha was characterised above in chapter 1, when treating its Mesolithic stratigraphic units. Stratigraphic unit 2 was found at a depth around -160 and 180 cm from the conditional zero in a layer of yellow light sandy loam (horizons P(h)k and Pk according to Zh. Matviishyna **[fig. 5]**). The SU2 consists of four separate zones in planum **[fig. 25]**: SU2b is a scatter of flint-knapping activities **[fig. 25: A]**, SU2a is a zone of disturbed sediments closer to the river **[fig. 25]**: D, SU2c is a scatter of freshwater molluscs' shells **[fig. 25: C]**, and SU2d is a zone of cultural layer with dispersed finds in the very east of the excavated zone **[fig. 25: I]**.

The zone SU2b is marked by the waste from the decortication of one or two nodules of honey and light grey flint with a white-red cortex and the manufacture of a series of blades. Numerous primary and semi-primary flakes record the decortication of the raw material '*in situ*'. The single-sided, single-surface nucleus **[fig. 26: 21]** was used for the blades production. The sub-conical nuclei are small, with a single platform, for blades and flakes with careless knapping around the entire perimeter of a core.

The purpose of the knapping was a 12-20 mm wide blade of rather irregular outline. The set of tools includes retouched flakes and blades **[fig. 26: 25-26]**. The retouch is mostly marginal, small, partial and irregular. Most end-scrapers are made on the sides of flakes. Some end-scrapers are made on ends of blades and of flakes. There are blades with convergent semi-steep retouch on both sides **[fig. 26: 17]**. The trapeze is made by two oblique truncations with steep, regular retouch.

This scatter of lithic debris was dated using two animal bone samples. The dates cover the range 5975-5790 calBCE **[ST 1-2]**.[137] These dates are in fact synchronous with the dating from the antler T-shaped axe from the scatter of freshwater molluscs' shells nearby. The T-shaped axe is 23.5 cm long and 7.5 cm high **[fig. 27]**.

The shells' scatter yielded two pottery sherds and a fragment of a vessel's rim **[fig. 28: 9]**. The latter has a slightly bent rounded edge, a light

136 Haskevych 2018b.

137 Kiosak et al. 2021b; Kiosak, Salavert 2018.

grey well-smoothed outer surface and a dark grey inner surface. The sherd's fracture is grey, lumpy, and of uniform firing. There is a mica temper. On a rather steep bend to the shoulders, the remains of decorations are preserved – depressions made with a comb stamp. This piece finds analogues in the finds traditionally attributed to the late stage of the 'Buh-Dniester culture'.[138] The three above-mentioned dates from this layer that contains pottery, even if rarely, are quite consistent and can be combined in the timeslot 5834-5727 calBCE (2σ, [ST 1-2] [fig. 29]).

Another T-shaped axe [fig. 27: 2] was found in an area of the dispersed finds of para-Neolithic in some 20 m to the east of shell scatter. It yielded somewhat younger date of 5736-5651 calBCE (2σ).

A radiocarbon date was also obtained for another scatter of para-Neolithic finds at Melnychna Krucha, located 150 meters from the main excavation area described earlier. It remains uncertain whether these finds represent separate habitation episodes within the same site or two distinct sites. This new area was designated Melnychna Krucha - R4 and produced Trypillian painted pottery, as well as Seredny Stog II style ceramics from the subsequent Eneolithic epoch, dating to the late fifth to early fourth millennium BCE (see § 3.4 for a detailed discussion). These ceramics were primarily found above a scatter of chipped stone and animal bones associated with para-Neolithic potsherds [fig. 28: 1-8], without a sterile interlayer between them. The para-Neolithic horizon was identified at depths of -120 to -145 cm. The only radiocarbon date, obtained from an animal bone, was calibrated to a range of 4973-4836 calBCE (2 sigma) [ST 1-2] [fig. 29].[139] The chronology of this promising site requires verification by the serial dating.

Mykolyna Broiaka [fig. 21: 6] is situated on Chornyi Tashlyk, an eastern tributary of the Southern Buh river. From 1928 to 1932, the site was studied by P.V. Harlampovych. Under the conditions of Soviet repressions, the researcher disappeared after January 1933.[140] Only preliminary information about Mykolyna Broiaka was published then.[141] The collection of those years is lost. In 1955, V. Danilenko opened a small excavation and several test trenches (about 50 square metres in total) on the site. Finds from these works form the basis of modern ideas about the material culture of the site. Its pottery is attributed to the Savran style. The site is treated as one of the latest para-Neolithic sites from typo-chronological point of view.[142]

138 Kotova 2015; Tovkailo 2005.

139 Kiosak 2019a.

140 Yanenko 2016.

141 Kozubovsky 1933.

142 Tovkailo 2005.

Mykolyna Broiaka yielded two distinct dates. The earlier date, spanning from 5719-5620 calBCE, 2σ, comes from a scatter of finds at a depth of -280 cm designated as 'dwelling 1' by the excavator.[143] Above this, at a depth of 268 cm, an animal bone was dated to 4678-4493 calBCE, 2σ (Be-18270). The legacy date from animal bone, produced in a Kyiv laboratory, falls between these two AMS-dates **[fig. 30]**. The analysis of field documentation allowed us to identify two successive layers of unknown chronology.[144] However, these layers were not separated in the publication of the site.[145] Given the late relative position of this site within the Buh-Dniester para-Neolithic, it is especially important to determine the nature of its upper layer.

Puhach 2 **[fig. 21: 18]** is located on the slope of the left bank of the Southern Buh. M. Tovkailo excavated it in 1983-85 over an area of 655 m^2.[146] Finds of the Mesolithic, para-Neolithic, Eneolithic and Late Bronze Age were discovered. The cultural layer containing para-Neolithic and Early Trypillian pottery and other items was located at a depth of 2.05-2.4 m. The para-Neolithic ware of the site is ornamented in the Savran style. The first date of the site was done in the late 1980-ies in Kyiv laboratory and fell into the early fifth millennium BCE (Ki-3030, 5920 ± 60 BP). Then, the site received six dates of the dubious Kyiv series (Ki-6648-49, Ki-6656-57, Ki-6678-79), which fell into the first half of the sixth millennium BCE and had not been confirmed by new dating. Recently, the site was dated to 4686-4503 calBCE, 2σ by a single AMS date on a tooth of a deer coming from a depth of 2.4-2.5 m. This date is later than the Ki-3030 conventional date[147] and could be related to the Early Trypillian habitation as well as to the para-Neolithic stratigraphic unit. Thus, a para-Neolithic occupation may have taken place at Puhach 2 in the first half of the fifth millennium BCE. However, due to the apparent presence of Early Trypillian findings, the homogeneity of its complex remains open for discussion.

Shumyliv-Cherniatka. The site is located on the high floodplain of the left bank of the Southern Buh River between villages Shumyliv and Chernyatka, Vinnytsia region. It was excavated by V. Danilenko in 1960 with an area of 300 m^2. Several scatters of para-Neolithic and Early Trypillian materials lay at a depth of 0.5-0.8 m in a layer of dense grey-green loam. The site is attributed to the Savran phase

143 Danilenko 1969.

144 Polischuk, Kiosak 2018.

145 Danilenko 1969.

146 Tovkailo 2005.

147 Tovkailo 2004; Tovkailo 2014.

of the 'Buh-Dniester culture'.[148] Its collection includes approximately equal proportions of para-Neolithic and Early Trypillian potsherds.[149] A single vessel from the site obtained a pair of dates: on TOCC of the potsherd and organic residues stuck to it. The dates are consistent and encompass 4723-4491 calBCE, being roughly contemporaneous with the Early Trypillian dispersal in the region (see chapter 3 for further discussion).

The site of Tătăreuca Nouă 1 **[fig. 21: 20]** 5 was discovered in 1996 by V.A. Dergachev, K.-P. Wehler and O.V. Larina. It was investigated in 1997 by a joint German-Moldovan expedition on an area of 150 square metres. The settlement is located on the right bank of the Dniester River. In addition to the Neolithic layer, the site includes materials of the Late Trypillia and Iron Age.[150] The para-Neolithic layer contains Buh-Dniester culture materials. However, in addition to them, the layer contains a significant proportion of ceramics, the origin of which is attributed to the carriers of the north-eastern para-Neolithic and Neolithic cultures of Ukraine: Strumel-Gastiatin, Volhynian Culture and LBK.[151] The ceramics of the LBK is represented by 54 mostly small fragments from about 14-16 vessels. These potsherds are a rather peculiar complex of pottery, combining both the classical traditions of this culture and traditions related to the late phases of the 'Buh-Dniester' culture. The site received three relevant dates. Two were done on organic residue stuck to a single potsherd. They can be combined and jointly encompass 5472-5067 calBCE, 2σ, KIA-3705 a and b. An antler fragment was dated from the same layer, yielding an age of 4895-4676 calBCE, 2σ (KIA-4160). Thus, the site's chronology can be understood in several ways: 1. Dates refer to the late LBK occupation, and the Buh-Dniester site remains undated; 2. The dates fix a joint occupation of the site by an LBK group and para-Neolithic hunter-gatherers; 3. Dates relate to a post-LBK period and are connected with a group of hunter-gatherers living on a place of an LBK site. None of these hypotheses seems preferable at the moment.

Two Berlin charcoal dates have been known for quite some time for sites from the Dniester valley: Soroca-2 and Soroca-5 **[fig. 21: 16-17]**. The former (Bln-586) covers the 5990-5480 calBCE, 2σ, while the latter, Bln-589, covers the 5625-5224 calBCE, 2σ. The wide standard deviation hinders comparison of these dates with other dates. These interesting sites require further serial dating to update their chronology.

148 Danilenko 1969, 121-5.

149 Haskevych et al. 2019.

150 Wechler et al. 1998.

151 Larina 2006.

Thus, today, the number of reliably dated homogeneous complexes of 'Buh-Dniester' culture is negligible. On their basis, it is impossible to characterise the material culture typical for the population of this territory in the 'Buh-Dniester' period (or rather periods, as was shown above). Accordingly, the very existence of the 'Buh-Dniester culture' as a reliable taxon of archaeological classification becomes problematic.

'The Buh-Dniester culture' consists of six 'ceramic' phases according to V. Danilenko, five according to V. Marchevici, and three according to D. Telegin and R. Tringham.[152] Some have their distribution areas, which only partially coincide with the Buh-Dniester area.[153] The flint inventory was also variable: artefacts of the Kukrek cultural tradition disappeared at the beginning of the Late Period[154] or were present among the finds of the Savran phase.[155] Nowadays, several complexes of the early period (Pechera phase) have exclusively 'geometric' lithic complexes, while most collections have a 'Kukrek' appearance.[156] However, is it not the result of post-depositional processes? After all, Mesolithic layers, unnoticed by V. Danilenko, have recently been identified on Bazkiv Ostriv[157] and Melnychna Krucha.[158] Mesolithic materials are present in Dobrianka 3[159] and Gard.[160] In any case, these facts show that we do not know how ceramic wares, flint artefacts and bone tools correlate. And, therefore, we have no grounds to call them a 'culture' – "certain types of remains that are constantly found together, […] a complex of related features [of material culture]".[161]

On the other hand, the unity expressed in the unfortunate, in our opinion, term 'Buh-Dniester culture' does exist, but its characteristic features lie in a different aspect – in the economy and adaptation to the resource-rich river valleys.

The Buh-Dniester people embraced a unified way of life, despite variations in ceramic designs. V.M. Danilenko frequently utilised lifestyle characteristics to associate specific sites with the 'Buh-Dniester culture'. He identified these traits as the proximity of settlements

152 Danilenko 1969; Markevich 1974; Telegin 1977; Tringham 1971.

153 Gaskevych 2011.

154 Kotova 2003.

155 Tovkailo 2005.

156 Gaskevych 2003.

157 Haskevych et al. 2020.

158 Kiosak 2019a.

159 Zaliznyak et al. 2013.

160 Tovkailo 2014.

161 Childe 1929, v–vi.

to rapids and rifts along riverbanks, the inhabitation of islands and low-lying regions of floodplains, and a consistent internal arrangement of encampments. This lifestyle epitomised a 'riverine' existence centred around the abundant resources of the Southern Buh and Dniester rivers.[162] Utilising these resources involved recurrent visits to favoured locations along the riverbanks, resulting in the establishment of complex, stratified sites. Consequently, there was a notable degree of re-deposition and mechanical mixture of artifacts from various periods of human occupation within a given area.

Even regardless of the outcome of the long-running debate about the presence of domesticated animals and plants in the economy of the Buh-Dniester people, it is already clear that the carriers of early ceramics from the valleys of the Southern Buh and Dniester were not early farmers in the modern sense of the word. After all, the Neolithic way of life is not only about domestic animals and plants. It is a complex of closely related features, among which a sedentary way of life, permanent houses, settlement-type sites, and numerous evidences of fertility cults of a particular type play an important role.[163] All these components are lacking in the Buh-Dniester para-Neolithic. Therefore, complexes with early ceramics from the valleys of the Southern Buh and Dniester cannot be attributed to the Neolithic period. Hunters, gatherers and fishermen lived at these sites. They were mobile groups that, despite their early acquaintance with pottery,[164] continued to lead a lifestyle radically different from the adaptation patterns of their neighbours, the early farmers.[165]

The term 'para-Neolithic', proposed for the communities of northern Europe and the Baltic Sea basin, is a good description of this state.[166] This term describes hunter-gatherer communities, often with pottery, that existed simultaneously with Neolithic communities in the adjacent regions. Although there are arguments against the use of this term,[167] its use in the Circumbaltian area has a long tradition. It is well suited to the probable structural similarity of the Buh-Dniester communities and Baltic hunter-gatherer and fishers groups.

The Buh-Dniester para-Neolithic is located at the intersection of the world of fishermen, hunters and gatherers of Northern and Eastern Europe and the world of early farmers of the Balkans and Central

162 Danilenko 1969, 90, 150.

163 Whittle 1996.

164 Kotova 2015.

165 Demchenko 2016; Kiosak 2014.

166 Kempisty 1982; Nowak 2007.

167 Werbart 1998.

Europe. It has a frontier character in the sense of M. Zvelebil.[168] The boundary of the expansion of early agricultural cultures has mainly been shifted to the east by studies of the last quarter of a century.[169] In particular, it has repeatedly crossed parts of the alleged area of the Buh-Dniester people. For example, the former Buh-Dniester sites of Sacarovca 1 and Selişte are reasonably attributed to the eastern-most manifestations of the late Criş culture.[170] The LBK once limited its area to the Zbruch River (clearly following the state borders after the 1921 Riga Peace Treaty).[171] Now it is known that it spread to both the Prut-Dniester and Buh-Dniester interfluve, with its first sites discovered in the valley of the Southern Buh[172] and on its eastern bank (Zhakczyk 3).[173]

The diversity of cultural manifestations in the decoration and morphology of pottery is a characteristic feature of Northern and Eastern Europe in the sixth-fifth millennia BCE. This pottery is predominantly pointed or round-bottomed, decorated with incised, often comb or pitted ornamentation.[174] At this time, unified flat-bottomed ware was spreading in Central and Southern Europe. The first distribution area, 'in general', is associated with societies based on fishing, hunting and gathering (in its various forms), and the second with the world of early farmers. The structure of the two ceramic complexes is also radically different: early agricultural ware is usually well divided into kitchen and table ware, while the ceramics of hunter-gatherer communities are mostly uniform in this respect.[175] There were different models of the functioning of tableware in the everyday life of these two groups of societies.

In this context, the problem of the Buh-Dniester ceramic styles is directly linked by many researchers to the problem of the origin of the Buh-Dniester para-Neolithic as a whole.[176] Given the dubious correlation of different types of Buh-Dniester ceramics with each other and with the rest of the material culture of the region's para-Neolithic sites, this approach is obviously insufficient. In this case, the origin of the ceramic styles and the nature of society which produced them are different problems.

168 Zvelebil, Rowley-Conwy 1984.

169 Dergaciov, Larina 2015; Kiosak 2017; Saile 2020.

170 Larina 1994.

171 Markevich 1974.

172 Kiosak 2014; Kiosak 2017.

173 Peresunchak 2018.

174 Piezonka 2015.

175 Courel et al. 2021.

176 Haskevych et al. 2020; Kotova 2015; Tovkailo 2014.

Archaic ceramics, as recently established, spread across Eurasia quite early and without connection with the agricultural-pastoral way of life.[177] Accordingly, the people of the Buh-Dniester para-Neolithic could have adopted ceramics from various sources – from the Criş culture,[178] from the Thracian Neolithic by sea,[179] from their eastern neighbours – hunters and gatherers.[180] The diversity of Buh-Dniester pottery may be related to the different sources of its origin. The flat-bottomed ware, rich in organic temper, can be logically linked to Balkan influences (both of the Criş and other early farming societies, as V. Danilenko, L. Zaliznyak, M. Tovkailo argued),[181] and ceramics with comb ornamentation (primarily of the Samchyntsi style) to eastern influences as V. Danilenko supposed,[182] or to the maritime expansion of early and yet unknown 'Eastern Impresso' cultures as suggests D. Haskevych.[183] The Savran style of pottery (flat-bottomed, mostly decorated with incised lines, but also with comb decoration) has much in common with Azov-Dnieper ceramics[184] and may have been formed together with it as a result of a single cultural impulse.

The heterogeneity of the sources of the Buh-Dniester ceramic complex has been noted by many researchers, starting with V. Danilenko.[185] L. Zalizniak attributed the pointed-bottom ceramic ware to local features difficult to explain by the Balkan influence.[186] D. Haskevych showed the spread of elements of the Samchyntsi style far beyond the area of the 'Buh-Dniester culture'.[187] N. Kotova believes that the Pechera and Samchyntsi-Savran sites have different origins and 'a minimum of continuity in traditions'.[188] In the context of the diversity of sources of the para-Neolithic ceramic styles of the Southern Buh and Dniester, it is natural to assume the diversity of the local population.

So what do we know so far about 'Buh-Dniester' para-Neolithic? Basically, not that much. There were some fishers, hunters, gatherers equipped with pottery with blurry chronology and little-known

177 Dolbunova et al. 2023; Kuzmin 2002; Piezonka 2015.

178 Tovkailo 2020.

179 Gaskevych 2011; Kotova 2009.

180 Dolbunova et al. 2023.

181 Danilenko 1969; Tovkailo 2014; Zaliznyak 1998.

182 Danilenko 1969.

183 Gaskevych 2011.

184 Kotova 2003, 8.

185 Danilenko 1969.

186 Zaliznyak 1998.

187 Gaskevych 2011.

188 Kotova 2015, 65.

material culture – para-Neolithic or sub-Neolithic. Some of them lived in the early sixth millennium BCE – Melnychna Krucha SU2, Soroca 2, the lower layer of Mykolyna Broiaka. Others lived between 5600 and 5400 BCE, in synchroneity with the settlements of the Criş culture 100-150 km to the west (Soroca 5, several dates of Bazkiv Ostriv, TKA-80731 and related Kyiv dates). Finally, the third group of sites is associated with the end of the sixth – beginning of the fifth millennium BCE (the upper layer of Mykolyna Broiaka, Tătăreuca Nouă 15, Puhach 2, Shumyliv-Cherniatka).

2.3 East of the Dnieper: Refining the Chronology of Pottery Hunter-Gatherers

Moving further east, we enter a different region – the Dnieper Valley, which is rich in archaeological sites, and the region between the Dnieper and the northern shore of the Sea of Azov. The 'Neolithic' sites of this region have served as the archaeological basis for many theories of the early and unusual Neolithisation of southern Eastern Europe.[189] Therefore, we will examine the available archaeological data regarding their chronology.

For a long time, the Surskyi archaeological culture was believed to be the oldest Neolithic (para-Neolithic in the terminology of this book) culture in Central Ukraine and east of the Dnieper. According to the accepted scheme, the sites of its first period should have emerged in the Dnieper Rapids region in the late seventh millennium BCE, in order to spread to the region north of the Sea of Azov in the early sixth millennium BCE. Thereafter, the Surskyi sites continued their development in parallel with the development of another population – the carriers of the Azov-Dnieper culture. The latter emerged in the early sixth millennium BCE and lasted until the beginning of the fifth millennium BCE, when the first Eneolithic communities appeared in the region.[190] To date, the available radiocarbon dates are either insufficient to support these optimistic chronological estimates or directly contradict them.

The earliest period of 'Surskyi culture' was defined on the basis of radiocarbon dates. Typological considerations suggested that the earliest sites of Surskyi culture should be Vynohradnyi, Kodachok and Surskyi 1 **[fig. 31: 13, 16-17]**. However, the earliest dates were obtained for the site of Surskyi 2 **[fig. 31: 13]** which convinced N.S. Kotova to modify the proposed periodisation.[191]

189 Danilenko 1969; Gorelik et al. 2016; Kotova 2009.

190 Kotova et al. 2021; Tovkailo 2020.

191 Kotova 2015.

The chronology of sites with Surskyi pottery is supported by dates of several series:

1. conventional dates on bones obtained in the Kyiv radiocarbon facility;
2. conventional dates on potsherds, also from Kyiv;
3. dates on human bones from cemeteries of Dnieper Rapids, both from Kyiv and Oxford;
4. novel series of AMS dates on animal bones from stratified sites of the North Azov region.

The first group of dates belongs to the same 'suspicious' series from the Kyiv radiometric laboratory as the dates for the so-called 'new' chronology of the southern Buh para-Neolithic (see § 2.2) and those of the Early Trypillia (see § 3.4). All the criticisms discussed above also apply to these dates in the region east of the Dnieper. As demonstrated above, we can confidently assert that there were no systematic discrepancies or errors associated with the radiocarbon series at this facility. However, due to numerous inconsistencies, suspicious Kyiv dates should only be used when they were confirmed by cross-laboratory validation.[192] Moreover, as discussed in the previous section, the stratigraphies of numerous pivotal sites in the Buh-Dniester region have proven to be more intricate than previously understood. Mesolithic horizons have been identified at some sites and this fact has helped to elucidate the presence of some exceptionally early dates. Similar findings were observed in Eastern Ukraine, specifically at the Kamyana Mohyla 1 site, where a series of Mesolithic stratigraphic layers were identified before the first instances of 'ceramic-bearing' habitation (See chapter 1). Furthermore, the direct dates on the TOCC of potsherds cannot be trusted. There are several 'direct' dates for Surskyi-style potsherds: from Popov Mys, Strilcha Skelia and Ihren 8 **[fig. 32]**.

The well-established chronology of the Dnieper Rapids cemeteries[193] requires additional research to establish links between the burial goods of cemeteries and assemblages of residential sites. Otherwise, the sequence of cemeteries has no implications for the region as a whole. Moreover, the problem of identifying Surskyi burials in these sacred areas of long-term use is far from being unambiguously solved. The burials are mostly without burial goods, and the search for cultural attribution is often arbitrary based on the logic of 'who else could these burials belong to?'. However, such reflections implicitly assume the equity of culture and people behind it, which is far from evident in the case of Surskyi-type ceramics and

192 Kiosak et al. 2023c.

193 Lillie et al. 2020a.

other categories of material culture whose association remains to be proven.

Thus, hopes for establishing a chronology rest on the few homogeneous complexes for which AMS radiocarbon dating is available. The notion of homogeneity is relative and refers to the absence of overt foreign cultural and temporal impurities. Given the considerable doubts about the reliability of the established cultural and historical scheme, there is a danger of a logical circle. Therefore, in the current state, the chronology of Surskyi ceramic style can be established only in the most general terms.

Three sites yielded Surskyi style potsherds and the dates of the late seventh mill. BCE: Surskyi 2 **[fig. 31: 13]**, Semenivka 1 **[fig. 31: 1]** and Kamyana Mohyla 1 **[fig. 31: 2]**.

The case of Kamyana Mohyla 1 was discussed in details in chapter 1. The late seventh millennium BCE dates were posed in correspondence with the Late Mesolithic lenses of the layer C of this site.[194]

The Surskyi 2 site is situated in the southeast part of the Surskyi island on the Dnieper River. It was excavated by V.M. Danilenko in 1946 and yielded a complex stratigraphic picture.[195] There were 'Late Neolithic' (Eneolithic nowadays) layers of Seredny Stog 2 type. They were underlain by 'final Early Neolithic' layers severely disturbed by periodical flooding. The lowest level was found under sediments brought by flooding, namely those of sterile sand. This layer contained a habitation complex: several shallow pits of irregular shape filled with dark sand, charcoals, fragmented bones, and chipped stone implements. The Surskyi potsherds represented 2-3 vessels and were far from being numerous. The lithic inventory had 'archaic features'. These features include conical cores with regular scarring patterns, numerous burins on blade fragments, backed bladelets, also combined with truncations. In our opinion, it resembles the lithic assemblages of Kukrek cultural tradition or even Kukrek *sensu stricto*. Such an assemblage was attested in clearly Mesolithic (without associated potsherds and bones of domestic animals as well as remains of cultivated plants) at the sites of Melnychna Krucha and Kamyana Mohyla 1 (see chapter 1).[196] The latter sites brought a set of dates comparable with the pair of dates for the lowest layer of Surskyi 2. Thus, we can hypothesise that there was a Mesolithic habitation on the site of Surskyi, which was not recognised by the excavator. Two radiocarbon dates from Surskyi 2 site (Ki-6691, 7245 ± 60 BP and Ki-6690, 7195 ± 55 BP, **[ST 2-2] [fig. 32]**)[197] are consistent with this interpretation.

194 Kiosak et al. 2022.

195 Danilenko 1950; Danilenko et al. 1957.

196 Kiosak 2019a; Salavert et al. 2020.

197 Kotova 2015.

The site of Semenivka (Semenovka) 1 yielded the most important stratigraphic sequence in the region east of Dnieper and north of the Azov Sea. In 1991 and 1992, Nadezhda Kotova and Oleg Tuboltsev investigated this site, located near Melitopol in the Zaporizhzhia Region.[198] The site is situated on the first terrace of the right bank of the Molochna River **[fig. 31: 1]**. The excavated area covers 276 m^2. The site revealed a sequence of layers from the Mesolithic to the Middle Ages, with an overall depth of 2 meters. However, during construction activities, most of the upper layers were removed, leading to the preservation of Mesolithic and some pottery-bearing cultures (Surskyi, Azov-Dnieper) in certain zones, while other areas suffered from contamination due to the destruction of the upper layers with the following re-deposition of their content on the surface of the lower stratigraphic units.

Within these mixed sediments, an exceptional Eneolithic collection of the Skelia phase of the Serednyi Stog culture (initially classified as part of the Skelianska culture) was discovered. Subsequent re-analysis of the site helped establish a stratigraphic unit with Serednyi Stog materials in the southern part and another group of Eneolithic materials attributed to the Dereivka culture in the eastern part of the site.[199]

The excavations at Semenivka 1 revealed three distinct stratigraphic units in the lower, well-preserved part of the sequence. The lowest layer was the Mesolithic, found beneath sterile soil layers 35-60 cm thick in excavation squares 34b, 35, and 36 of excavation pit 1. The sterile soil horizon was thinner in other squares, and some Mesolithic admixture in the upper units was anticipated. Radiocarbon dating of auroch's bone from the Mesolithic unit yielded a date of 8058 ± 55 BP, UA-42032.[200]

The layer immediately above the Mesolithic was termed 'Neolithic' (para-Neolithic here). It was identified in squares 1-6 of excavation pit 2 and was located in the yellow loam at depths ranging from 140/170 to 150/180 cm (depending on the local topography). This layer contained over 200 potsherds, originating from at least 22 vessels. The pottery was tempered with plant remains, crushed shells, and sand. The vessels exhibited pointed bottoms and were categorised into bowls (vessels without necks) and those with well-defined necks. They were adorned with pits, pinches, incised lines, and, on occasion, short (2-3 teeth) comb imprints. Additionally, fragments of stone vessels were found in this stratigraphic unit. The lithic industry here was oriented toward blade production. Tools, constituting 27%

198 Kotova, Tuboltsev 1996.

199 Kotova 2008.

200 Kiosak et al. 2023c.

of the assemblage, included end-scrapers (on the ends of blades and on flakes, oval, circular, and other variations), burins (simple and multifaceted types), etc. The microlithic complex comprised geometric (trapezes) as well as non-geometric (backed points on microblades, oblique points) microliths. N. Kotova included this assemblage into her first period of the Surskyi culture.[201]

The upper layer was attributed to the second period of the Azov-Dnieper culture, according to N. Kotova. At least nine vessels were represented by potsherds. They were crafted from clay paste, tempered with sand, and sometimes mixed with crushed shells. These vessels featured rounded bodies, flat bottoms, and rims with protruding 'collar' extensions. Their decoration included triangular and rectangular pits, incised lines, and comb imprints. One vessel displayed a complex composition of stripes filled with comb imprints. The lithic assemblage in this layer primarily consisted of blades and tools made from blades and large flakes. Furthermore, a fragmented polished stone axe was discovered in this layer.[202]

The Semenivka 1 site's dating relies on a combination of stratigraphic observations and a series of radiocarbon dates.

Radiocarbon dating of animal bones from the lower (Surskyi) stratigraphic unit at Semenivka 1 [ST 2-3] [fig. 33] placed this particular layer within 6358-5625 calBCE (2σ). An outlier was identified in the earliest date (Ki-7679, 7285 ± 70 BP) based on OxCal software analysis, while the other three dates presented a continuous sequence spanning from 6083 to 5625 calBCE (2σ). The pairs of dates (1: Ki-6689 and Ki-6688, and 2: Ki-6688 and Ki-7678) could be combined, but Ki-6689 and Ki-7678 were mutually exclusive, failing the χ^2 test. The first pair was successfully combined, aligning with the timeslot of 5988-5841 calBCE (2σ), and the second with 5969-5718 calBCE (2σ). Additionally, the only AMS date (sample Poz-137920, 7010 ± 40 BP, Bos sp. bone [fig. 33]) corresponded well with the combination of Kyiv dates Ki-6689 and Ki-6688 (the 'first pair' mentioned earlier), possibly coinciding with both intermediate dates for this stratigraphic unit, though not necessarily with the earliest and latest Kyiv dates from this unit. Consequently, most anthropogenic remains in the lower layer were deposited during the first quarter of the sixth millennium BCE.

Moving on to the upper (Azov-Dnieper) stratigraphic unit at Semenivka 1, several animal bones were dated in the Kyiv laboratory. The obtained dates presented some contradictions. One date (Ki-7675, 6360 ± 70 BP, 5475-5210 calBCE, 2σ) agreed with the multiple dates from various laboratories for sites belonging to the second period of Azov-Dnieper culture.

201 Kotova, Tuboltsev 1996.

202 Kotova, Tuboltsev 1996.

However, three other dates (Ki-7672-74) were notably later, dating to approximately 4656-4056 calBCE (2σ), "corresponding to the chronology of Eneolithic cultural groups".[203] Thus, the dating results proved that the Azov-Dnieper stratigraphic unit (in the squares 1, 4, and 6) was contaminated by materials of the upper layers (Eneolithic), removed by the heavy construction technique prior to excavations.

The AMS date (Poz-137919, 6480 ± 40 BP **[fig. 33]**) was done on a canine of *Canis* sp. from Azov-Dnieper stratigraphic unit. This date falls within 5524-5336 calBCE (2σ) and aligns reasonably well with the Ki-7675 date. By combining these two dates, we arrive at a calibrated range of 5479-5332 calBCE (2σ), and this combination is valid based on the χ^2 test (df=1 T=2.2 at the 5% significance level, 3.8 overall).[204]

Hence, it is plausible to infer that the main habitation of this layer likely occurred during the third quarter of the sixth millennium BCE. It is worth noting that there appears to be a gap of 300-600 years between the Semenivka 1 site's upper and lower layers.

While the list of the homogenous complexes of Surskyi culture is short (the lower layer of Semenivka 1 and the undated lower layer of Strilcha Skelia[205] probably being the only such complexes), it is not the case for the Azov-Dnieper culture, which is represented by several well-defined sites also in the stratigraphic sequences.

In 1989-90, Nadezhda Kotova and Yuriy Rassamakin conducted an archaeological investigation at the Chapaevka site, located near the village of Chapaevka in Tokmak District, Zaporizhzhia Region.[206] Subsequently, another excavation took place in 2019.[207] This site is situated on the northern slope of a cape on the right bank of the Molochna River. The area of 160 m^2 was excavated.

The site revealed a single layer associated with the Azov-Dnieper culture covered by more than a meter of sterile sediments. Notably, the lithic complex comprised an elevated percentage of macro-blades and blades, no cores, some chips resulting from retouching endscrapers, and a high prevalence of tools.[208] The tool assemblage included retouched blades, some with convergent semi-abrupt retouch, and 'fan-shaped' end-scrapers.[209]

There were potsherds from a single high bowl exhibiting imprints of a short comb stamp. Additionally, there may have been one more

203 Kiosak et al. 2023c.

204 Kiosak et al. 2023c.

205 Kotova 2003.

206 Kotova, Rassamakin 2001.

207 Kotova et al. 2021.

208 Kotova et al. 2021.

209 Kotova et al. 2021.

vessel with a similar decoration, although the shape of this second vessel remained unspecified.[210]

A pair of radiocarbon dates from Kyiv was acquired for animal bones extracted from the cultural layer. These dates are consistent and can be calibrated to the range of 6023-5669 calBCE (2σ) or even combined within 5977-5736 calBCE (2σ). In contrast, newly obtained AMS dates, derived from fragments of large herbivore bones originating from the cultural layer and situated several meters away from the Kyiv-dated samples, are notably younger, falling within the range of 5203-4718 calBCE. While these new dates cannot be statistically combined (as indicated by a failed χ^2 test), there is a period in which they might coexist, namely, 4934-4847 calBCE, 2σ **[fig. 34]**.[211]

Considering the stratigraphic context, it appears plausible that these dates should be combined despite the statistical challenges mentioned earlier. Furthermore, the presence of a radiocarbon 'plateau' during the late sixth millennium BCE impacts the earlier date, extending its calibration well into the sixth millennium BCE. Consequently, the date from the early fifth millennium BCE appears more plausible in this context.

In light of the re-dating of the Chapaevka site, the palm of the earliest site for the Azov-Dnieper moves to the Rozdolne (Razdolnoe) site further to the east **[fig. 31: 5]**. This archaeological site has yielded several stratigraphic units that shed light on the early ceramic traditions in the West Meotic region. The site is situated on the banks of the Kalmius River.[212]

The early complexes of Rozdolne (dating back to the sixth – fourth millennium BCE) are scatters of lithic tools, fragmented bones and potsherds separated in stratigraphy and in plan. N. Kotova proposes to interpret them as traces of short-duration small camps.[213] One of these complexes included accumulations of *Unio* shells, flint tools, animal bones, and a fragment of comb-ornamented ceramic ware. Radiocarbon dating of a cow mandible places the age of this camp between 5604 and 5514 calBCE (or 6609 ± 49 BP, Ua-42031 **[fig. 34]**). The ceramic paste of the Neolithic potsherd was tempered with sand and decorated with oblique comb imprints, creating horizontal rows.

The lithic complex of Rozdolne is microlithic. A notable feature of this collection is the high percentage of retouched tools, suggesting an emphasis on the final stages of flint-working. Artefacts in this

210 Kotova et al. 2021.

211 Kiosak et al. 2023c.

212 Kotova et al. 2017a.

213 Kotova et al. 2021.

assemblage include a 'knife-like blade' (over 10 cm long),[214] with a fractured distal end and regularly retouched sides, along with five blade fragments,[215] a flake, a fragment of a rejuvenated blade core, an end-scraper with a burin detachment, and end-scrapers on flakes and blades. Some of these end-scrapers exhibit distinctive features, such as a convex scraper front on the side of a flake with ('Oskol type'),[216] as well as circular and sub-circular varieties.

The second early complex at Rozdolne was located approximately 100 meters from the first one.[217] It yielded ceramics with comb imprints and band ornamentation,[218] a shard with oval impressions,[219] and a pot with a low neck featuring a complex design comprising 'walking comb imprints', incised lines, and oval impressions.[220] Additionally, flint tools and a fragment of an axe made from local raw materials were discovered in this stratigraphical unit.

Radiocarbon dating of animal bones from this layer yielded the following results: 6550 ± 80 BP (Ki-8002), 6490 ± 80 BP (Ki-8001), and 6475 ± 80 BP (Ki-8000), **[ST 2-4]** **[fig. 34]**.[221] These dates place the age of this para-Neolithic camp between 5460 and 5430 calBCE. However, they are again the Kyiv dates of the 'suspicious' series and, thus, require a cross-laboratory comparison. Notably, the fragments of the cow's jaw from this complex produced two somewhat younger dates when analysed at the Uppsala laboratory in Sweden: 6428 ± 37 BP (Ua-41433) and 6310 ± 38 BP (Ua-41434). These dates can be combined into a range of 5371-5313 calBCE (χ^2-Test: df=1 T=4.9(5% 3.8)).

Similar results were brought to light from layer D, the Azov-Dnieper layer of the Kamyana Mohyla site (see chapter 1). It obtained four radiocarbon dates on animal bones: a single AMS date BE-21066, 6171 ± 27 BP and three conventional dates Ki-4023-25. They encompass the timeslot 5474-4839 calBCE (2σ). When modelled, the age of layer D encompasses 5472-4950 cal BCE, 2σ and is very consistent with the chronology of Rozdolne and Semenivka 1 Upper layer.

A series of burials from several cemeteries have been attributed to the Azov-Dnieper period with sufficient evidence, including the associated Azov-Dnieper ceramics.[222] These burials were extensively

214 Telegin 1976.

215 Kotova et al. 2021, fig. 5: 2-7.

216 Telegin 1976.

217 Kotova et al. 2017a.

218 Kotova et al. 2021, fig. 7: 2, 3, 5.

219 Kotova et al. 2021, fig. 7: 4.

220 Kotova et al. 2021, fig. 7: 1.

221 Kotova et al. 2017a.

222 Kotova 2015.

dated in the Kyiv laboratory and elsewhere, so the requirement for cross-laboratory comparison is met here.[223] However, as the human bones were dated, the outcome was likely influenced by a reservoir effect.[224] Therefore, their age is likely to be distorted, but to what extent – without an accurate natural science basis, any guess will remain a guess. So far, these dates (Kyiv and Oxford) form a dense series encompassing 5350-5000 calBCE **[fig. 35]**.

A somewhat later pair of dates (Kyiv and Poznan) comes from Lysa Hora cemetery **[fig. 31: 15]**. In 1959, O. Bodianskyi investigated the Lysa Hora (Lysaya Gora) cemetery, situated on the left bank of the Dnieper River. A layer of soil enriched with ochre was identified at a depth of 70-90 cm, covering an area of around 21 m^2. Within this layer, the researcher discovered potsherds, human and animal bones, shells, flint and bone tools. Notably, the ochre-rich layer contained several individual graves, five pits with collective burials, and traces of other ritual activities.[225] This cemetery can be attributed to the second phase of the Azov-Dnieper culture.[226]

The Lysa Hora cemetery featured three distinct groups of burials arranged in a stratigraphic sequence. The earliest group consisted of six supine burials, all oriented to face southeast. In the intermediate layer, researchers uncovered five pits containing multiple partial inhumations. The third layer comprised partially burnt skeletons scattered above pit 3.[227]

The Kyiv laboratory received a radiocarbon date from a human bone from pit 4, yielding an age of 5890 ± 70 BP (Ki-8181 **[ST 2-5]** **[fig. 35]**). Subsequently, two additional dates were obtained from the Poznan Radiocarbon Laboratory. A date pertained to the partly burnt skeleton 17, which was found above pit 3.[228] It yielded an age of 6010 ± 40 BP and, when combined with the Kyiv date on human bone, suggested the age of the cemetery between 4988-4784 calBCE, 2σ. These dates support a younger pair of dates from Chapaevka, thus placing the demise of Azov-Dnieper culture well into the fifth millennium BCE.

Interestingly, a similar date (4949-4799 BCE) was obtained for a skeleton from the Dereivka cemetery. This individual (I3719, burial 102) exhibited a genetic ancestry closely related to the northwestern Anatolian Neolithic, making it a noteworthy example of early farming

223 Lillie et al. 2020a.

224 Kotova 2018; Lillie et al. 2009.

225 Bodianskyi 1961.

226 Kotova 2015.

227 Bodianskyi 1961; Kiosak et al. 2023c.

228 Kiosak et al. 2023c, fig. 5.

ancestry from the fifth millennium BCE.[229] While the Dereivka cemetery encompassed burials from various periods, Azov-Dnieper culture tombs were notably prevalent.

Thus, it is doubtful that the sites with Surskyi type of pottery appeared in the late seventh millennium BCE. The later date, most likely the first quarter of the sixth millennium BCE is much more probable, considering the current evidence. The long persistence of this type of pottery is very questionable and lacks sufficient radiometric evidence to support it.

Recent re-dating of the Chapaevka site has raised questions about the previously accepted chronology of the early phases of the Azov-Dnieper culture, which was believed to have commenced in the early sixth millennium BCE. New AMS dates have shown that it is not the case. The series of dates, obtained from the Kyiv and Uppsala laboratories, focused on the early Azov-Dnieper complexes at the Rozdolne site. These dates firmly establish the presence of this cultural aspect by the mid-sixth millennium BCE. Furthermore, a date from a lower stratigraphic layer at Semenivka 1 offers a *terminus post quem* (the earliest possible date) for the Azov-Dnieper stratigraphic unit at that site, aligning it with the third quarter of the sixth millennium BCE according to another new date. These new findings position the Azov-Dnieper culture as a contemporary of the western Linear Pottery culture in the eastern region.

The chronology of the Lysa Hora cemetery sheds fresh light on the timing of the later phases of the Azov-Dnieper aspect. These phases extend well into the fifth millennium BCE, suggesting that the Azov-Dnieper culture likely played a significant role in the formation of the Steppe Eneolithic.

2.4 The Problem of the Earliest Pottery in the North Pontic Steppes: A Brief Overview of the State-of-Art

Pottery was introduced in southern Eastern Europe in at least two ways: through the Balkans and Central Europe with migrating early farmers and from the east within the hunter-gatherer *milieu*. In the latter case, the Far East is the primary region of origin,[230] while there are several assumptions about the exact region from which the pottery first spread through the study area.[231] All of them are quite distant from the study area, so the concept of generalised 'eastern' route fits the range of issues raised by this section. The hypothesis

229 Mathieson et al. 2018.

230 Kuzmin 2002.

231 Dolbunova et al. 2023; Gorelik et al. 2016.

of a maritime route for the appearance of the first ceramics on the northern shores of the Black Sea has also been proposed, but so far, the evidence is indirect.[232]

The issue of the spread of ceramic ware among hunter-gatherers has significant pan-European implications. Thus, it concerns the nature and originality of the communities of 'ceramic hunter-gatherers' of the Baltic and Northern Europe and the lowlands of Poland and Belarus.[233] Until recently, direct dating programmes pointed to a relatively early appearance of ceramics in Eastern Europe – as early as the seventh millennium BCE.[234] However, given that the dating of pottery based on the organic carbon content of a sample can be wildly inaccurate,[235] these estimates have had to be revised. According to a recently completed major project, the earliest ceramics enter southern Eastern Europe only after 6000 BCE.[236] The earliest dates for pottery in the study area were obtained north of the Caspian Sea at the site of Baibek, ~5900 calBCE. Considering the rejection of extremely early age estimates for the pottery found in the lowest layers of the Rakushechny Yar site,[237] the sites of the northern Azov region (Semenivka 1) appeared to yield unexpectedly early evidence for this innovation.[238]

Modelling spatiotemporal data by the same project's team suggests that the 'eastern' wave of ceramic dissemination should have extended to the Dnieper rapids, the Lower Dnieper Region and the Southern Buh valley around 5750-5500 BCE.[239] However, the chronology of several complexes, supported by fairly reliable modern AMS dates derived from short-lived materials, predates the anticipated timing. Namely, the dating of the lower layer at Semenivka 1, which places it in the early part of the sixth millennium BCE, contradicts this expected chronology as well as the chronology of SU2 of Melnychna Krucha.[240]

This observation can face criticism on several grounds. Firstly, sites like Baibek, Kairshak, and others from the Caspian region

232 Gaskevych 2011; Kotova et al. 2021.

233 Piezonka 2015.

234 Zaitseva et al. 2009; Zaliznyak et al. 2013.

235 Meadows 2020.

236 Dolbunova et al. 2023.

237 Dolbunova et al. 2020.

238 Kiosak et al. 2023c.

239 Dolbunova et al. 2023.

240 Kiosak et al. 2023c.

and the Don River's Valley[241] have established robust chronologies through extensive dating programs. In contrast, Melnychna Krucha and Semenivka 1, although dated with the assistance of AMS, lack a comparably extensive series of dates. Re-evaluation of their chronology could result in a shift towards younger estimates, especially given that we are dealing with relatively short timeframes that were previously considered challenging to precisely date using radiocarbon method. On the other hand, despite their limitations, the available dates (comprising 4 AMS dates for MK SU2 and 1 AMS date along with 4 conventional dates for Semenivka 1) still support the initially proposed ages for these sites.

In addition, the ceramic collection of Rakushechnyi Yar was considered to be a reference and to contain the oldest ceramic finds in the region.[242] Consequently, many typological schemes of relative chronology used the materials of the lowest layers of Rakushechnyi Yar as a starting point for the typological development of ceramics. Accordingly, given the significant shift in the dating of this starting point, these schemes are equally 'younger'. However, as we have seen repeatedly, natural science data (such as radiometric dating) can significantly alter schemes of relative chronology based on typological considerations, especially in the absence of a statistically significant archaeological seriation and the dubious homogeneity of most complexes.

The ceramic finds from SU2 of Melnychna Krucha are sufficiently rare and fragmented to make their connection with the dated stratigraphic unit questionable. Nevertheless, they were found in clear stratigraphic conditions with no visible signs of cultural layer disturbance that would explain their hypothetical downward displacement. Furthermore, there are no other para-Neolithic units above SU2, only Eneolithic and Bronze Age units, for which such ceramics are not typical. In Semenivka 1, the abundance and diversity of the ceramic assemblage from the lower layer leaves little doubt about the relationship between the sherds and the rest of the material in this layer.

In support of this point, we note that the sites of the first stage of ceramic distribution according to the above model – Baibek and Kairshak 3 – have a date that is slightly later than expected according to the model, while the site of the next stage – Cherkasskaya 5 – has a date that is slightly ahead of the expected date according to the model **[figs 35-36]**.[243] At the same time, if we abstract from the model, the dates of all three sites are actually simultaneous – and close to the dates of Melnychna Krucha SU2 and Semenivka 1. Thus, early

241 Dolbunova et al. 2023.

242 Kotova 2015; Telegin 1977.

243 Dolbunova et al. 2023.

ceramics were discovered in large areas of southern Eastern Europe at approximately the same time – in the first quarter of the sixth millennium, and the rate of its spread was higher than expected.

Thus, several sites with early ceramics scattered hundreds of kilometres apart were dated to the first quarter of the sixth millennium BCE. However, this is precisely the picture we have systematically encountered when trying to date the spread of early farmers, agriculture and herding.[244] This picture of the simultaneity of the earliest manifestations of a particular innovation was explained in other ways: planned long-distance migration, explosive spread, leap-frog colonisation, significant development of intercommunal exchange networks, etc. So why do we deny such explanations for hunter-gatherers? After all, the proposed spatio-temporal model[245] is implicitly based on the assumption that ceramics did spread as an idea by diffusion. However, hunter-gatherer communities were not that simple at all.[246] They were complex enough to move hundreds of kilometres within their annual cycle, to communicate over distances of thousands of kilometres. Thus, perhaps, the observed chronological discrepancy is not a matter of errors in the chronology of Melnychna Krucha and Semenivka 1. But it results from a need to take into account other more complex social mechanisms of the spread of early ceramics among hunter-gatherers than the slow diffusion of an innovative idea from carrier to carrier. These mechanisms will explain the virtually simultaneous appearance of ceramics from the northern shore of the Caspian Sea to the northern shore of the Black Sea.

2.5 Conclusion

Thus, para-Neolithic groups emerged in the study area in the early sixth millennium BCE. They are recorded in the valleys of the Southern Buh and Dniester, as well as in the Dnieper Valley and between the Dnieper and the Sea of Azov. The grid of archaeological cultures that describes these sites may undergo radical changes as the understanding of the archaeological record improves. For the most part, the cultures correspond to ceramic styles, while their relationship to other elements of material culture remains questionable. The spread of the first ceramics in the region is a rapid process that is difficult to explain by the spread of an innovative idea. Ceramics spread in several local variants at once. Rather, we should talk about other

244 Biagi et al. 2005; Dolukhanov et al. 2005; Forenbaher, Miracle 2005.

245 Dolbunova et al. 2023.

246 Kelly 1995; McCall, Horowitz 2014.

more complex social mechanisms: the migration of ceramic-making groups, and/or supercommunal-level networks for the exchange of things and people.

In the Southern Buh valley, after the decline of the LBK, there was a resurgence of para-Neolithic sites, which flourished for several centuries before the expansion of Early Trypillian groups, possibly partially coexisting with early farmers, both earlier and later.

Figures

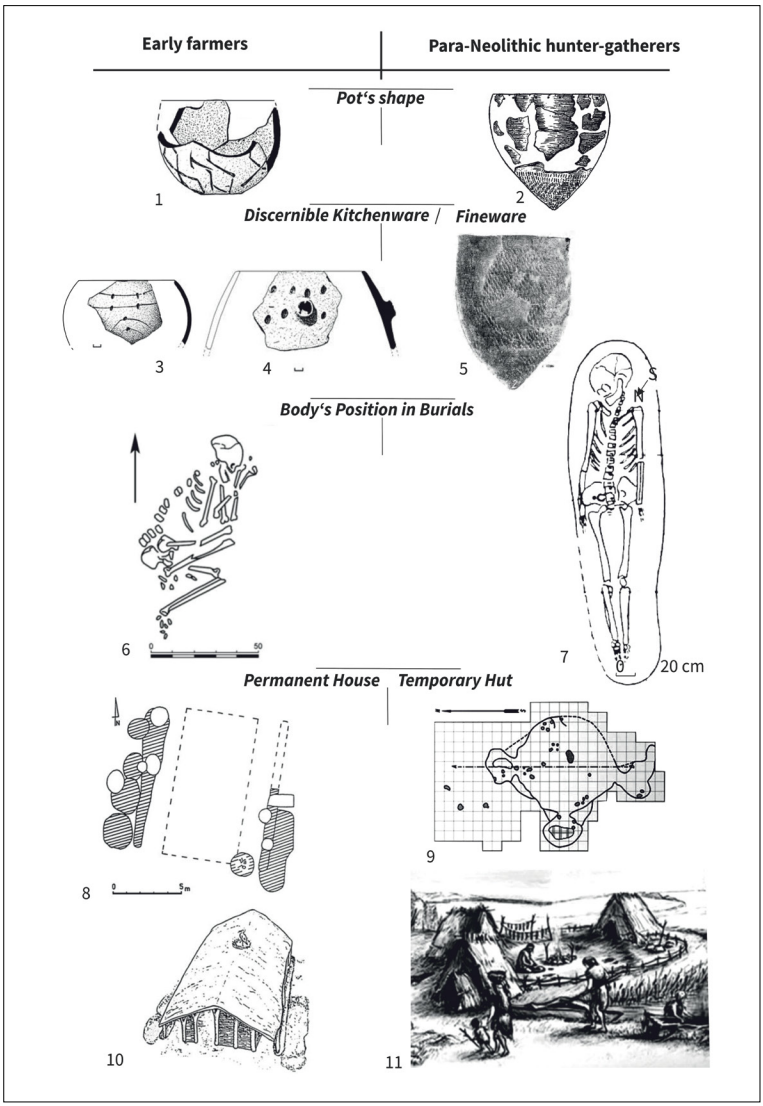

Figure 19 Archaeological markers of early farmers versus ceramic hunter-gatherers. 1, 3, 5: Kiosak 2019; 2, 5: Kotova 2015; 6: Haskevych 2018; 7: Telegin, Potekhina 1987; 8, 10: Lenartovich 2011; 9, 11: Demchenko 2016. Collage by the Author

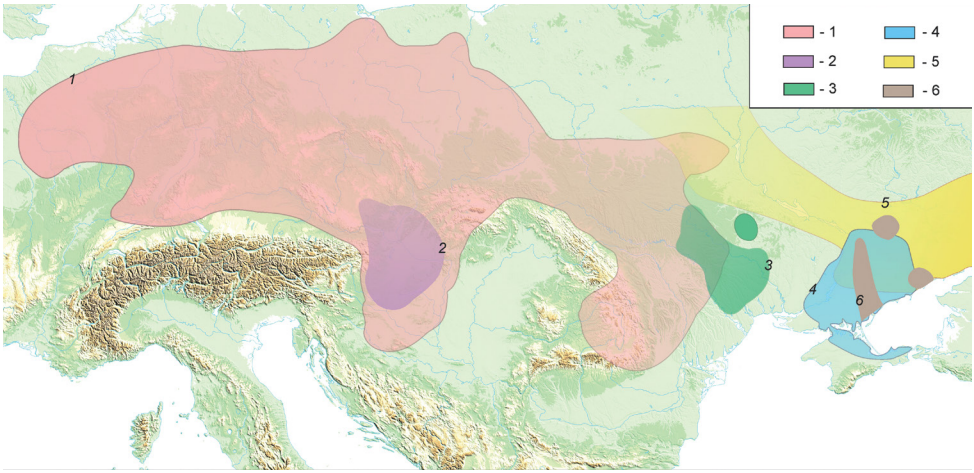

Figure 20 Map of archaeological cultures. After Telegin 1985, 1987; Kotova 2015; Kiosak et al. 2023, fig. 8 with modifications. 1: Younger LBK; 2: Formative LBK; 3: 'Buh-Dniester'; 4: Azov-Dnieper; 5: Dnieper-Donetsk, 6: Surskyi. Drawn by the Author

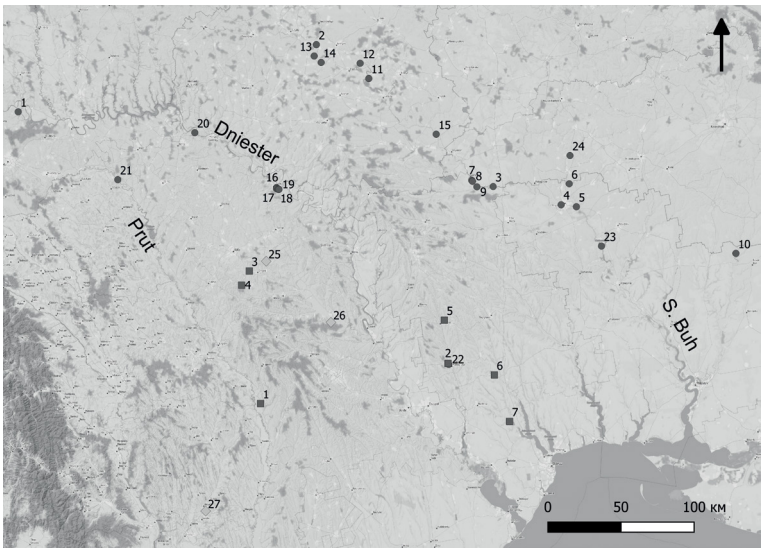

Figure 21 Para-Neolithic sites and settlements of the Criș culture. 'Buh-Dniester' para-Neolithic (circles). 1: Perebykivtsi; 2: Kanava; 3: Melnychna Krucha; 4; Pervomaisk; 5: Hrushivka; 6: Mykolyna Broiaka; 7: Zavallia; 8: Zhakchyk; 9: Savran; 10: Novorozanivka; 11: Sokiltsi 2, 6; 12: Samchyntsi; 13: Nova Mykolaivka; 14: Pechera; 15: Dzhulynka; 16-19: Tsykynivka, Soroca sites; 20: Tătăreuka Noua 15; 21: Pereryta; 22: Hirzheve; 23: Gard cluster (Gard, Gard 3-4, Puhach 1 and 2); 24: Dobrianka 1-3. Criș Culture (diamonds), 25: Sacarovca 1; 26: Seliste; 27: Trestiana. Sites with ceramics and microlithic tools: (squares), 1: Sarateni; 2: Hirzheve; 3: Biliceni Vechi 12; 4: Chischereni 5; 5: Zakharivka 1; 6: Katarzhyno 1; 7: Karpove. Topo: Stamen Terrain. Mapping by the Author

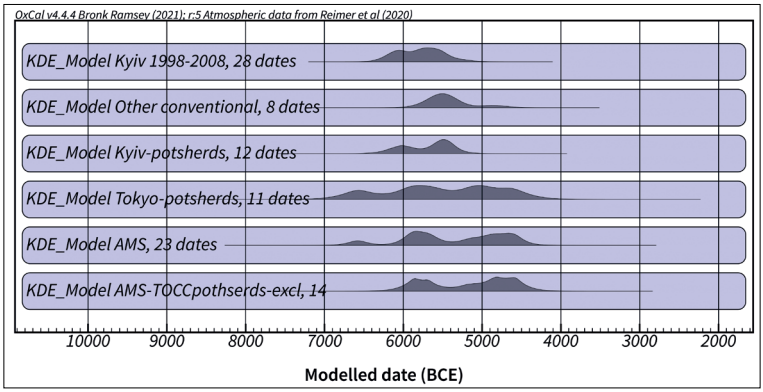

Figure 22 Buh-Dniester sites. Comparison of conventional Kyiv (1998-2008), other conventional, AMS dates, Dates on TOCC of potsherds from Kyiv, dates on TOCC of potsherds from Tokyo. **ST 2-1. Model 2-1.** Done In OxCal by the Author

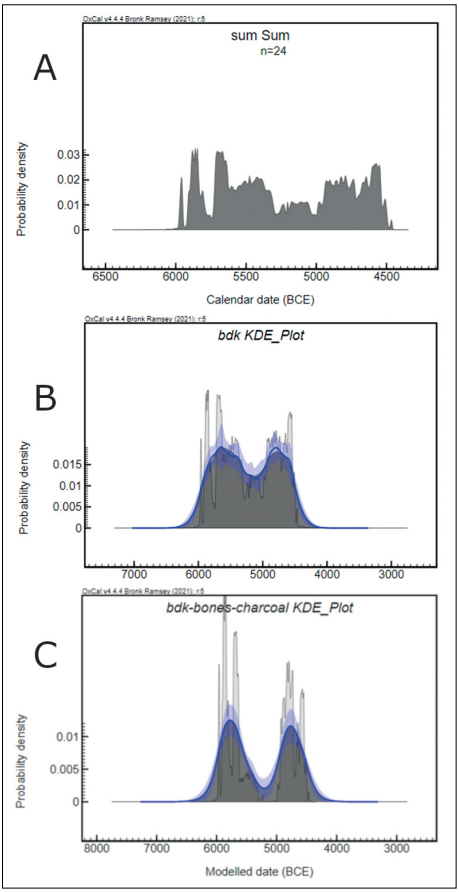

Figure 23
Sum (A) and Kernel Density estimates calculated for a set of relevant (24 dates) dates of Buh-Dniester para-Neolithic. **ST 2-1.** Dates with mark Incl.
Done in OxCal by the Author

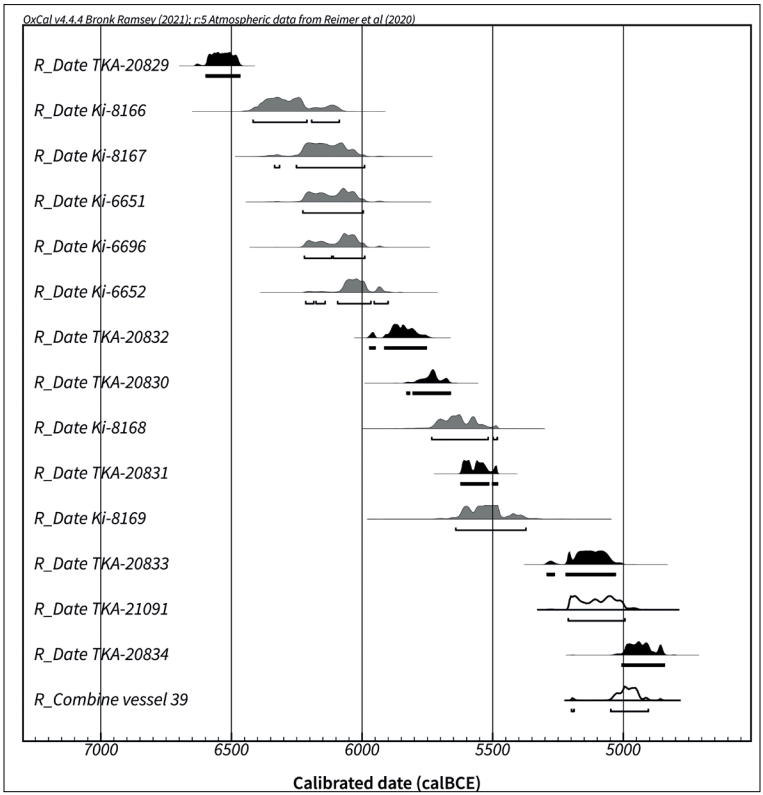

Figure 24 The radiocarbon dates for the site of Bazkiv Ostriv. Black: dates on TOCC of potsherds; grey: dates on animal bones; empty: a date of organic residue stuck to the potsherd. R_Combine vessel 39 – combination of dates TKA-21091 and TKA-20834, which failed X-Test fails at 5% – vessel 39 X2-Test: df=1 T=5.984(5% 3.8). After Haskevych et al. 2019. **ST 2-1**. Done in OxCal by the Author

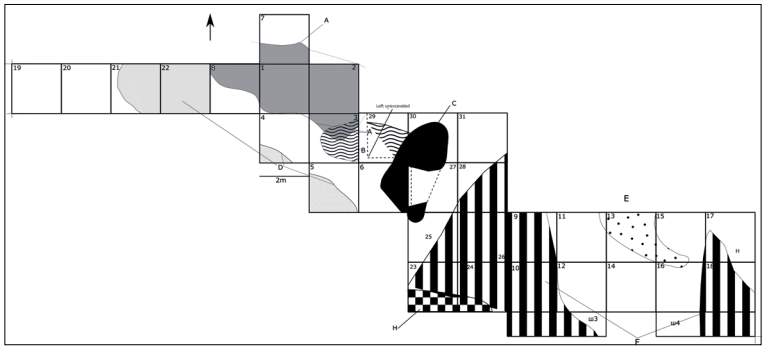

Figure 25 Plan of Melnychna Krucha. SU2: A. decortification zone (SU2b); C. shell scatter (SU2c); D. zone of disturbed sediments by the river bank (SU2a); I. dispersed cultural layer (SU2d), SU3; B. the charcoal-rich scatter; E. chipped stone scatter, SU4 – F-H. Drawing by the Author

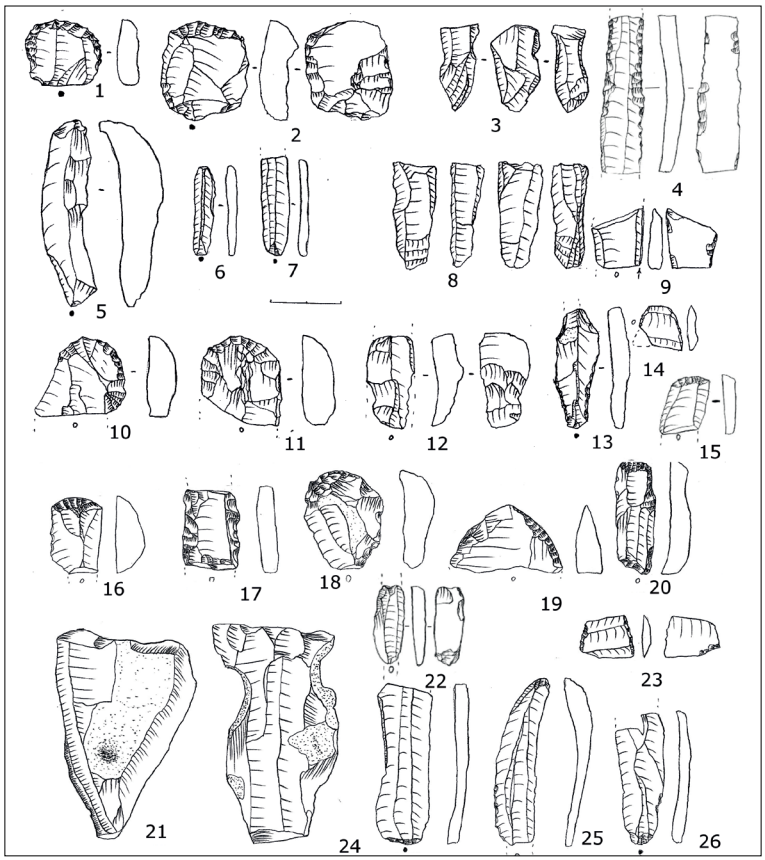

Figure 26 Melnychna Krucha. Lithic tools of SU2. After Kiosak 2019

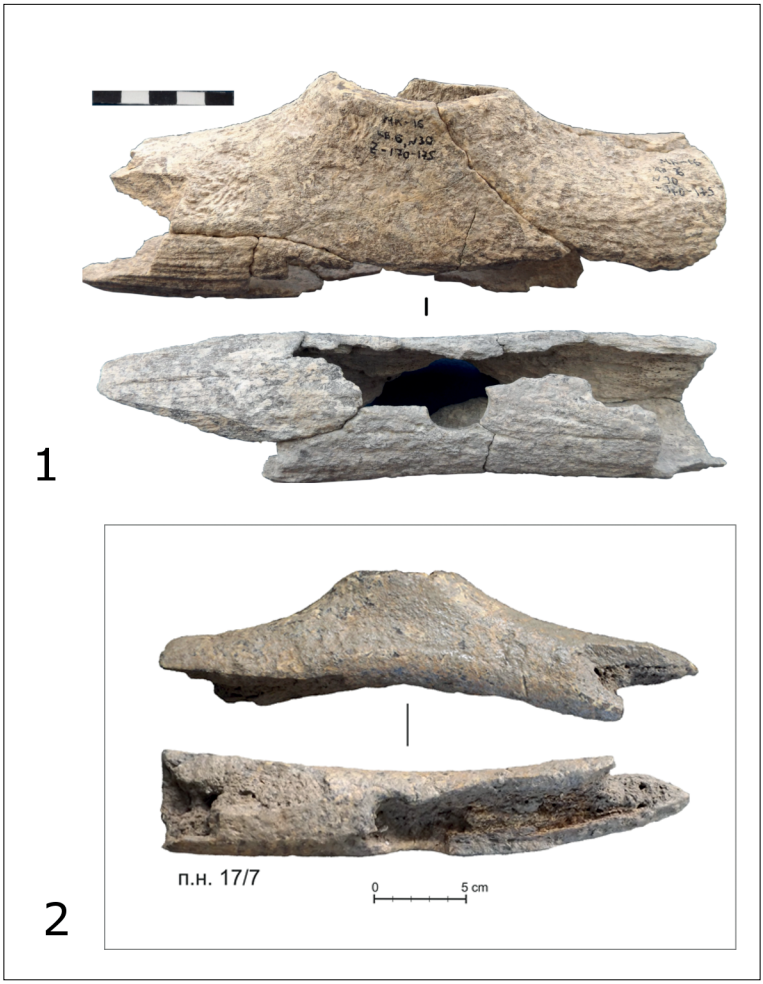

Figure 27 Melnychna Krucha SU2. T-shaped axes. The upper axe is directly dated to 5834-5727 calBCE (2σ), the lower axe is directly dated to 5736-5651 calBCE. Photo by the Author

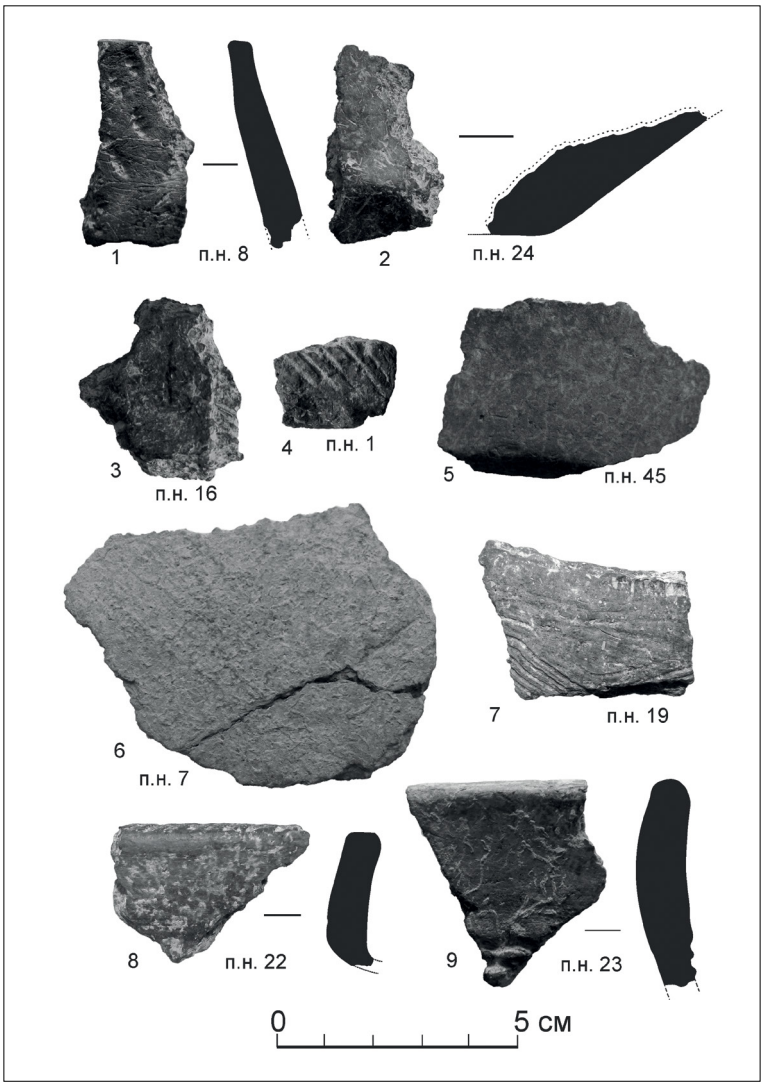

Figure 28 Melnychna Krucha. SU2 and R4. Potsherds. Photo by the Author

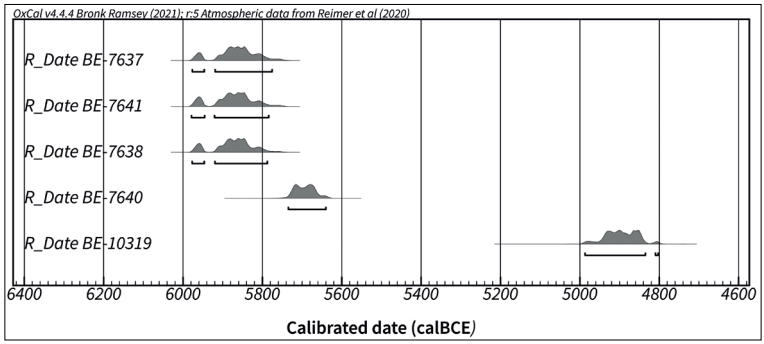

Figure 29 Melnychna Krucha, SU2 – four upper dates and R4 – lower date. Done in OxCal by the Author

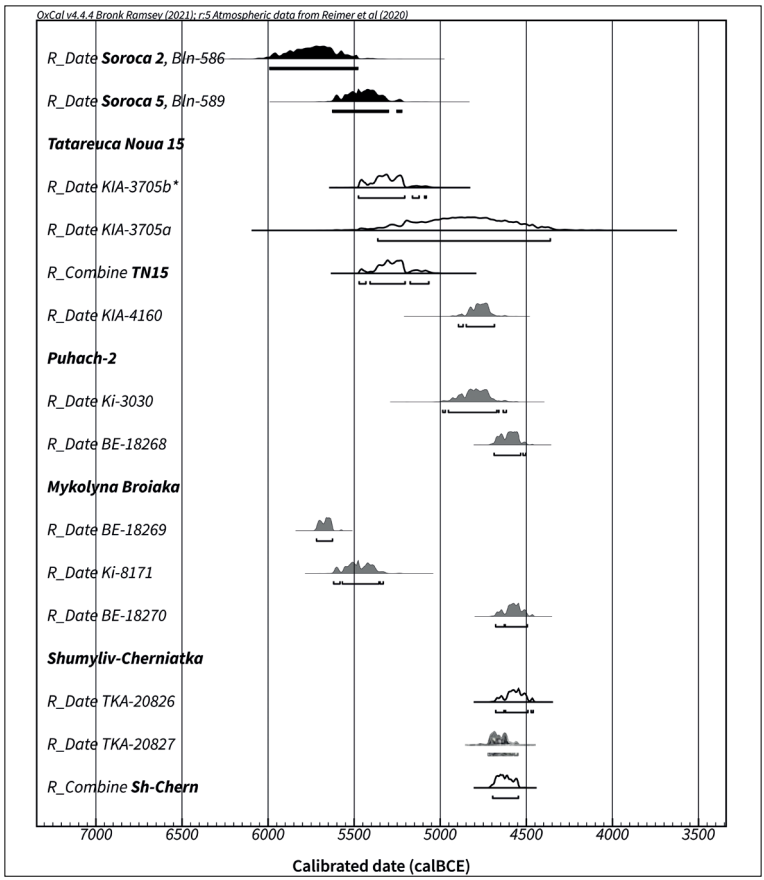

Figure 30 Relevant dates for Buh-Dniester para-Neolithic. Black: charcoal; empty: organic residues; grey: animal bone and antler; dirty: TOCC of a potsherd. R-Combine TN15 – a combination of dates KIA-3705a and b. R-Combine Sh-Chern – a combination of dates TKA-20826-27. Done in OxCal by the Author

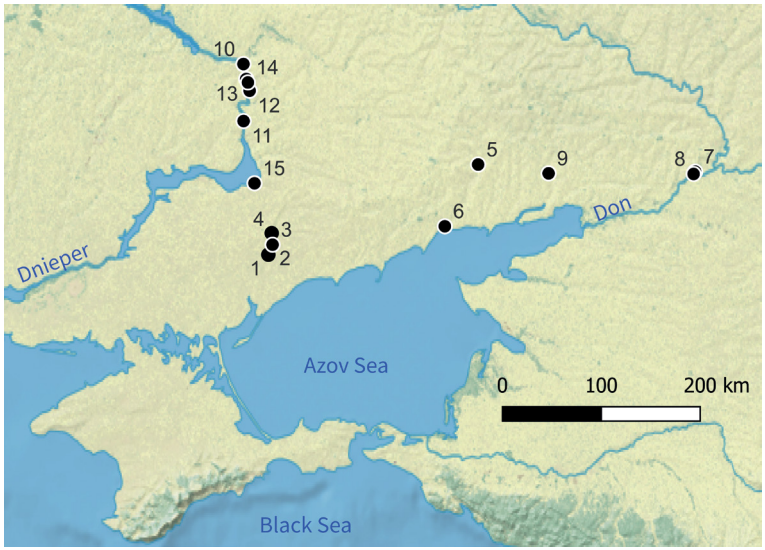

Figure 31 Map of the sites of Surskyi and Azov-Dnieper culture. 1: Semenivka 1; 2-3: Kamyana Mohyla 1 and 3; 4: Chapaevka; 5: Rozdolne; 6: Mariupol; 7-8: Rakushechnyi Yar, Razdorskaia; 10: Ihren 8; 11: Vovchok; 12-14: Shulaiv, Surskyi, Strilcha Skelia; 15: Lysa Hora. Topo: Natural Earth. Mapping by the Author

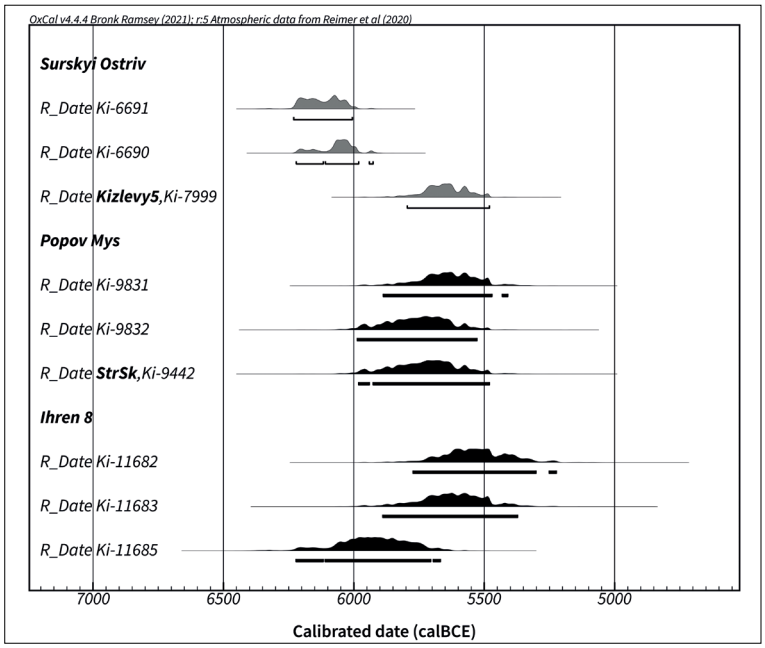

Figure 32 Legacy dates for the sites with Surskyi-style pottery. Grey: dates on bones; black: dates on potsherds. **ST 2-2**. Done in OxCal by the Author

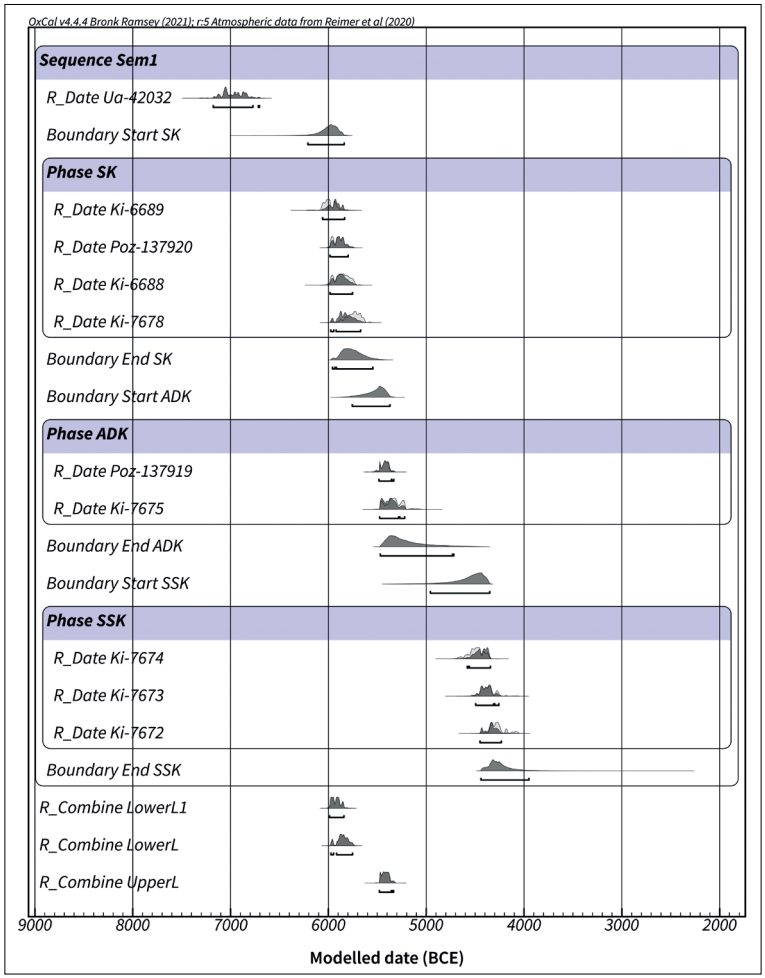

Figure 33 Semenivka 1. Modeled radiocarbon dates in sequence and combinations of dates. Sem1 – Semenivka 1, SK – Surskyi, ADK – Azov Dnieper, SSK – Eneolithic stratigraphic units respectively. LowerL1 – combination of dates Ki-6689, Poz-137920 and Ki-6688. LowerL – combination of dates Poz-137920, Ki-6778 and Ki-6688. UpperL – combination of Poz-137919 and Ki-7675.
Model 2-2. **ST 2-3**. Done in OxCal by the Author

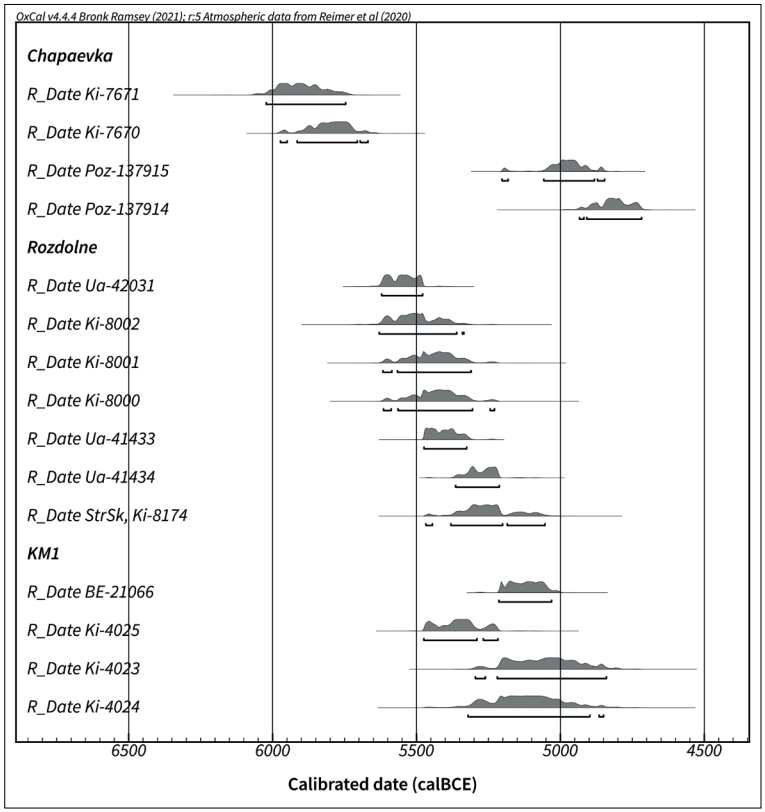

Figure 34 Radiocarbon dates for Azov-Dnieper sites. StrSk – Strilcha Skelia, KM1 – Kamyana Mohyla 1. All dates are from animal bones. **ST 2-4**. Done in OxCal by the Author

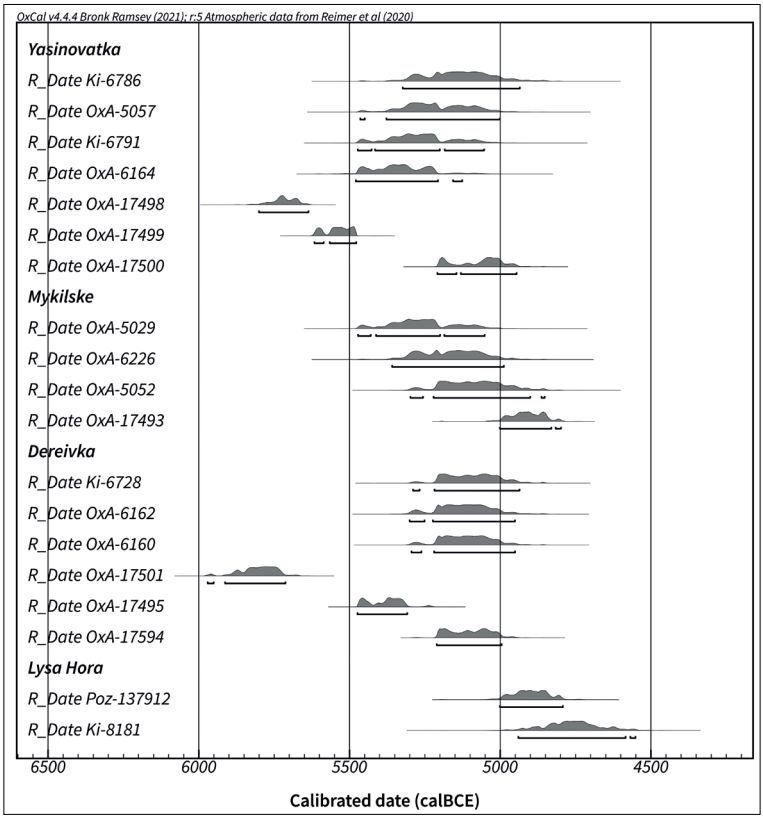

Figure 35 Radiocarbon dates of Azov-Dnieper cemeteries. All dates are from human bones. Done in OxCal by the Author

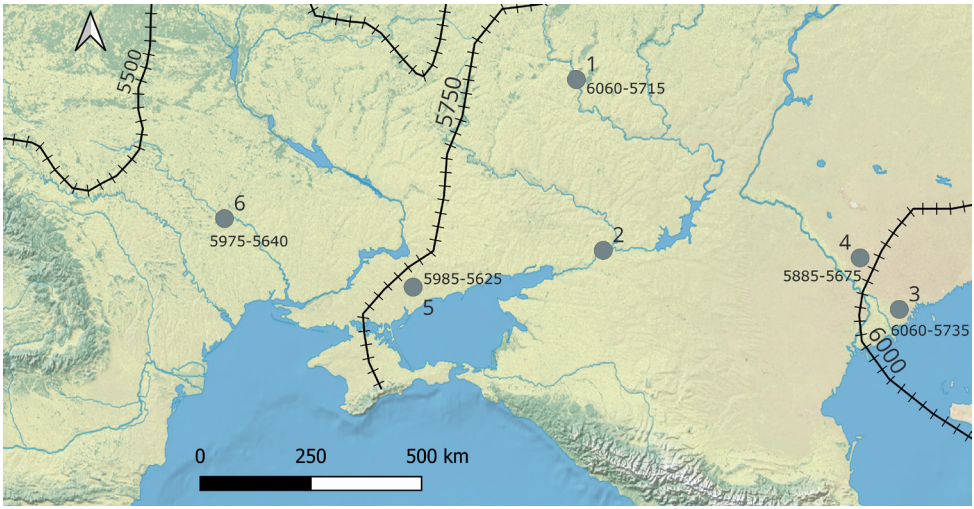

Figure 36 Map of the sites with early ceramic ware in the Ponto-Caspian region. 1: Cherkasskaya 5; 2: Rakushechnyi Yar; 3: Baibek; 4: Kairshak 3; 5: Semenivka 1; 6: Melnychna Krucha. The barred lines – isochrones of ceramic diffusion as modelled by Dolbunova et al. 2023. Topo: Natural Earth. Mapping by the Author

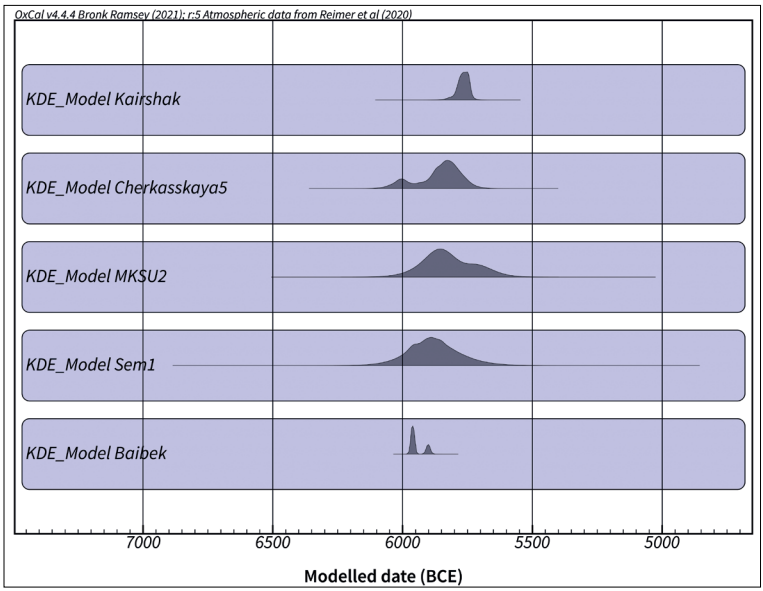

Figure 37 KDE models of the sites in question. MKSU2, Melnychna Krucha SU2, Sem1, Semenivka 1. Done in OxCal by the Author

Supplementary Tables

ST 2-1 Radiocarbon dates for 'Buh-Dniester' sites

Site name	Provenance	Lab. no.	Date BP	SD	Phase	Material	Calibration date range BC (1 sigma)	Calibration date range BC (2 sigmas)	Reference	Mark of relevance
The "old" chronology										
Soroca-2-l.1	Cultural layer	Bln-586	6825	150	Pechera	Charcoal	5885-5620	I	Markevich 1974	Incl
Gard	Lower layer	Ki-14790	6630	90	Pechera	Pottery	5630-5490	5721-5385	Tovkailo 2014	Excl
Gard	Lower layer	Ki-14789	6480	80	Pechera	Pottery	5520-5360	5612-5310	Tovkailo 2014	Excl
Gard	Upper layer	Ki-14791	6710	80	Savran	Pottery	5710–5560	5734-5489	Tovkailo 2014	Excl
Gard	Upper layer	Ki-14792	6520	80	Savran	Pottery	5560-5370	5618-5338	Tovkailo 2014	Excl
Gard	Upper layer	Ki-14793	6400	90	Savran	Pottery	5480–5310	5546-5210	Tovkailo 2014	Excl
Soroca-5	Cultural layer	Bln-589	6495	100	Savran	Charcoal	5545-5360	5631-5234	Markevich 1974	Incl
Tătărăuca Nouă-1	Cultural layer	KIA-3705b*	6340	70	Savran	Food crust	5460-5220	5478-5081	Wechler 2001	Incl
Tătărăuca Nouă-1	Cultural layer	KIA-3705a	5960	230	Savran	Food crust	5210–4580	5366-4362	Wechler 2001	Incl
Tătărăuca Nouă-1	Cultural layer	KIA-4160	5900	40	Savran	Antler				Incl
Puhach-2	Cultural layer	Ki-3030	5920	60	Savran	Charcoal	4877-4717	4961-4618	Tovkailo 2014	Incl
"New" chronology										
Bazkiv Ostriv		Ki-8166	7410	65	Pechera	Bone	6382-6225	6416-6086	Kotova 2003	Excl
Bazkiv Ostriv		Ki-8167	7270	70	Pechera	Bone	6220-6067	6333.5-5989.5	Kotova 2003	Excl
Bazkiv Ostriv		Ki-6651	7235	60	Pechera	Bone	6214-6023.5	6225.5-5994.5	Kotova 2003	Excl
Bazkiv Ostriv		Ki-6696	7215	55	Pechera	Bone	6202-6016	6216-6002	Kotova 2003	Excl
Bazkiv Ostriv		Ki-6652	7160	55	Pechera	Bone	6070-5988	6207-5912	Kotova 2003	Excl
Pechera		Ki-8164	7205	70	Pechera	Bone	6204-6006	6227-5930	Kotova 2003	Excl
Bazkiv Ostriv	Sq. U4	Ki-8168	6720	70	Savran	Bone	5705-5565	5736-5514	Kotova 2003	Incl
Bazkiv Ostriv	Sq. Tsch14, depth 60 cm	Ki-8169	6580	80	Savran	Bone	5615-5480	5644-5374	Kotova 2003	Incl
Savran	dwelling 2	Ki-6653	6920	50	Savran	Bone	5845-5735	5969-5716	Kotova 2003	Excl
Savran		Ki-6654	6985	60	Savran	Bone	5975-5800	5986-5744	Kotova 2003	Excl
Puhach-2	Trench 2, depth 2,5-2,6 m	Ki-6656	6895	50	Savran	Animal bone	5835-5725	5890-5674	Telegin et al. 2000	Excl
Puhach-2	XIX-51	Ki-6657	6810	60	Savran	Animal bone	5735-5645	5836-5622	Telegin et al. 2000	Excl
Puhach-2		Ki-6649	6780	60	Savran	Animal bone	5720-5635	5788-5564	Telegin et al. 2000	Excl
Puhach-2		Ki-6648	6740	65	Savran	Animal bone	5715-5620	5741-5534	Telegin et al. 2000	Excl
Puhach-2	Trench 1, depth 2,8-2,9 m	Ki-6679	6560	50	Savran	Animal bone	5555-5480	5621-5390	Telegin et al. 2000	Excl
Puhach-2	Trench 1, depth 2,4-2,5 m	Ki-6678	6520	60	Savran	Animal bone	5550-5385	5615-5363	Telegin et al. 2000	Excl
Gard-3	Sq. 5	Ki-6655	6930	55	Savran	Animal bone	5875-5740	5976-5716	Telegin et al. 2000	Excl
Gard-3		Ki-6650	6865	50	Savran	Animal bone	5810-5675	5875-5650	Telegin et al. 2000	Excl
Gard-3	trench 8	Ki-6687	6640	50	Savran	Animal bone	5620-5535	5636-5486	Telegin et al. 2000	Excl
Mykolyna Broyaka	Sq. 1, depth 120 cm	Ki-8171	6520	70	Savran	Animal bone	5555-5380	5618-5356	Kotova 2003	Incl
Dobrianka-1	Cultural layer	Ki-9833*	6530	140	Kyiv-	Pottery	5616-5370	5714-5224	Man'ko 2006	Excl
Dobrianka-1	Cultural layer	Ki-9834	6360	150	Kyiv-	Pottery	5490–5080	5616-4991	Man'ko 2006	Excl
Tashlyk2	cultural layer	Ki-10789	6160	60		Animal bone	5206.5-5038.5	5296.5-4939.5	Man'ko 2006	
Hirzheve	Cultural layer	Ki-11241	7280	170	Samchynts	Pottery carbon	6365.5-5990.5	6461-5804	Man'ko 2006	
Hirzheve	Cultural layer	Ki-11743	7200	220	Samchynts	Pottery carbon	6349.5-5841.5	6464.5-5664.5	Man'ko 2006	
Dobrianka-3	Cultural layer	Ki-11108	7260	170		Pottery carbon	6359.5-5982.5	6442-5797	Man'ko 2006	
Dobrianka-3	Cultural layer	Ki-11106	7070	150		Pottery carbon	6068.5-5782	6230-5665.5	Man'ko 2006	
Dobrianka-3	Cultural layer	Ki-11107	7050	160		Pottery carbon	6058.5-5760.5	6229-5637.5	Man'ko 2006	
New AMS dates										
Melnychna Krucha	*SU2*	*BE-7637*	*6980*	*24*	*Unknown*	*Bone*	*5980-5900*	*5990-5880*	*Kiosak et al. 2021*	Incl
Melnychna Krucha	*SU2*	*BE-7641*	*6986*	*24*	*Unknown*	*Bone*	*5872-5778*	*5888-5748*	*Kiosak et al. 2021*	Incl
Melnychna Krucha	*SU2*	*BE-7638*	*6985*	*22*	*Unknown*	*Antler*	*5773-5724*	*5835-5714*	*Kiosak et al. 2021*	Incl
Melnychna Krucha	*SU2*	*BE-7640*	*6812*	*24*	*Unknown*	*Bone*	*5762-5716*	*5806-5675*	*Kiosak et al. 2021*	Incl
Melnychna Krucha	*SU-R4*	*BE-10319*	*6008*	*21*	*Unknown*	*Bone*	*4880-4795*	*4930-4780*	*Kiosak et al. 2021*	Incl
Hlyns'kel	vessel 16, Complex 1	TKA-20828	7795	30	Pechera	Organic	6645-6600	6685-6530	Haskevych et al.	Excl
Hlyns'kel	vessel 7	TKA-21090	7080	30	Criș import	Organic	6002-5918	6014-5898	Haskevych et al.	Excl
Bazkiv Ostriv	vessel 23	TKA-20829	7710	25	Pechera	Organic	6586-6503	6597-6477	Haskevych et al.	Excl
Bazkiv Ostriv	vessel 1	TKA-20830	6855	30	Samchynts	Organic	5769-5707	5807-5666	Haskevych et al.	Excl
Bazkiv Ostriv	vessel 22	TKA-20831	6625	25	Skybentsi	Organic	5613-5534	5621-5514	Haskevych et al.	Incl
Bazkiv Ostriv	vessel 21	TKA-20832	6970	25	Skybentsi	Organic	5891-5810	5972-5769	Haskevych et al.	Incl
Bazkiv Ostriv	vessel 2	TKA-20833	6190	35	Samchynts	Organic	5212-5069	5288-5030	Haskevych et al.	Incl
Bazkiv Ostriv	vessel 39	TKA-20834	6040	25	Samchynts	Organic	4987-4907	5003-4847, mistakenly reported as 5211-	Haskevych et al.	Incl
Bazkiv Ostriv	vessel 39	TKA-21091	6145	35	Samchynts	Charred	5205-5027	5211-5000, mistakenly reported as 5003-	Haskevych et al.	Incl
Shumyliv-Chemiatka		TKA-20826	5725	30	Savran	Charred	4608-4515	4683-4491	Haskevych et al.	Incl
Shumyliv-Chemiatka		TKA-20827	5805	25	Savran	Organic	4709-4615	4723-4558	Haskevych et al.	Incl
Puhach-2	cultural layer	BE-18268	5750	26	Savran	animal bone	4656-4543	4686-4503	Kiosak et al. subm	Incl
Mykolyna Broiaka	*House 1, 280 cm deep*	*BE-18269*	*6762*	*27*	Savran?	*Animal*	*5708-5631*	*5719-5625*	Kiosak et al. subm	Incl
Mykolyna Broiaka	cultural layer	BE-18270	5731	26	Savran	animal bone	4647-4505	4678-4493	Kiosak et al. subm	Incl
Zakharivka-1	Cultural layer	Poz-21999	5935	35	?	Animal bone	4876-4726	4927-4716	Kiosak 2019	

ST 2-2 Radiocarbon dates for sites with Surskyi style pottery

Site Name	e	Lab. Number	Date BP	SD	Material	CalBCE (1 sigma)	CalBCE (2 sigmas)	Reference	Remark
Surskyi Ostriv	lower layer	Ki-6691	7245	60	animal bone	6216.5-6029	6229.5-6005	Kotova 2003	
Surskyi Ostriv	lower layer	Ki-6690	7195	55	animal bone	6085-5987	6219.5-5925	Kotova 2003	
Kizlevy V		Ki-7999	6740	90	Bone tool	5726-5560.5	5794-5479	Kotova 2015	
Popov Mys		Ki-9831	6720	120	TOCC potsherd	5725-5529	5885.5-5409	Kotova 2015	
Popov Mys		Ki-9832	6840	130	TOCC potsherd	5878-5624.5	5985.5-5527.5	Kotova 2015	
Strilcha Skelia		Ki-9442	6810	140	TOCC potsherd	5875-5564.5	5980.5-5479.5	Kotova 2015	
Ihren 8	PD8, D	Ki-11682	6600	140	TOCC potsherd	5655.5-5385	5771.5-5223	Man'ko 2005	N. Kotova doubts Surksyi outlook of this potsherd
Ihren 8	PD8, E	Ki-11683	6700	140	TOCC potsherd	5721.5-5480.5	5887.5-5371.5	Man'ko 2005	N. Kotova doubts Surksyi outlook of this potsherd
Ihren 8	PD8, D2	Ki-11685	7050	140	TOCC potsherd	6055.5-5783.5	6220-5667.5	Man'ko 2005	N. Kotova doubts Surksyi outlook of this potsherd

ST 2-3 Radiocarbon dates for the site of Semenivka 1

Site name	Provenance	Lab. no.	Date BP	SD	Phase	Material	CalBCE (1 sigma)	CalBCE (2 sigmas)	Reference
Sem1		Ua-42032	8058	55	Mesolithic layer	auroch bone	-7129.5 till-6829	-7175.5 till-6703	Kiosak et al. 2023
Sem1		Ki-7679	7285	70	Surskyi layer	animal bone	-6220.5 till-6074	-6357.5 till-6010.5	Kiosak et al. 2023
Sem1		Ki-6689	7125	60	Surskyi layer	animal bone	-6059 till-5921	-6083 till-5842.5	Kiosak et al. 2023
Sem1	**Exc. tr. 2, sq. 1, depth 120-140 cm**	Poz-137920	**7010**	40	Surskyi layer	II ph Bos sp.	-5976.5 till-5840.5	-5986 till-5786	Kiosak et al. 2023
Sem1		Ki-6688	6980	65	Surskyi layer	animal bone	-5972 till-5789.5	-5984 till-5731.5	Kiosak et al. 2023
Sem1		Ki-7678	6850	70	Surskyi layer	animal bone	-5799.5 till-5659.5	-5885.5 till-5624.5	Kiosak et al. 2023
Sem1	**Exc. tr. 2, sq. 1, depth 90-100 cm**	Poz-137919	**6480**	40	Azov-Dnieper layer	tooth of small canid	-5476.5 till-5380	-5523 till-5334.5	Kiosak et al. 2023
Sem1	**Exc. tr 2/ sq. 3, z -110-120 cm**	Ki-7675	6360	70	Azov-Dnieper layer	animal bone	-5467 till-5219	-5475 till-5209.5	Kiosak et al. 2023
Sem1	**Exc. tr 2/ sq. 6, z -100-120 cm**	**Ki**-7674	5655	60	Seredny Stog layer	animal bone	-4545.5 till-4368.5	-4656 till-4352.5	Kiosak et al. 2023
Sem1	**Exc. tr 2/ sq. 4, z -90-115 cm**	**Ki**-7673	5525	70	Seredny Stog layer	animal bone	-4447 till-4328.5	-4534.5 till-4241.5	Kiosak et al. 2023
Sem1	**Exc. tr 2/ sq. 1, z -90-100 cm**	**Ki**-7672	5440	60	Seredny Stog layer	animal bone	-4349.5 till-4240	-4441 till-4056	Kiosak et al. 2023

ST 2-4 Radiocarbon dates for Azov-Dnieper culture residential sites

Site name	Provenance	Aspect/Phase	Lab. no.	Date BP	SD	Material	CalBC (1 sigma)	CalBC (2 sigmas)	Reference
Chapaevka	Sq. 3, -64 cm	ADK/I	Ki-7671	7030	70	Animal bone	5985-5840	6021-5745	Kotova 2015
Chapaevka	Sq. 6, -62 cm	ADK/I	Ki-7670	6910	60	Animal bone	5875-5726	5972-5668	Kotova 2015
Chapaevka	sq. 27 / z -136 cm		Poz-137915	6070	35	animal bone	5033-4911	5202-4845	Kiosak et al. 2023
Chapaevka	sq. 29 / z = -128 cm		Poz-137914	5940	40	incisor of Equus sp.	4887-4728	4933-4717	Kiosak et al. 2023
Rozdolne	2010, tr. 1, -280 cm		Ua-42031	6609	49	Mandible of cattle	5615-5481	5620-5478	Kotova et al. 2017
Rozdolne	1991, tr. 2, sq. 1, -120-140 cm		Ki-8002	6550	80	Animal bone	5615-5407	5629-5335	Kotova et al. 2017
Rozdolne	1991, tr. 2, sq. 1, -120-140 cm		Ki-8001	6490	80	Animal bone	5527-5365	5616-5310	Kotova et al. 2017
Rozdolne	1991, tr. 2, sq. 1, -120-140 cm		Ki-8000	6475	80	Animal bone	5516-5335	5614-5228	Kotova et al. 2017
Rozdolne	2000, tr. 5, sq.6Б, -174		Ua-41433	6428	37	Mandible of cattle	5471-5368	5473-5325	Kotova et al. 2017
Rozdolne	2000, tr. 5, sq.6Б, -174		Ua-41434	6310	38	Mandible of cattle	5318-5216	5363-5211	Kotova et al. 2017
Strilcha Skelia	Sq. 8, cut 9	ADK/II	Ki-8174	6290	65	Bone tool	5359-5208	5466-5053	Kotova 2015

ST 2-5 Radiocarbon dates for cemeteries attributed to Azov Dnieper culture

Site name	Provenance	Lab. no.	Date BP	SD	Cultural aspect	Material	Calibration date range BC (1 sigma)	Calibration date range BC (2 sigmas)	Reference
Yasinovatka	burial 34	ADK/II	Ki-6786	6195	80	Human bone	5290-5039	5323-4934	Kotova 2015
	burial 36	ADK/II	OxA-5057	6260	80	Human bone	5314-5071	5463-5000	Kotova 2015
	burial 45	ADK/II	Ki-6791	6305	80	Human bone	5460-5130	5472-5053	Kotova 2015
	burial 45	ADK/II	OxA-6164	6360	75	Human bone	5468-5219	5478-5125	Lillie 1998
	burial 65		OxA-17498	6840	37	Fish tooth	5744-5666	5800-5635	Lillie et al. 2009
	burial 54		OxA-17499	6593	35	Human fibula	5606-5481	5616-5477	Lillie et al. 2009
	burial 54		OxA-17500	6121	34	Deer tooth pendant	5204-4990	5208-4945	Lillie et al. 2009
Mykilske	burial 125	ADK/II	OxA-5029	6300	80	Human bone	5372-5126	5471-5051	Lillie 1998
	burial 94	ADK/II	OxA-6226	6220	75	Human bone	5299-5054	5356-4987	Lillie 1998
	burial 137	ADK/II	OxA-5052	6145	70	Human bone	5207-5000	5297-4852	Lillie 1998
	unknown		OxA-17493	6020	34	Animal tooth	4950-4844	5000-4798	Lillie et al. 2009
Dereivka	burial 11	ADK/II	Ki-6728	6145	55	Human bone	5206-5003	5288-4935	Kotova 2015
	burial 33	ADK/II	OxA-6162	6175	60	Human bone	5210-5045	5300-4950	Lillie 1998
	burial 49	ADK/II	OxA-6160	6165	55	Human bone	5207-5045	5294-4950	Lillie 1998
	burial 29		OxA-17501	6915	50	Fish tooth	5839-5732	5970-5712	Lillie et al. 2009
	burial 29		OxA-17495	6398	35	Human bone	5467-5320	5473-5308	Lillie et al. 2009
	burial 29		OxA-17594	6147	35	Deer bone	5206-5010	5210-4995	Lillie et al. 2009
Lysa Hora	burial 17, above pit 3		Poz-137912	6010	40	Human bone	4950-4838	5000-4791	Kiosak et al. 2023
	pit 4		Ki-8181	5890	70	Human bone	4877-4680	4939-4551	Kiosak et al. 2023

Models

Model 2-1 Buh-Dniester sites. Comparison of conventional Kyiv (1998-2008), other conventional, AMS dates, dates on TOCC of potsherds from Kyiv, dates on TOCC of potsherds from Tokyo

```
Plot()
  {
    KDE_Model("Kyiv 1998-2008, 28 dates")
    {
      R_Date("Ki-8166",7410,65);
      R_Date("Ki-8167",7270,70);
      R_Date("Ki-6651",7235,60);
      R_Date("Ki-6696",7215,55);
      R_Date("Ki-6652",7160,55);
      R_Date("Ki-8164",7205,70);
      R_Date("Ki-8168",6720,70);
      R_Date("Ki-8169",6580,80);
      R_Date("Ki-6653",6920,50);
      R_Date("Ki-6654",6985,60);
      R_Date("Ki-6656",6895,50);
      R_Date("Ki-6657",6810,60);
      R_Date("Ki-6649",6780,60);
      R_Date("Ki-6648",6740,65);
      R_Date("Ki-6679",6560,50);
      R_Date("Ki-6678",6520,60);
      R_Date("Ki-6655",6930,55);
      R_Date("Ki-6650",6865,50);
      R_Date("Ki-6687",6640,50);
      R_Date("Ki-8171",6520,70);
      R_Date("Ki-9833*",6530,140);
      R_Date("Ki-9834",6360,150);
      R_Date("Ki-10789",6160,60);
      R_Date("Ki-11241",7280,170);
      R_Date("Ki-11743",7200,220);
      R_Date("Ki-11108",7260,170);
      R_Date("Ki-11106",7070,150);
      R_Date("Ki-11107",7050,160);
    };
    KDE_Model("Other conventional, 8 dates")
    {
      R_Date("Bln-586",6825,150);
      R_Date("Ki-14790",6630,90);
      R_Date("Ki-14789",6480,80);
      R_Date("Ki-14791",6710,80);
      R_Date("Ki-14792",6520,80);
      R_Date("Ki-14793",6400,90);
      R_Date("Bln-589",6495,100);
      R_Date("Ki-3030",5920,60);
    };
```

```
KDE_Model("Kyiv-potsherds, 12 dates")
{
  R_Date("Ki-14790",6630,90);
  R_Date("Ki-14789",6480,80);
  R_Date("Ki-14791",6710,80);
  R_Date("Ki-14792",6520,80);
  R_Date("Ki-14793",6400,90);
  R_Date("Ki-9833*",6530,140);
  R_Date("Ki-9834",6360,150);
  R_Date("Ki-11241",7280,170);
  R_Date("Ki-11743",7200,220);
  R_Date("Ki-11108",7260,170);
  R_Date("Ki-11106",7070,150);
  R_Date("Ki-11107",7050,160);
};
KDE_Model("Tokyo-potsherds, 11 dates")
{
  R_Date("TKA-20828",7795,30);
  R_Date("TKA-21090",7080,30);
  R_Date("TKA-20829",7710,25);
  R_Date("TKA-20830",6855,30);
  R_Date("TKA-20831",6625,25);
  R_Date("TKA-20832",6970,25);
  R_Date("TKA-20833",6190,35);
  R_Date("TKA-20834",6040,25);
  R_Date("TKA-21091",6145,35);
  R_Date("TKA-20826",5725,30);
  R_Date("TKA-20827",5805,25);
};
KDE_Model("AMS, 23 dates")
{
  R_Date("KIA-3705b*",6340,70);
  R_Date("KIA-3705a",5960,230);
  R_Date("KIA-4160",5900,40);
  R_Date("BE-7637",6980,24);
  R_Date("BE-7641",6986,24);
  R_Date("BE-7638",6985,22);
  R_Date("BE-7640",6812,24);
  R_Date("BE-10319",6008,21);
  R_Date("TKA-20828",7795,30);
  R_Date("TKA-21090",7080,30);
  R_Date("TKA-20829",7710,25);
  R_Date("TKA-20830",6855,30);
  R_Date("TKA-20831",6625,25);
  R_Date("TKA-20832",6970,25);
  R_Date("TKA-20833",6190,35);
  R_Date("TKA-20834",6040,25);
  R_Date("TKA-21091",6145,35);
  R_Date("TKA-20826",5725,30);
  R_Date("TKA-20827",5805,25);
  R_Date("BE-18268",5750,26);
```

```
    R_Date("BE-18269",6762,27);
    R_Date("BE-18270",5731,26);
    R_Date("Poz-21999",5935,35);
  };
  KDE_Model("AMS-TOCCpothserds-excl, 14")
  {
    R_Date("KIA-3705b*",6340,70);
    R_Date("KIA-3705a",5960,230);
    R_Date("KIA-4160",5900,40);
    R_Date("BE-7637",6980,24);
    R_Date("BE-7641",6986,24);
    R_Date("BE-7638",6985,22);
    R_Date("BE-7640",6812,24);
    R_Date("BE-10319",6008,21);
    R_Date("TKA-21091",6145,35);
    R_Date("TKA-20826",5725,30);
    R_Date("BE-18268",5750,26);
    R_Date("BE-18269",6762,27);
    R_Date("BE-18270",5731,26);
    R_Date("Poz-21999",5935,35);
  };
};
```

Model 2-2 Semenivka 1. Sequential phases and some combinations of dates

```
Plot()
  {
    Sequence(Sem1)
    {
      R_Date("Ua-42032", 8058, 55);
      Boundary("Start SK");
      Phase("SK")
      {
        R_Date("Ki-6689", 7125, 60);
        R_Date("Poz-137920", 7010, 40);
        R_Date("Ki-6688", 6980, 65);
        R_Date("Ki-7678", 6850, 70);
      };
      Boundary("End SK");
      Boundary("Start ADK");
      Phase("ADK")
      {
        R_Date("Poz-137919", 6480, 40);
        R_Date("Ki-7675", 6360, 70);
      };
      Boundary("End ADK");
      Boundary("Start SSK");
      Phase("SSK")
      {
        R_Date("Ki-7674", 5655, 60);
        R_Date("Ki-7673", 5525, 70);
        R_Date("Ki-7672", 5440, 60);
      };
      Boundary("End SSK");
    };
    R_Combine("LowerL1")
    {
      R_Date("Ki-6689", 7125, 60);
      R_Date("Poz-137920", 7010, 40);
      R_Date("Ki-6688", 6980, 65);
    };
    R_Combine("LowerL")
    {
      R_Date("Poz-137920", 7010, 40);
      R_Date("Ki-6688", 6980, 65);
      R_Date("Ki-7678", 6850, 70);
    };
    R_Combine("UpperL")
    {
      R_Date("Poz-137919", 6480, 40);
      R_Date("Ki-7675", 6360, 70);
    };
  };
```

Model 2-3 Kernel Density Models for earliest pottery in southern Eastern Europe

```
Plot()
  {
    KDE_Model("Kairshak")
    {
      R_Date("OxA-40228",6908,26);
      R_Date("SUERC-93642",6973,44);
      R_Date("OxA-40229",6890,27);
      R_Date("SUERC- 100998",6934,27);
      R_Date("SUERC- 100999",6885,25);
      R_Date("SUERC- 101001",6872,25);
      R_Date("SUERC- 101000",6901,27);
    };
    KDE_Model("Cherkasskaya5")
    {
      R_Date("OxA-39520",6999,27);
      R_Date("OxA-39521",7130,26);
      R_Date("OxA-39522",6982,26);
      R_Date("SUERC-86147",6987,28);
      R_Date("SUERC-86148",6966,28);
      R_Date("SUERC-86149",6943,28);
      R_Date("SUERC-86150",6950,28);
      R_Date("SUERC-86151",7140,28);
      R_Date("SUERC-86156",6938,28);
      R_Date("SUERC-86157",6908,28);
      R_Date("SUERC-86158",6886,28);
    };
    KDE_Model("MKSU2")
    {
      R_Date("BE-7637",6980,24);
      R_Date("BE-7641",6986,24);
      R_Date("BE-7638",6985,22);
      R_Date("BE-7640",6812,24);
    };
    KDE_Model("Sem1")
    {
      R_Date("Ki-6689", 7125, 60);
      R_Date("Sem1", 7010, 40);
      R_Date("Ki-6688", 6980, 65);
      R_Date("Ki-7678", 6850, 70);
    };
    KDE_Model("Baibek")
    {
      R_Date("DeA-20722",6992,37);
      R_Date("DeA-20723",6976,37);
      R_Date("DeA-20724",7097,41);
      R_Date("DeA-20725",7034,43);
      R_Date("OxA-39162",7010,27);
      R_Date("DeA-20726",7056,38);
      R_Date("DeA-20727",7036,37);
```

```
      R_Date("DeA-20728",6998,39);
      R_Date("DeA-20729",7023,39);
      R_Date("DeA-20957",6952,40);
      R_Date("DeA-20958",7012,34);
      R_Date("DeA-20730",7023,39);
      R_Date("OxA-39163",7060,28);
      R_Date("OxA-39164",7030,28);
      R_Date("OxA-39165",7012,28);
      R_Date("OxA-39166",7035,27);
      R_Date("OxA-39296",7030,27);
      R_Date("OxA-39074",7048,25);
      R_Date("OxA-39332",6989,32);
      R_Date("OxA-39075",7023,24);
      R_Date("OxA-39076",7016,24);
      R_Date("OxA-39077",7024,25);
      R_Date("OxA-39133",6994,29);
      R_Date("OxA-39232",6978,28);
      R_Date("OxA-39134",6994,28);
      R_Date("OxA-39518",7041,27);
      R_Date("OxA-39136",6999,29);
      R_Date("OxA-39137",7020,28);
      R_Date("OxA-39138",7002,29);
      R_Date("OxA-39139",7022,29);
      R_Date("DeA-20731",7037,37);
      R_Date("DeA-20732",7026,76);
    };
};
```

3 The Neolithisation as Seen from the East

Summary 3.1 The First Temperate Neolithic in the Pontic Steppe. – 3.2 Linear Pottery Culture at Its Easternmost Fring. – 3.3 Chronology of the First Domesticates. – 3.4 Eneolithisation or Late Neolithic Crisis? – 3.5 Conclusion.

The theory of early and non-Balkan Neolithisation of the south of Eastern Europe was revived in the 2010s and found some appreciation.[1] However, in-depth attempts to approach the problem mainly do not support the unusual ways and pace of the Neolithisation of this region (see Chapter 2 for details). The earliest pottery from the south of Eastern Europe dates back to the sixth millennium BCE.[2] The supposed imprints of cultivated plants' parts on the earliest potsherds appeared to be left by rests of wild flora.[3] A re-analysis of archaeozoological assemblages failed to find clear domesticates in the crucial collections.[4] It is possible that there were also settlements of maritime migrants from Thrace and Anatolia before the Neolithisation

1 Gaskevych 2011; Gorelik et al. 2016; Kotova 2015; Reingruber 2016.

2 Courel et al. 2021; Dolbunova et al. 2023.

3 Endo et al. 2022.

4 Benecke 1997; Stupak et al. 2022.

by land,[5] but the evidence for this is indirect and consists of distant analogies of material culture elements. Moreover, the archaeological record for the arrival of domestic fauna and flora, sedentary way of life and elaborated ceramic industry is unambiguous and overwhelmingly abundant[6] – but rather for later periods (not earlier than the second quarter of a sixth mill. BCE) and for archaeological phenomena with clear Balkan (FTN) or Central European origin (LBK). Thus, in the further discussion, we will refer to the expansion of FTN and LBK as Neolithisation, dismissing the hypothesis of some earlier Neolithisation.

Early farmers in Eastern Europe attempted to expand their presence several times. As the late Criş groups ventured into the region, they apparently circumvented the Carpathians, likely from the southern routes (§ 3.1). Subsequently, a significant cultural impetus from the LBK communities surged towards the Dnieper and Southern Buh Rivers, albeit slightly later (§ 3.2). These migrations were accompanied by introducing a distinct array of cultivated plants, documented in the archaeological record (§ 3.3). Another expansion phase unfolded during the Precucuteni-Early Trypillian period, particularly into the territories of Central Ukraine, where LBK settlements had not previously been established. As the Eneolithic period dawned, the vast swathes west of the Dnieper River became the domain of Trypillian communities. Meanwhile, mobile Eneolithic communities emerged in the southern steppe regions and east of the Dnieper, which seem to have already known agriculture and pastoralism (§ 3.4).

3.1 The First Temperate Neolithic in the Pontic Steppe

The first settlements of early farmers known in the south of Eastern Europe **[fig. 21: 25-27]** belong to the Criş culture.[7] The Criş culture is a part of the significant cultural and historical area Karanovo IV – Starčevo – Körös – Criş **[fig. 38]**. The latter represents the earliest, reliably dated Neolithic of the Inner Balkans – FTN, First Temperate Neolithic. The territory of this archaeological phenomenon covers the expanses of Southeastern Europe.[8]

The early FTN sites are widely scattered across the inner Balkans and have similar dates. Namely, 6200-5900 BCE saw the rapid spread

5 Gaskevych 2011; Kotova 2009.

6 Moskal-del Hoyo et al. 2023; Motuzaite Matuzeviciute, Telizhenko 2016; Salavert et al. 2020.

7 Larina 1994; Zvelebil, Lillie 2000.

8 Lazarovici 1993.

of FTN in the Balkan Peninsula, which occurred as a single event somewhere in this timeslot.[9] In general, 6050 BCE is a milestone. It was in the last decades before it that an explosive migration took place.[10] It has long been observed that this process unfolds immediately after the end of the '8200 calBP climatic event'.[11] Thus, the earliest FTN is a rapid initial settlement phase characterised by a uniform material culture that can be observed throughout the region.[12]

Moldavia, the first southern Eastern European region to see Neolithisation, is situated east of the Carpathians and up to the Dniester. It was settled by Criş early farmers relatively late during their expansion, namely during the third – fourth stages of the periodisation proposed by G. Lazarovici (we will refer to it here and thereafter) for the Criş culture.[13]

Most likely, the area of Moldavia was settled by moving through Muntenia from the Danube and Olt valleys from the southwest. However, direct contact with the population on the opposite side of the Carpathians is possible, too.[14] Here, the earliest radiocarbon dates (the turn of the seventh/sixth millennium BCE) come from a settlement at a salt spring in the Carpathians – Poiana-Slatinei Lunca, but these radiocarbon dates can be associated with a pre-agricultural population.[15] Instead, the rest of the sites are represented by materials from Phases 3-4 of the Criş culture.[16] The oldest materials (III-A '*spiraloid* ware') come from the lower layer of the Trestiana settlement **[fig. 21: 27]**, and the vast majority of the characteristic potsherds from this complex still indicate the Phase IIIA '*garlandoid* ware'.[17]

Further east, about ten sites of Criş culture are known between the Prut and Dniester rivers in the current-day Republic of Moldova. All of them represent the later phases of the development of this cultural phenomenon. The third phase's materials are found in the collection of the Viişoara 1 settlement, known mainly from the surface finds. The fourth phase is represented by materials from the Sacarovca 1 settlement, where a wide area was excavated **[fig. 21: 25]**. Initially, these occupations and their associated material culture were

9 Biagi et al. 2005; Biagi, Spataro 2005.

10 Krauss 2016, 212.

11 Weninger et al. 2006.

12 Biagi et al. 2005.

13 Dergachev, Dolukhanov 2007; Larina 1994.

14 Ursulescu 1984, 83.

15 Weller, Dumitroaia 2005.

16 Larina 1994.

17 Ursulescu 1984.

categorised under the label of 'Buh-Dniester Neolithic'.[18] However, it was subsequently demonstrated that their similarities with the actual Criş culture were extensive.[19] Deepened dwellings, pits, and scatters of finds (ground dwellings) represent settlement structures. Quite large wooden-frame houses are also known in the Siret-Prut region.[20] The presence of agriculture was proved by direct finds of charred remains of domestic plants.[21]

Their economy should be seen as a multi-sectoral system with agriculture and animal husbandry leading. They grew einkorn and emmer wheat, barley, and several other crops. Thus, the population of the Criş culture led a primarily sedentary lifestyle in the Carpathian-Danubian region. Their spread to the region was probably accompanied by agricultural development of the land, clearing of forests and creation of field systems.[22]

Contacts with the early farmers on the other side of the Carpathians never stopped and are evidenced by both the finds of Carpathian obsidian[23] and influences in the ceramic complex.[24] At the same time, the 'frontier' character of the settlements of the Prut-Dniester region is reflected in 1. the high role of wild fauna in archaeozoological complexes, 2. the presence of para-Neolithic ceramics at some settlements (Sacarovca 1, Selişte **[fig. 21: 26]**), 3. and possibly some borrowings in the flint inventory.[25]

The chronology of the Starčevo-Körös-Criş cultural complex has been established through the analysis of more than 400 relevant dates.[26] However, until recently, the chronology of the Criş sites of Moldova and Eastern Romania was based on a handful of conventional radiocarbon dates. Their list was notably short and included a series of dates for the site of Sacarovca 1, a pair of dates for Trestiana, and a single insufficiently published date for Selişte.

Several other dates are known that can be indirectly related to the activities of the Criş culture groups in the study region **[fig. 39]**. For example, the Sărăteni site **[fig. 21: squares 1]** in southern Moldova (see also section 1.4) yielded a large and distinctive set of

18 Markevich 1974; Yanushevich 1989.

19 Larina 1994.

20 Larina 1994.

21 Kuzminova et al. 1998.

22 Dergaciov, Larina 2015.

23 Dergaciov, Larina 2015; Turcanu 2009, 123.

24 Comşa 1987.

25 Dergaciov, Larina 2015.

26 Meadows 2019.

flint products of Mesolithic typology and several dozen sherds of pottery,[27] which, according to their texture and surface treatment, were attributed to Early Neolithic, possibly Criş, ware.[28] These finds were found at a variable depth in the cultural layer. Direct dating in the Kyiv laboratory was based on one of these sherds' total organic content. The determination was repeated twice. The first attempt yielded a date with a significant standard deviation corresponding to the time of the Criş culture in the region. The second attempt indicated a much earlier time. In our opinion, neither determination can be used without additional support from the dating of other materials from Sărăteni.

Also, in this context, the radiocarbon date on charcoal from layer 1 of the para-Neolithic site Soroca 2 is often mentioned. Indeed, sherds of Criş pottery were found in this layer, but the para-Neolithic complex is much more numerous, and the date is more likely to relate to it in the first place.[29]

In 2018, a series of radiocarbon dates were obtained from sherds of ware found at the para-Neolithic sites of the Southern Buh, which either derived directly from Criş in terms of morphology, texture and decoration or belonged to ware with certain stylistic analogies in Criş collections.[30] Two of the four dates were too early. The third one (TKA-20828: 7080 ± 30 BP) is also assessed as being too early by the study's authors. This date is obtained from a TOCC of a sherd of a Criş vessel and should be among the earliest evidence of Criş presence in Europe in general. It is earlier than the dates of Phase 3-4 of the Criş and corresponds to the beginnings of this culture, which is highly unlikely in a given geographic context. The fourth date (TKA-20831: 6625 ± 25 BP), derived from a sherd with stylistic similarities to Criş materials, is in reasonable agreement with the information on the chronology of the Criş to the east of the Carpathians but is unlikely to refine this information. In general, attempts to date ceramics based on the organic content of pottery sherds can be highly flawed due to several factors discussed in Chapter 2.

Recently, new AMS dates were obtained from animal bones from two Criş sites in the region of interest: Grumăzeşti-Deleni[31] and Sacarovca 1.[32] Together with relevant conventional dates, they enable us to estimate Criş chronology east of the Carpathians.

27 Covalenco 2017.

28 Dergaciov, Larina 2015, 340.

29 Markevich 1974; Tovkailo 2020.

30 Haskevych et al. 2019.

31 Diana et al. 2019.

32 Kiosak et al. 2023b.

Namely, the Trestiana settlement [fig. 21: 27] has two conventional radiocarbon dates: 5640-5550 and 5480-5290 calBCE (1σ, [ST 3-1]). The first corresponds well to the Phase IIIA dating in Transylvania.[33] The second is slightly later.

Several AMS dates were obtained from the site of Grumăzeşti-Deleni in Romanian Carpathians (Neamţ county, defined as Late Criş).[34] The earlier date comes from a feature F21 (a pit with Late Criş pottery), which also yielded a much later date. The dates combine poorly (χ^2 test fails: df=1 T=11.6(5% 3.8)). However, it is rather unlikely that the pit functioned for several centuries. Thus, an interval when both dates can be true (5635-5524 calBCE (94.3%)) is a likely solution for the issue of this feature's chronology [fig. 39]. The latter is close to the interval defined by the earlier Trestiana date and could reflect the actual timing of agricultural settlement to the east of the Carpathians – 57th-56th centuries BCE.

Four new AMS dates are known for Sacarovca 1 [ST 3-1]. The samples consist of four bones from *Cervus elaphus*.[35] These specimens comprise two metacarpal fragments, a substantial piece of femur, and an unidentified long bone fragment. These samples were obtained from three distinct locations within the site: pit 21 (one dated sample), pit 44 (two dated samples), and pit 46 (one dated sample). In addition to these bone specimens, these pits also yielded an abundance of lithic and ceramic artefacts and noteworthy archaeozoological and palaeobotanical collections.[36] Three newly obtained dates (Be-16910, Be-16911, Be-18271) represent a coherent cluster falling within 5617-5479 calBCE at a 2σ confidence level. In contrast, a single date (Be-16192) slightly lags in time, spanning from 5481 to 5373 calBCE, 2σ, [fig. 40]. The first three dates, when considered together, can be combined within the timeframe of 5613-5482 calBCE (2σ). These findings align with previously established radiocarbon dates for Sacarovca 1 [fig. 39]. What is intriguing is that the legacy date Bln-2425 can be effectively combined with both the three earlier AMS dates and the most recent date. However, when these four dates are treated as a group, they cannot be combined with the Berlin date, underscoring the enhanced precision offered by AMS dating. This suggests that the Sacarovca 1 complexes might have been occupied over an extended period, with pit 46 being later than objects 21 and 44.

Thus, taking into account the new results, three somewhat overlapping groups of radiocarbon dates can be distinguished for the eastern group of Criş culture: 1. slightly earlier (RoAms-729.6 and, probably

33 Biagi et al. 2005.

34 Diana et al. 2019.

35 As defined by A. David and O.P. Siekerska, for which we extend our gratitude.

36 Dergaciov, Larina 2015; Kuzminova et al. 1998.

also Ki-13899, 5730-5580 calBCE at 1σ), 2. the main group (three Bern dates, Berlin and Groningen charcoal dates and RoAms-729.5, roughly 5610-5477 calBCE at 1σ) 3. slightly later (5475-5226 calBCE at 1σ). Here, 1σ ranges are used to underline differences between groups of dates, not to suggest an actual duration of events. When plotted on the curve **[fig. 40]**, it is visible that every group listed above corresponds to a slight wiggle of the calibration curve. These wiggles result in dates having larger probability intervals due to variable inclinations of the calibration curve between 5750 and 5350 BCE. It made the dates in the middle of this range (main group) undistinguishable and, thus, prolonged intervals of calibrated dates falling closer to the start and end of this range. There is an interval when every date can be relevant: roughly 5650-5400 BCE. Likely, the spread of early farmers into modern-day Romanian Moldova and the Republic of Moldova happened in this time slot. The earlier dates can indicate some episodes of human activity predating Criş III-IV. However, there is also a period when they could be contemporaneous with the dates of the main group. The same can be said about the later dates.

The final Criş sites have limited representation within the radiocarbon dataset.[37] When we compare the new dates to the existing data, it becomes evident that Criş sites to the east of the Carpathians are not the most recent nor exceptionally early. It neatly fits within the established time frame for the late Criş culture **[fig. 41]**. Considering that the Starčevo-Körös-Criş cultural complex is unlikely to have persisted much beyond 5400 years BCE,[38] the chronology of Sacarovca 1 and other sites appears reasonable. It aligns with our general historical understanding of the development of early farming communities in the region.

Thus, having dated the Late Criş sites more precisely, we can try to take a fresh look at the problem of the chronological correlation between the first early agricultural communities and the oldest ceramics in the region of study. This problem traditionally has two solutions: 1. the first ceramics come with neolithisation and the migration of early farmers;[39] 2. the oldest ceramics come from the hunter-gatherer environment of the east.[40] The current set of radiocarbon dates indicates that, in a broad sense, both solutions can be valid – and ceramics actually arrive in the Carpathian-Dnieper region via both routes almost simultaneously – in the first half of the sixth millennium BCE. However, the increased accuracy of AMS radiocarbon dates enables us to take a closer look at the problem.

37 Biagi, Spataro 2005; Meadows 2019.

38 Meadows 2019.

39 Monah, Monah 2002; Zaliznyak 1998.

40 Zaitseva et al. 2009.

As demonstrated in chapter 2, the ceramic hunter-gatherer sites of the region are unlikely to date from the second half of the seventh millennium. Most of these dates were obtained from pottery sherds, generalising the organic content of the sherd, and this approach cannot be methodologically correct.[41] Instead, these sites (see § 2.2) are divided into three groups: the early sixth millennium BCE,[42] the middle of the sixth millennium BCE, and the post-LBK block of the late sixth and early fifth millennia BCE. The latter is not relevant to our research question, the second rather corresponds to the chronology of the Late Criş, while the sites of the former may indicate that the oldest ceramics in the region belonged to hunter-gatherers.[43]

Namely, the newly established dates for Sacarovca 1 firmly place its existence between the 57th and 55th centuries BCE. This timeframe is somewhat later than a conventional date obtained from charcoal at the Soroca-2 para-Neolithic site. Furthermore, it is definitively later than the radiocarbon dates acquired for the para-Neolithic stratigraphic unit 2 of Melnychna Krucha, situated approximately 200 kilometres to the east in the Southern Buh River valley **[fig. 41]**.

The 'direct' dating of potsherds from the 'Buh-Dniester' region has yielded inconsistent results (see § 2.2 for a detailed discussion). The only two consistent dates (from the lower layer of Gard, Ki-14790 and Ki-14789 **[fig. 41]**) encompass 5719-5232 calBCE. However, they are in reverse stratigraphic order with the dates obtained for the upper layer of the same site.[44]

Thus, it is likely that the earliest ceramics of the Carpathian-Dnieper region originated in the world of hunter-gatherers of Eurasia. Its appearance precedes the first early farmers (carriers of the Late Criş) in the study area by 100-200 years. At the same time, a significant array of para-Neolithic sites is synchronous with the early agricultural colonisation of the Prut and Dniester interfluve. The para-Neolithic groups were the hunter-gatherers with whom these early farmers could have met.

Doubts about this solution to the problem of the oldest ceramics lie in the correlation of ceramic finds with the layers of ceramic hunter-gatherer sites that have brought dates from the early sixth millennium BCE. Repeated, serial dating of their materials is urgently needed to finally resolve this problem.

41 Meadows 2020.

42 Courel et al. 2021.

43 Dolbunova et al. 2020.

44 Tovkailo 2014.

3.2 Linear Pottery Culture at Its Easternmost Fringe

Other than the Balkans, Central Europe was another source of early farmers' spread to the south of Eastern Europe. The next episode of the Neolithisation of the region is associated with the early farmers of Central Europe – the bearers of the LBK **[fig. 42]**. During their rapid migration eastwards, bypassing the Carpathians from the north, they appeared in Volhynia around 5250 BCE. Later, in the next 'music-note' phase of development, the LBK people spread to the valleys of the Dniester, Prut, and Siret rivers up to the southern spurs of the Carpathians. J. Pavuk defined a particular zone of LBK: east of the Carpathians, referring to the sites of southeastern Poland, Ukraine, Moldova, and eastern Romania.[45] A prolonged survival of the traditions of the 'music note' phase with the *Notenkopf* IV subperiod took place already at the time of the spread of Želiezovce ware in Central Europe at the sites of Lesser Poland and Red Russia.[46]

The LBK is well known in western Ukraine and Moldova. Over 200 settlements and sites with LBK materials are known in Ukraine.[47] O. Larina lists 69 sites in the Republic of Moldova.[48] Currently, more than 80 are known here.[49] Information on another 55 settlements was collected by M.-C. Valeanu in his catalogue for Romanian Moldova.[50] Thus, the number of LBK settlements in the Carpathian-Dnieper region is nearly 320 (including settlements of Middle Dniester and Bukovina).

In the region of study, the first shards of the LBK were discovered by Polish archaeologist W. Demetrykiewicz in the Verteba cave near the village of Bilche-Złote in 1879-80.[51] In the Carpathian Mountains, at the Baia monument, the first LBK materials were discovered by N. Beldiceanu in 1888.[52] However, the findings on the multilayered settlements remained unrecognised by the authors of the works and were lost in numerous collections of materials from other periods, primarily numerous Trypillian artefacts. Already in the 1930s, the map of the region was filled with the sites of the LBK finds, largely thanks to the work of O. Cynkalowski, J. Fitzke, J. Pasternak.[53] After the Second World War, classical exploration and excavation works

45 Pavuk 1969.

46 Kadrow 1990; Kulczycka-Leciejewiczowa 1970.

47 Dębiec, Saile 2015; Haskevych 2024.

48 Larina 1999.

49 Saile et al. 2016a.

50 Valeanu 2003, 91.

51 Kadrow, Trela-Kieferling 2013.

52 Valeanu 2003.

53 Pasternak 1948.

on a large scale were carried out by V.I. Marchevici, T. Passek, K. Chernysh, M. Peleshchyshchyn, V. Konoplia, O. Larina, N. Zakharia, N. Ursulescu, M. Marinescu-Bîlcu, etc.[54] More than 30 sites have been investigated by excavations in Ukraine and Moldova (Nezvysko, Torske, Floreşti, Ţira II, Dănceni I, Gura-Camencii VI, Tadani, Rivne, Blyshchanka I, Yosypivka, Bilshivtsi I, Hirka Polonka, Hnidava, Holyshiv are the most famous settlements). However, none of them has been published monographically.

The current state of affairs was summarised in the works of N. Ursulescu, O. Larina, H. Okhrimenko, M Dębiec, T. Saile and O. Lenartovych.[55] They distinguish between three main phases of the development of LBK east of the Carpathians. The early (pre-music-note) phase is represented by four sites: three settlements (Rivne, Mezhyrich, Yosypivka **[fig. 42: 13-15]**) and a burial (Baiiv). All of them are located in western Ukraine. Most sites existed during the 'music-note' (*Notenkopf*) phase of the LBK development. Only a few settlements can be identified as belonging to the following third phase. It is characterised by preserving the tradition of *Notenkopf* ornamentation, but there are also small quantities of Želiezovce-style wares (Hnidava, Yezupil, Pidhirtsi). Sometimes, the amount of late ware is so small that it raises the question of whether it is an admixture in predominantly 'music-note' collections (Blyshchanka 1).[56]

Early 'pre-music-note' LBK sites hold a variable geographic position in the Western Ukraine. Two settlements and Baiiv[57] are situated nearby on the well-defined loess plateau of the Volhynian upland surrounded by lowlands of sander origin (Male and Volynske Polissia). In contrast, Yosypivka is situated somewhat to the south, on the edge of Male Polissia lowland.[58] The settlements of Rivne[59] and Yosypivka[60] were extensively excavated, while Mezhyrich was studied on a smaller scale.[61] The supposed burial from Baiiv is, in fact, a stray find of a single vessel and a shoe-last adze (*Schuleistenkeil*).[62]

While it is evident that these sites represent the LBK pre-dating the widely spread *Notenkopf* phase, there is still much space to range

54 Lenartowicz 2009.

55 Dębiec, Saile 2015; Larina 1999; Lenartowicz 2013; Okhrimenko 2009; Saile 2020; Saile et al. 2016a; Ursulescu 1990.

56 Konoplia 2008.

57 Dębiec, Saile 2015.

58 Lenartowicz 2011.

59 Okhrimenko 2009.

60 Mylian et al. 2009.

61 Dębiec, Saile 2015.

62 Pasternak 1948.

them regarding their relative chronology. In this sense, their exact position was estimated in several ways. The Baiiv vessel finds parallels in materials of the final Zofipole phase in Poland, while the earliest complex from Rivne could be earlier: Zofipole or Gniechowice. The Yosypivka collection was labelled 'pre-music-note' without specification. In contrast, the Mezhyrich collection was separated on typological grounds from the later *Notenkopf* materials found on the same site, and thus, its typological attribution to the early Gniechowice can be misleading.[63]

The archaeological features of these settlements include pits and scatters of finds interpreted as underground and ground dwellings, respectively.[64] This interpretation does not fit in the archaeological record of the western, better-studied LBK areas of Central Europe. Here, 'long houses' are known from the Formative phase and continue to exist throughout the subsequent phases of development.[65] The pits are identified as household waste disposal sites rather than living spaces, and the concentrations of the finds do not correspond to actual dwellings. The same can be valid for the early LBK of Western Ukraine; however, direct 'in-field' proof of this is still lacking. The pottery assemblage of these easternmost settlements is typical for the pre-music note LBK in general.[66] It consists of hemispherical bowls, small bottles and jars. Jars are typically decorated with lugs, while bowls carry incised decoration, sometimes in a very typical motive (for example, spiral ornament). Small bottles often had small pierced grips.[67]

The material culture of the following 'music note' phase is known much better. Settlement structures usually include 'dugouts' and 'semi-dugouts', pits of various shapes, and some traces of above-ground dwellings (marked by rows of post holes). The absence of typical 'long' houses in the eastern part of the LBK range was postulated for a long time. Their absence was even interpreted as a characteristic feature of the 'peripheral group' of LBK sites in Ukraine and Moldova.[68] Instead of 'long houses', archaeologists described various types of dugout dwellings. Today, several surface dwellings are known from the territories of Ukraine and Moldova.[69] Several structures initially interpreted as semi-dugout dwellings have been

63 Dębiec, Saile 2015.

64 Okhrimenko 2009.

65 Stadler 2005.

66 Pavuk 2005.

67 Okhrimenko 2009.

68 Telegin 1985b.

69 Larina 1999; Lenartowicz 2013; Passek, Chernysh 1963.

re-interpreted instead as components of a typical residential complex with a long house in the centre.[70] First, we are talking about 'long pits', usually located along the walls of long houses. They were undoubtedly present among the numerous sites studied from 1943 to the present but were often described as half-dugout dwellings. Accordingly, only a few above-ground structures were recorded.

An interesting example of this situation is the well-known settlement of Kotovane-Zapust. J. Pasternak excavated it in 1942.[71] The excavations revealed two LBK pits filled with shards, animal bones, and split flints. When publishing the materials of these excavations in 1954, I. Sveshnikov interpreted these depressions as semi-dugouts (subterrain dwellings).[72] The first pit was 9.8 m long and 0.7-2.8 m wide, with a 0.4-1.2 m depth. The bottom was irregular, with numerous depressions, up to 62 cm. The edges had wavy contours. The other pit was located 7.5 m southeast of pit 1, which corresponds well to the distance between pits on the sides of a typical long house. Both pits were orientated from southeast to northwest, a typical orientation for long pits in Central Europe.

In support of his point of view, I. Sveshnikov referred to the recent and well-known work of W. Buttler at the Köln-Lindenthal settlement.[73] The latter carried out the first excavations of a large LBK settlement area and interpreted some pits found as dugout dwellings (*Grubenwohnung*). His approach was criticised, and the modern understanding of ground dwellings as the main type of LBK dwelling was proposed.[74] The modern view finally prevailed only in the 1950s thanks to the work of B. Soudský.[75]

In the USSR, however, other views prevailed. For example, S. Bibikov fervently defended the concept of an early agricultural dugout dwelling based on the materials of the Trypillian settlement of Luka-Vrublevetska.[76] Thus, I. Sveshnikov chose one of the available views of his time. Interestingly, on the other side of the Iron Curtain, in exile in Germany, the author of the excavations, J. Pasternak, came to similar views. According to him, various types of dugouts were characteristic of the LBK people, and rectangular ground houses were also known, but "these were grain keeping facilities […],

70 Lenartowicz 2013; Saile et al. 2016a.

71 Pasternak 1948.

72 Sveshnikov 1954.

73 Buttler 1938.

74 Paret 1942.

75 Soudský 1966.

76 Danilenko et al. 1957.

not residential houses".[77] It was I. Sveshnikov's interpretation that gained a foothold in the Soviet literature. The semi-dugouts from Kotovane are mentioned in several important generalisations.[78] Only recently, O. Lenartovych proposed to interpret the depressions from Kotovane as long pits that stood on both sides of a long house.[79]

Several similar cases are known in the archaeology of Moldova. Here, long houses hypothetically existed between the 'long pits' of Floreşti 1 **[fig. 42: 17]**. Most likely, the remains of a long house (rows of postholes) were recorded at the Durleşti settlement, but they were interpreted as the remains of an outbuilding next to the actual dwelling – a semi-dugout.[80]

Recent discoveries changed this situation. A small long house (*Kleinbau*) marked by rows of postholes was excavated in Moldova at the site **[fig. 42: 16]** of Nicolaevca 5.[81] A typical layout of a long house was revealed by rescue excavation at the site of Modrychi 1 in Western Ukraine.[82] These discoveries have finally proved that there were no differences in the long house distribution between the west and east areas of LBK, but rather cultural differences in local archaeologies on both sides of the Soviet Union border.

The excavations at the sites of the easternmost *Notenkopf* LBK unearthed a set of artefacts typical of the LBK. These findings included pottery adorned in distinctive styles (mostly *Notenkopf*), ceramic weights, grinding stones, blade sections with their characteristic gloss known as 'sickle inserts', and remains of domestic animal bones.[83] *Schuleistenkeil* were found alongside other 'flat' polished adzes. It is a set of material culture items typical for LBK residential sites.[84]

The lithic industry associated with these artefacts often utilised Volhynian or other high-quality flint and displayed limited resemblance to the assemblages found in the local para-Neolithic cultures[85] (but contra).[86] Notably, scalene trapezes may signify external influences. However, intriguingly, closer parallels were identified in the

77 Pasternak 1948, 7.

78 Passek, Chernysh 1963.

79 Lenartowicz 2013.

80 Saile et al. 2016a.

81 Kiosak et al. 2021a; Saile 2020.

82 Telizhenko, Silaiev 2022.

83 Bardetskiy 2012; Kiosak 2017b; Larina 1999; Passek, Chernysh 1963.

84 Birkenhagen 2003; Lüning 1982; Pyzel 2009; Stadler 2005.

85 Kiosak 2019b.

86 Man'ko, Telizhenko 2016.

early farming settlements of Moldova and Romania rather than within the contemporaneous sites of para-Neolithic.[87]

It becomes apparent that the LBK phenomenon in the study region emerged as a migratory phenomenon with little connection to the local Mesolithic or para-Neolithic background. There is no discernible 'contact zone' where LBK characteristics blend with local traits.[88]

To illustrate this point, let's take a closer look at a typical example of the easternmost LBK residential site. Recently, with the author's participation, a group of LBK sites on the Southern Buh was discovered and investigated. This includes the easternmost LBK settlement investigated by excavations – Kamyane-Zavallia – and three smaller sites.[89]

Kamyane-Zavallia **[fig. 42: 6-7]** is so far the only settlement of the easternmost LBK group that has been investigated by excavations. The trench 1 was excavated in 2014-16 and uncovered Object 1 **[fig. 43]**, which is most likely a typical 'long pit'. Thousands of such sites have been investigated in Central Europe. In most cases, they bound the 'long houses' from the sides, and sometimes they stand alone. In this case, they are conventionally called clay pits (*Lehmahnamegrube*).[90]

Such pits are known at almost every LBK settlement in Romania, Moldova and Ukraine that has been excavated. As it was discussed above, they have traditionally been interpreted as semi-dugouts, contrasting their interpretation in Central European archaeology. Object 1 has a typical shape and orientation. Its irregular edges and bottom, as well as its rubbish fill, rule out residential use. A sub-parallel orientated narrow and deep trench (pit 3) was observed next to it, which may correspond to the foundation trenches of the LBK buildings. Pits 1 and 3 form part of a typical LBK house plan – a 'long pit' and foundation trench facing the same direction.[91] In 2019, a larger area (some 480 sq m) was opened in a new location at the Kamyane-Zavallia site. The excavations yielded remains of six LBK pits of various shapes, including a 'long pit'.[92]

There are more than 3,000 potsherds, predominantly discovered in pit 1. The fine wares constitute around two-thirds of the uncovered potsherds and more than half of the represented vessels when counted by the preserved rims. These vessels are primarily globular or hemispherical bowls with closed shapes, measuring 8 to 22

87 Kiosak 2016a.

88 Kiosak 2017.

89 Kiosak 2013; Kiosak 2017b.

90 Birkenhagen 2003.

91 Kiosak 2017.

92 Kiosak et al. 2023a; Moskal-del Hoyo et al. 2023.

centimetres in diameter as measured by their rims. These bowls feature light yellow, grey, or dark grey, well-polished outer surfaces and smooth interiors. Within pit 1 and pit 3, there are five vessels with complete or nearly complete profiles **[fig. 44]**.

Open bowls are less abundant, with only one almost complete specimen found. This bowl was adorned with four knobs and boasted a well-smoothed surface. There are also remnants of necked vessels, potentially resembling 'amphorae', consisting of fragments with relatively narrow necks, measuring 5-6 centimetres in width. Some of the vessels were placed on low hollow pedestals. Some distinctive ceramic finds, such as a ceramic weight, perforated items, and a rhyton-like vessel, were also discovered.

The pottery assemblage from Kamyane-Zavallia is characteristic of the LBK in Ukraine and Moldova. The fine-ware decorations align with the *Notenkopf* II/III style, corresponding to the middle stage of the music-note phase in Ukraine and Moldova. The variability of kitchen wares has analogies in nearby Ukrainian sites[93] and sites in Moldova.[94] Further research is required to determine whether there are any indications of interaction with the indigenous pottery-bearing population.

The chipped stone assemblage comprises more than 690 items. It is primarily made from two types of silicites. Approximately 90% of the artifacts are crafted from dark-grey, transparent, fine-grained plastic flint that becomes transparent when thin. This raw material is not known to exist in the vicinity of the site. However, similar flint (as defined by micropetrographic analysis by H. Wehren) is found in the Middle Dniester Valley (about 180 kilometres to the northwest) and in Volyhnia (over 250 kilometres to the NNW). Some flakes were also knapped from low-quality pebble chert, possibly sourced locally.

Most cores are prismatic or subprismatic **[fig. 45]**. Blades and bladelets outnumber microblades. These items often have thick and sizeable butts, sometimes without overhang removal or preparation. The angle of percussion typically ranges from 85 to 95 degrees. Their sides and edges are usually regular and parallel, albeit slightly wavy, consistent with the punch technique rather than pressure blades detachment or soft organic percussion.

The most prevalent tools are end-scrapers, displaying considerable formal diversity. The categories of tools include semi-circular and circular end-scrapers, microscrapers, retouched blades/bladelets and their fragments **[fig. 45]**, and less common types like side-scrapers, points, and perforators, as well as simple burins. Some blade segments exhibit a distinct oblique 'sickle gloss'.

93 Okhrimenko 2009.

94 Larina 1999.

Five trapezes were found in Kamyane-Zavallia, with two originating from pit 1 and thus directly linked to LBK assemblages. These scalene trapezes **[fig. 45]** are made from high-quality raw material and differ in production technique from the scalene trapezes of the para-Neolithic assemblages. They feature a retouched notch on one edge and an oblique truncation on the other, similar to asymmetrical microliths found at Romanian LBK sites[95] and particularly at the Criş site of Sacarovca 1 in Moldova.[96]

Kamyane-Zavallia also yielded potsherds resembling Middle Neolithic ceramics from the Danube basin, primarily Dudeşti wares. They indicate that the LBK groups actively interacted with early farmers of the Balkans, even over long distances (over 300 km from Kamyane Zavallia to the Danubian sites of Dudeşti). Perhaps the general similarity of lifestyle and material culture facilitated these contacts.[97]

The chronology of the LBK east of the Carpathians is still poorly understood and is based on 'imports' and typological seriation rather than radiocarbon dates and stratigraphic observations. O. Larina dated the Prut-Dniester group of sites to the late sixth – early fifth millennium BCE. Its whole duration did not exceed 300 years.[98] Based on a series of radiocarbon dates, N. Kotova believed that the first period of the LBK of western Ukraine took place around 5500-5450 BCE, the second lasted 5450-5050, and the third – 5050-4650 BCE.[99]

In total, 33 radiocarbon dates **[fig. 43]** have been published for the Ukrainian LBK, 6 – for Moldova and 2 for Romania **[ST 3-2]**.[100] Since the technique of dating the organic content of ceramic sherds is dubious at best,[101] some of the determinations for this material can be questioned (a series of dates from Holyshiv and one from Hnidava). Some other Kyiv dates (obtained in 1998-2008) belong to the 'suspicious' series (as defined above in chapter 1) and should be treated only when cross-laboratory validation is available.[102]

Only a single site from the first period of LBK in the region was dated by the radiocarbon method. Four dates were obtained from animal bones from the settlement of Rivne. From a typological point of view, it belongs to the pre-music-note phase. Some dates are too early.

95 Păunescu 1970.

96 Dergaciov, Larina 2015.

97 Kiosak 2017.

98 Larina 1999.

99 Kotova 2003.

100 Kiosak 2017b; Kovaliukh et al. 2007; Mantu 2000; Moskal-del Hoyo et al. 2023; Motuzaite Matuzeviciute, Telizhenko 2016.

101 Kovaliukh et al. 2007.

102 Kiosak et al. 2023c.

N. Kotova has shown that the earliest date (Ki-12506, 6570 ± 60 BP) came from a pit, where only antler pieces were found. Thus, although this pit was located on the settlement's territory, it did not contain any finds directly related to the LBK and could belong to some earlier episode of habitation on the site. Two more dates were obtained in different laboratories on two ends of the same animal bone. Namely, Ki-12508, 6475 ± 80 BP and VERA-4244, 6230 ± 31 BP. The dates are inconsistent and indicate some methodological problems with dating in cross-laboratory comparison.[103] N. Kotova is inclined to date the site of Rivne immediately before 5250 BCE. Two dates from Kyiv and Vienna, namely Ki-13856, 6310 ± 70 BP and VERA-4244, 6230 ± 31 BP, confirm this thesis.[104]

The legacy conventional dates **[fig. 47]** are of little help in refining the chronology of the music-note phase sites from the study region. At best, they encompass the period of the *Notenkopf* phase, which is well–known by numerous dates from Central Europe.[105] At the same time, wide standard deviations for most dates make studying the chronological order of individual settlements difficult. For example, the two conventional determinations of the Berlin Laboratory based on charcoal samples from the Tîrpeşti settlement[106] cover the interval 5465-4840 calBCE, 2σ. Alternatively, two dates of the Kyiv Laboratory for animal bones from the Mainova Balka settlement[107] cover 5630-4910 calBCE, 2σ.

AMS dating generally has narrower standard deviations, but this does not help to solve the problem of relative chronology within the duration of *Notenkopf* LBK.

Namely, a series of determinations have been published for the Ratniv II settlement, which belongs to the 'music-note' phase of the LBK.[108] They (UBA-30429, 6366 ± 41 BP and UBA-27678, 6299 ± 33 BP) are direct dates on charred remains of cultivated plants. When calibrated, they encompass 5410-5214 calBCE, 2σ **[fig. 48]**. The music-note phase should begin in the 53rd century BCE,[109] possibly at the very end of this century.[110] Accordingly, the dating of Ratniv II seems somewhat too early. The younger date probably better reflects the site's absolute chronology (UBA-27678). It corresponds well to

103 Kiosak et al. 2023c.

104 Stadler, Kotova 2013; Stadler, Kotova 2021.

105 Lenneis, Stadler 1995; Stadler, Kotova 2021.

106 Marinescu-Bîlcu 1971.

107 Sapozhnikov, Sapozhnikova 2011.

108 Motuzaite Matuzeviciute, Telizhenko 2016.

109 Oross, Banffy 2009.

110 Stadler, Kotova 2021.

the dating of the other *Notenkopf* sites. Namely, it corresponds well to the conventional dating of Bilshivtsi.[111] In 2013, two dates were obtained for an animal bone and charcoal from the Object 1 of the Kamyane-Zavallia settlement.[112] In 2023, they were complemented with eight more dates on charred plant remains from this site.[113] They correspond to 5295-4960 calBCE **[fig. 48]** and are in good agreement with the Central European music-note phase chronology of the LBK.

In 2018, two more determinations by accelerated mass spectrometry were provided by the Bern Laboratory on two animal bone samples from the pit of the Hnyla Skela settlement, located only 3 km south of Kamyane-Zavallia. They are mostly synchronous with the dating from Kamyane-Zavallia **[fig. 48]**.[114] The classic site of Moldavian LBK, Floreşti 1, was perceived as a late site in the framework of the local music-note phase.[115] However, its only AMS date (BE-16907, 6227 ± 27 BP, on animal bone from pit 18) does not reflect this position. It calibrates to 5305-5050 calBCE, 2σ. The site of Nicolaevca 5 received five AMS dates on charred remains of plants. Four of them are consistent, encompassing 5305-4645 calBCE, 2σ. A single date (Poz-137958, 5890 ± 70 BP) is notably younger and could be related to the Early Trypillian episode of habitation, which is well-attested at the site.[116]

In addition, the shape of the radiocarbon calibration curve between 5300 and 5000 BCE is not conducive to the development of accurate chronologies. It consists of two horizontal sections (plateaus) separated by a distinct peak in this interval. The plateau on the calibration curve corresponds to the time when the concentration of radioactive carbon in the atmosphere of that time changed in such a way as to compensate for the loss of carbon in the samples due to its radioactive decay. Consequently, samples of different ages within the plateau will have similar amounts of ^{14}C when analysed, and dating will be difficult. It is easy to see that even with the small standard deviations typical of modern dates obtained by accelerated mass spectrometry, they cover virtually the entire plateau interval when calibrated within the plateau.

Therefore, it is currently impossible to speak about the chronological position of any of the settlements within the time of the 'music-note' phase of the LBK on the basis of radiocarbon dates alone.

111 Kovaliukh et al. 2007.

112 Kiosak, Salavert 2018.

113 Moskal-del Hoyo et al. 2023.

114 Kiosak et al. 2021b.

115 Larina 1999.

116 Moskal-del Hoyo et al. 2023.

The latest phase of LBK in the region is still poorly studied.[117] Only one site allegedly attributed to this phase was dated by the radiocarbon method. The Rovantsi – Hnidavska Hirka (Hnidava, Gnidava) site is located on the elevated floodplain terrace of the Styr River, nestled within a densely populated region of the LBK area. It is positioned amidst the confluence of two rivers, Chornohyzka and Serna, which flow into the Styr River, spanning both banks of the Styr.[118] Over time, this site has undergone multiple excavations, albeit with some gaps in field documentation. The most recent archaeological investigations were conducted by the Lutsk rescue archaeological expedition under the direction of O.E. Zlatohorskyi, with A.Bardetskyi serving as the head of the excavation team. An expansive area of 1350 m^2 was uncovered by them.[119]

Within the excavation trenches, notably trenches 10 and 12, an array of LBK features emerged, including the discovery of four distinctive long pits. An analysis of the pottery's typology suggests that the site corresponds to the later stages of the LBK in Ukraine, concurrent with the Želiezovce phase in Central Europe. It yielded several potsherds ornamented in Želiezovce style and some ceramic similar to the Šárka pottery. The vast majority of ceramic finds are still decorated in the *Notenkopf* way. However, a rare presence of later styles from the West is used as a temporal indicator of the complex's late relative chronological position. Moreover, the excavation unearthed a wealth of obsidian artefacts, potsherds from the Alföld and Bükk cultures, as well as Spondylus shells and even a partially preserved human skull.[120]

The site of Rovantsi was dated three times. 1. 'Direct' conventional date from a pottery sherd obtained in the Kyiv laboratory (5825 ± 90 (Ki-12504)).[121] Its calibration (4902-4456 calBCE) falls on a period later than the time of the LBK.[122] 2. Two AMS dates on human bones, namely on fragmented human skull, found in pit 19.[123] When combined (by R-Combine function of OxCal), they encompass 5307-5213 calBCE. This date is earlier than one can expect for the site of the latest stage of LBK in the region of interest.[124] There was an

117 Konoplia 2008.

118 Bardetskiy 2012.

119 Zlatohorskyi, Bardetskyi 2010.

120 Bardec'kyi et al. 2016; Bardec'kyi et al. 2018; Bardetskiy et al. 2017; Saile et al. 2018.

121 Kovaliukh et al. 2007.

122 Lenneis, Stadler 1995.

123 Saile 2020.

124 Dębiec 2015; Okhrimenko 2009.

explanation proposed for this incongruence, namely a prolonged use of the body of deceased.[125] However, we cannot exclude a reservoir effect too. 3. Two AMS dates on animal bones from pit 21. They encompass 5209-5007 calBC (2σ, when combined).[126] This time frame aligns with the previously discussed dates for the sites of *Notenkopf* phase, making impossible singling out the separate time slot for the latest phase of LBK in the region.

Thus, the carriers of the LBK culture inhabited the study area for at least 200-250 years at the turn of the sixth and fifth millennia BCE. They reached the region prior to the *Notenkopf* phase somewhere before 5250 BCE. However, their settlement area was limited, comprising mostly the loess plateau standing above the vast marshy lowlands of Northern Ukraine and Eastern Poland. Later on, during the *Notenkopf* phase, LBK groups expanded to the Dnieper and Southern Buh rivers. This expansion took place during 5250-5050 calBCE. The above-mentioned radiocarbon curve's plateau obscures the exact dating. The latest phase of LBK is expected to post-date this *Notenkopf* expansion. However, from a statistical point of view, the available dates for this later phase are indistinguishable from the dates for the *Notenkopf*. Thus, there is no evidence to support the long persistence of LBK groups in the region of study: there was likely no LBK in the fifth millennium BCE here, contrary to the consensus belief.[127]

3.3 Chronology of the First Domesticates

Today, the oldest known directly dated remains of cultivated plants in southern Eastern Europe come from the settlement of Ratniv II.[128] However, as the previous discussion in this chapter has shown, there are good reasons to believe that they will not remain so for long. The settlements of Criş and pre-music-note LBK date back earlier, and their inhabitants also practised agriculture. Moreover, some palaeobotanical data allow us to confirm and clarify this statement.

There are two types of such data: imprints of domestic plant remains (usually grains and spikelets) in potsherds and pieces of daub, as well as direct finds of charred remains. Both can be questioned. Recent studies of plaster casts based on pottery impressions have shown that many impressions, reported previously as those of

125 Bardetskiy et al. 2017.

126 Kiosak et al. 2023c.

127 Kotova 2003; Kovaliukh et al. 2007.

128 Motuzaite Matuzeviciute, Telizhenko 2016.

cultivated plants, are not identifiable.[129] Thus, subjective factors have previously played a significant role in these studies. Direct finds of plant remains can be moved down the stratigraphy by the soil process, as has been repeatedly demonstrated by direct dating of such remains, which yielded dates much later than expected.[130] Accordingly, we consider the descriptions of domestic plant imprints in the following discussion only when they are present in a distinct series repeated in different materials. And vice versa, finds of charred plant remains without direct dating will be taken into account only when they are present in a series, along with imprints on ceramics.

Botanical finds were relatively limited in the Criş sites between the Prut River and the Carpathians.[131] Several imprints of cultivated plant grains were reported on potsherds from Glavăneştii Vechi and some other sites.[132]

Further to the east, numerous imprints of domestic cereals were detected on the potsherds from Sacarovca 1 and Selişte.[133] If, in individual cases of imprint detection, we can doubt the subjectivity of the methodology of their identification at the time (1960-80-ies), the series of imprints from Sacarovca 1 and Selişte are so representative that they must at least partially reflect reality. The following set of plants was found here: *Triticum monococcum*, *T. dicoccum*, *T. spelta*, *T. aestivum/compactum*, *Hordeum vulgare*, *Avena sp.*, *Pisum sp.* etc. The discovered imprints of millet[134] could be due to misidentification with *Setaria viridis/glance*.[135]

Moreover, these observations are confirmed by the direct discovery of archaeobotanical remains. Several domestic and wild plant charred remains came from the settlement Sacarovca 1. They were found by flotation in the fill of feature 21. This list included two emmer grains, two grape seeds, plum stones of three different species, shells of several hazelnuts, oak acorns, etc.[136]

Feature 21 is an 8-shaped pit of two deep parts (3.6 × 3.6 m and 2.1 × 1.3 m) separated by a 'step' rising some 70 cm above the deeper parts. The bottom was uneven, with many bumps and small, deeper pits. The excavators interpreted object 21 as a dwelling. However, similar objects are often interpreted as waste-disposal facilities.

129 Endo et al. 2017; 2019; 2022.

130 Martin et al. 2021; Motuzaite Matuzeviciute 2020.

131 Monah, Monah 2002.

132 Comşa 1991.

133 Yanushevich 1989.

134 Kuzminova et al. 1998.

135 Motuzaite Matuzeviciute 2020.

136 Kuzminova et al. 1998.

Feature 21 contained a fireplace surrounded by many palaeobotanic remains visible to the naked eye. Object 21 yielded 1839 lithic artefacts, 2554 potsherds, 23 stone tools, 51 tools made of bone and antler, 7472 animal bones and some other finds.[137]

Feature 21 was dated by a single radiocarbon date on the red deer bone (as reported above **[fig. 39]**). It is calibrated to the timeslot 5616-5479 calBCE (2σ), making the palaeobotanic finds from pit 21 the earliest dated finds of this type in the south of Eastern Europe. However, direct dating of these remains is a necessity to exclude the possibility of their penetration from upper sediments.

The earliest LBK site in Ukraine, Rivne (see the discussion of its chronology in § 3.2), yielded 4 impressions of grains and spikelets of *Triticum dicoccon*, 1 impression of *Triticum aestivum*, 11 impressions of *Hordeum vulgare* and 3 of *Pisum sativum*.[138] However, precisely, this series of determinations is subject to doubt. It includes two millet impressions, likely to be a misidentification.[139] The same series included ten imprints from the site of Holyshiv, which were not confirmed by re-analysis.[140] Thus, the materials from Rivne have a significant potential for dating the first reliably established domesticated plants in Ukraine. However, the available information is insufficient to state that the remains of domestics exist at this site.

The LBK sites of the *Notenkopf* phase yielded numerous finds of charred remains of domestic plants. At the Ratniv site, researchers conducted archaeological and botanical investigations, along with direct radiocarbon dating, which revealed the earliest known dates for cereal grains in the south of Eastern Europe. These dates were established at 5471-5230 calBCE and 5341-5215 calBCE with a 95.4% confidence level (UBA-30429 6366 ± 41 BP, UBA-27678 6299 ± 33 BP).[141]

The cultivated crops included hulled wheat grains and chaff, comprising einkorn (*Triticum monococcum*) and emmer wheat (*T. dicoccon*), as well as possibly a 'new glume type wheat' (*T. timopheevii*).[142] Among other identified cultivated plants were flax seeds (*Linum usitatissimum/catharticum*), hulled barley (*Hordeum vulgare*), lentils (*Lens culinaris*), and peas (*Pisum sativum*).

The palaeobotanic samples were sourced from several pits in Kamyane-Zavallia.[143] Within the sediment, macroremains were

137 Dergaciov, Larina 2015.

138 Kotova, Pashkevich 2003.

139 Dal Corso et al. 2022.

140 Endo et al. 2022.

141 Motuzaite Matuzeviciute, Telizhenko 2016, 105.

142 Motuzaite Matuzeviciute, Telizhenko 2016, 108.

143 Kiosak, Salavert 2018; Salavert et al. 2020.

scattered and intermingled with LBK domestic artefacts, likely due to garbage disposal. The macroremains stem from unrelated activities and lack clear functional or temporal connections.

The recovered remains contained multiple instances of cultivated plants, namely more than 50% of the sample were represented by cereals *Triticum cf. monococcum* (einkorn), *Triticum turgidum* cf. *subsp. dicoccum* (emmer), *cf. Hordeum sp.*, *Hordeum sp./Triticum sp.* (barley/wheat). Moreover the weeds and wild taxa include *Fallopia convolvulus* (wild buckwheat), seeds of *Chenopodium album* type (fat-hen), and *Caryophyllaceae* type. Additionally, the notable presence of elongated dendritic phytoliths within the pit infill strongly indicates cereal processing. Dehusking or winnowing appears more plausible among the possible cereal processing activities, given the scarce presence of remnants from threshing processes, such as silica skeletons. Also, one rachis internode of *Hordeum vulgare* (barley) was found. In general, cereal remains were distributed unevenly among the features as they were relatively numerous only in features 2003, 2008 and 2009.[144]

Among the macroremains of weeds identified at Kamyane-Zavallia, both *Chenopodium album* type and *Fallopia convolvulus* have the potential to thrive in cereal fields and along field edges. *Chenopodium album* is frequently found in both summer and winter-sown fields in temperate regions and can also serve as a source of human consumption.[145]

The palaeobotanical assemblage from pits 2003, 2006, 2008 and 2009 of Kamyane-Zavallia received eight direct radiocarbon dates,[146] and two more dates came from Object 1.[147] The dates are consistent and could be combined into a timeslot 5291-5063 calBCE (2σ) [ST 3-2].

The LBK settlement in Nicolaevca 5, Moldova, is situated within the Răut catchment. It occupies gentle slopes on either side of a minor depression located west of a small, unnamed stream that converges with the Ciulucul de Mijloc River within the broader Ciulucul Mare river catchment. The site, Nicolaevca 5, was discovered and surveyed by V. Bicbaev between 1973 and 1976. In 2014-16 its area was subjected to geomagnetic survey. Its results were controlled by test-trenches. The site was excavated in 2019 by an international expedition led by Stanislav Ţerna and Maciej Dębiec.[148] There was a typical outline of a small LBK house.[149] The site belongs to the *Notenkopf* phase of the LBK. Regarding Nicolaevca, chaff remnants and

144 Moskal-del Hoyo et al. 2023.

145 Kotova, Pashkevich 2002.

146 Moskal-del Hoyo et al. 2023.

147 Kiosak 2017.

148 Saile et al. 2016a.

149 Saile 2020.

einkorn caryopses were predominantly associated with a specific feature known as feature 3028. A single glume base resembling the New Glume Wheat (NGW) type was also discovered. It has been recently verified that this particular glume base corresponds to *Triticum timopheevii*. In Nicolaevca, fragments of sizable seeds belonging to the *Fabaceae* family were discovered. It is worth noting that the presence of wild plant remnants was infrequent in Nicolaevca 5 as well as in Kamyane-Zavallia.[150]

Four direct radiocarbon dates were obtained for plant remains from features of the Nicolaevca 5 site. They are calibrated to the timeslot 5283-5052 calBCE after combination and are roughly contemporaneous with the dates of the Kamyane-Zavallia dataset **[fig. 48]**.

Charred cereal remains were also discovered in western Ukraine, specifically in the Nezvisko burial, which is associated with the *Notenkopf* phase of the LBK culture. The charred grains were located within two pottery vessels in a human burial context. Alongside these vessels containing cereal grains, a grinding stone, stone mattocks, 16 additional ceramic vessels, flint tools, and bone tools were also interred in the burial.[151]

LBK settlement Dănceni 1, which is situated in south Moldova, yielded a significant series of impressions on potsherd left by remains of einkorn, emmer and spelt as well as dwarf bread wheat, peas and bitter vetch. Dănceni 1 is a *Notenkopf* settlement attributed by O. Larina to the early phase of LBK in Moldova; however, it is still in the expected timeframe of the *Notenkopf* phase. Several other Moldavian LBK sites yielded smaller series of impressions and, thus, are subject to reasonable doubt.[152]

The re-analysis of LBK pottery assemblages from the sites of Rovantsi-Hnidavska Hirka (Hnidava) and Holyshiv 2 has shown that imprints of cultivated plants are not as numerous as suggested beforehand. Only two impressions of *T. cf. dicoccon* were detected in the former site (Endo et al. 2019). Rovantsi received five radiocarbon dates so far (see discussion in § 3.2). The most relevant pair of dates on animal bones make it synchronous with the Kamyane-Zavallia and Nicolaevca 5 sites, thus failing to diversify earlier and later sites as expected from typological considerations.

Ratniv 2 is placed slightly earlier by radiocarbon dating in relation to the other three dated sites (Kamyane-Zavallia, Nicolaevca 5, Rovantsi). However, this dating does not quite correspond to its relative chronology from the point of view of its typological position. The comprehensive analysis of the ceramic assemblage indicated that the site

150 Moskal-del Hoyo et al. 2023.

151 Passek, Chernysh 1963.

152 Larina 1999; Yanushevich 1989.

belongs to the middle stage of the *Notenkopf* phase.[153] Considering the available data on the origin and chronology of the *Notenkopf* in Central Europe and Poland, it is doubtful that it started before 5250 BCE. Thus, the latest part of the uncertainty ranges for the Ratniv 2 dates could be true, and Ratniv 2, then, could be earlier than other sites of *Notenkopf* discussed here, but not to the extent suggested by its dates. There is no *Notenkopf* in the 54th century BCE. The set of dates for other sites fell into the badly famous radiocarbon plateau of the late sixth mill. BCE, which makes them virtually indistinguishable and mainly covering 5250-5050 BCE.

The cultivated plants observed at the above-listed sites align with a typical crop selection for the European Neolithic, a set of plants of west-Asian origin. Here, it is characterised by a limited variety of crops and a predominance of hulled wheat.[154] While the role of barley in this context, whether as a crop or a weed, remains uncertain, the discovery of a rachis internode at Kamyane-Zavallia substantiates its presence within the eastern LBK agricultural system.[155] The Criş culture groups brought a set of cultivated plants of west-Asian origin to the forest-steppe of Moldova at least by 5600-5500 BCE, while LBK people spread it widely in the territories of modern-day Moldova and Ukraine by 5250-5050 BCE **[fig. 50]**.

The palaeobotanic record of the cultivated plants in the sites of Criş and LBK is abundant and diversified. When comparing it with the available claims of similar finds from the para-Neolithic contexts, the latter, in comparison with the former, looks like a pale copy. The impressions are few; the set of species varies from site to site. Recent improvements in this type of analysis methodology doubted the precision of impression identification. Attempts to detect the remains of cultivated plants at para-Neolithic sites by flotation have mostly failed. Only wild plants were found, or the cultivated plants found were intrusive from later periods of the sites' stratigraphy. Although it is often assumed that even without their agriculture, para-Neolithic groups could have obtained agricultural products through contact with early farmers, we must emphasise that there is no evidence for this today.

153 Telizhenko, Man'ko 2021.

154 Bogaard et al. 2011.

155 Salavert et al. 2020.

3.4 Eneolithisation or Late Neolithic Crisis?

The Eneolithic period is relevant only in some areas of Europe.[156] In the rest of Europe, it corresponds to the Late Neolithic. The reasons for singling out the Eneolithic period are related to the concept of the crucial importance of metallurgy for the social development of early agricultural communities.[157] However, there are good reasons to doubt the latter thesis. It has been proved that copper tools had only a slight technical advantage over stone tools.[158] Among the copper products of the Early Eneolithic, the majority are decorations, not tools. Moreover, even the latter have more prestigious value rather than could lead to a real economic effect. The first metallurgists of the Vinča culture (still late Neolithic) do not seem to have had a special status but instead operated within an egalitarian society based on blood kinship.[159]

Finally, in Western Europe, a network of exchange of socially prestigious products, jadeite axes, which probably had a social function similar to metal tools and ornaments in Southeastern Europe, was discovered and studied. They served as symbols of prestige and social status, were extracted by specialised communities in two or three outcrops, and were distributed through prestigious exchanges over hundreds of kilometres.[160]

The homologous similarity of both networks of exchange of high-status objects (both Western European and Balkan-Carpathian) is underlined by 1. the presence of extremely rich burial centres on the Black Sea (Varna) and Atlantic Ocean (Carnac) and 2. the partial overlap of these networks. Jadeite artefacts from the Alps are known in the burials of Varna and have also been recorded in the study region. The most distant point of their distribution to the northeast is the recently discovered Topoli settlement on the Southern Buh.[161]

Therefore, the essence of the Eneolithic needs to be re-thought. Copper products appear as early as the Late Neolithic and do not mark a significant milestone in social development.[162] Several solutions have been proposed.[163] In my opinion, the common thread that unites them all is the hypothesis of the new nature of social relations

156 Kadrow 2015.

157 Chernish 1982.

158 Korobkova 1987.

159 Borić 2015.

160 Petrequin et al. 2017.

161 Petrequin et al. 2017.

162 Shnirelman 1989.

163 Chapman et al. 2006; Govedarica 2004; Kadrow 2015.

in the Eneolithic period – with a much more significant role of social hierarchies than before. This change is significant, and the spread of copper products merely reflects one way in which material culture was manipulated to maintain a high social status.

The region between the Carpathians and Dnieper occupies a special place in Eneolithic Europe. It connects the first mining and metallurgical centres of the Balkans and the Great Eurasian steppe. Natives of the latter played a decisive role in the formation of the hierarchies of the Eneolithic period, according to several authors[164] (however, contra).[165]

Familiarity with the material is complicated by different approaches to drawing the boundary between the Neolithic and the Eneolithic. Soviet, Ukrainian, Moldovan, Romanian, and Bulgarian researchers tend to see the beginnings of the Eneolithic as early as the turn of the sixth/fifth millennium BCE.[166] Instead, a significant group of researchers from Western and Central Europe and the Romanian archaeological tradition place the Late Neolithic groups at this time, speaking of a 'Late Neolithic crisis', only after which bright and distinct cultural blocks of the Eneolithic proper emerged.[167] This significant change in cultural configurations occurred in 4650/4600 BCE (Late Eneolithic of Bulgarian archaeologists and the Eneolithic of Romanian archaeologists).[168] On the vast expanse from the Carpathians to Thrace, on both sides of the Danube, the cultural and historical community of Kodjadermen-Karanovo VI -Gumelnita emerged,[169] while to the east of the Carpathians, a cultural block of Cucuteni – Trypillia appeared. The beginning of Cucuteni – Trypillia B1 is treated as the start of the Eneolithic by Romanian historiographic tradition and is conventionally dated to 4550-4200 BCE.

Thus, Cucuteni-Trypillia cultural block represents the Eneolithic of the south of Eastern Europe and the chronology of its two earlier phases (Precucuteni – Early Trypillia and Cucuteni A3 – Trypillia B1) will be the subject of this section.

The Precucuteni or Early Trypillia archaeological aspect (P-ET) is a chronological phase representing the earliest evidence for the rich and varied family of cultural aspects united under the

164 Dergaciov 2007; Lichardus, Lichardus-Itten 1995.

165 Govedarica 2004; Manzura 2005.

166 Burdo 2003; Chernish 1982; Dergachev, Dolukhanov 2007; Dergaciov 2010.

167 Comşa 1987; Furestier et al. 2017; Hansen et al. 2012; Neagu 2003; Reingruber 2012.

168 Slavchev 2010.

169 Reingruber, Thissen 2009.

Cucuteni-Trypillia cultural block 'umbrella'[170] P-ET is still Neolithic in Romanian historiography – and already Eneolithic in the Ukrainian, Moldavian and Russian traditions. The formation of the Early Trypillian community is a problem that has a long history of study.[171] Among the cultural and historical communities involved in the formation of the Precucuteni-Trypillia A, different researchers name cultures: Boian (in its Giuleşti phase), LBK, Buh-Dniester culture, Dudeşti, Criş, Vinča-Turdoş.[172]

The Precucuteni-Early Trypillian community is generally believed to have emerged in the extreme west of the Carpathian-Dnieper region, on both slopes of the Carpathians **[fig. 50]**. The first of the stages of the typological development of the community, according to V. Dumitrescu, Precucuteni I, is known both in Transylvania and Moldavia, in the counties of Covasna and Bacău, which also host several important passages through the Carpathian Mountains. Less than a dozen sites of this aspect are known, and even fewer have been studied.[173] Based on the few radiocarbon dates and typological analogies, N. Burdo suggested that the phases identified by V. Dumitrescu should be considered not chronologically sequential but partially synchronous ceramic styles.[174] Given the general tendency to revise typological series on the basis of natural science data, this assumption takes on additional weight.

The first Trypillian settlers who crossed the Prut River brought ceramics of a different type, Precucuteni II. They moved into the valleys of the Dniester, Prut and Răut.[175] Some surface finds indicate they crossed the Dniester River and moved towards the Southern Buh River.[176] The Early Trypillia will spread to the Southern Buh Valley and Central Ukraine during the Precucuteni III or Trypillia A3 phase.[177]

While the early Trypillians were inhabiting the hilly landscapes of central Ukraine, a new type of community emerged in the Carpathians – the Cucuteni culture, characterised by the presence of painted pottery, sometimes as the dominant type of ware. Painted pottery is certainly only a marker of a new state of social development – it is unlikely that it had an independent evolutionary significance. However, it is correlated with a gradual increase in the average area of

170 Dumitrescu 1963; Passek 1949; Videiko 2004.

171 Videiko 2004.

172 Ursu 2016.

173 Boghian, Enea 2013.

174 Burdo 2011.

175 Passek 1961; Zbenovich 1989; Zbenovich 1996.

176 Kiosak 2016a.

177 Zbenovich 1996.

settlements, a differentiated material culture, numerous evidences of metalworking, the emergence of fortified settlements and settlements in a high 'defensive' topographic position, etc. In general, if the Precucuteni-Early Trypillia is difficult to distinguish from the usual society of early Neolithic farmers, in the case of Cucuteni we can confidently say that it is a significantly different society, which indeed resembles the communities of the Eneolithic Balkans, such as Gumelniţa, and may have been formed under their influence or together with them as a result of common transformational processes.

The eastern equivalent of Cucuteni is Trypillia. The early Cucuteni A1 and A2 phases are not known east of the Prut-Dniester interfluve. The Trypillia B1 period corresponds to the Cucuteni A3 phase (and A4, but the latter is mostly discarded as a separate chronological phase). The Trypillia B1 settlements occupy mostly the same area as the Early Trypillia sites, with some spread to the north, east and northwest in the Dniester Valley. It is noteworthy that no Trypillia B1 sites are known in the steppe (with an exception of a 'strange' site of Myrne **[fig. 56: 29]**), where significant ceramic collections of Trypillia A have been discovered. Many sites of Central Ukraine of this time continue the development of Early Trypillian traditions and innovations of the new era are very weakly felt in their material culture complexes (for example, the so-called Borysivka group sites). On the other hand, there are sites that are directly related to local manifestations of the Cucuteni A3 with a predominance of painted ware (particularly in the Prut and Dniester valleys), as well as sites with the dominance of local traditions, but clearly included in the network of innovation (such as so-called Sabatynivka group **[fig. 56: 1]**).

Trypillia B1 is of interest to us as a *terminus ante quem* for Neolithisation – the first no longer Neolithic society in the region – and also because its dating can be established by comparison with several relatively well-dated neighbours – Gumelniţa and burials of Steppe mobile groups. Their synchronism is established through numerous cross-validated 'imports' found in well-defined contexts such as dwellings, pits, and burials. This data allows for a refined chronology of the Trypillia B1 period. Moreover, its contemporaries, Seredny Stog culture groups, were mobile dwellers of the Steppe, descendants of 'eastern hunter-gatherers' in the palaeogenetics sense.[178] However, there are already well-defined finds of remains of cultivated plants in their sites.[179] Thus, agriculture and, likely, herding became widespread in the region by that time, and we can treat Neolithisation as being over. Let us attempt to date this important chronological step.

178 Allentoft et al. 2024.

179 Motuzaite Matuzeviciute 2020.

The Early Trypillia and Trypillia B1, like the Buh-Dniester para-Neolithic (see chapter 2), have two chronologies: 'new' and 'old' [fig. 53]. The 'new' chronology is based on conventional dates from the Kyiv laboratory obtained in the late 1990s and early 2000s.[180] According to it, the Early Trypillia's development occurred within 5318-4538 calBCE (2σ) and Trypillia B1 encompassed 4825-4400 calBCE (2σ). The 'old' chronology is based on conventional charcoal dates, conventional Kyiv laboratory dates, and some modern AMS dates. According to it, the Precucuteni I-III and early Trypillia developed between 49/48 and 45/44 centuries BCE and Trypillia B1 lasted in the second half of the fifth millennium BCE.[181]

The critical issue[182] here is the dating of the Bernashivka settlement (Mohyliv-Podilskyi district, Vinnytsia region). A 'new' chronology places the existence of this settlement, the earliest Trypillian settlement in Ukraine by typological considerations, in the range 5611-5309 calBCE.[183] Instead, the re-dating of its materials in the Oxford Laboratory and two new Kyiv dates indicate an interval of 4704-4066 calBCE.[184]

Moreover, another Early Trypillian site, Hrebeniukiv Iar (Grebeniukov Yar) obtained dates of the late sixth-early fifth millenia BCE (5295-473 5 calBCE, 2σ) thanks to three Kyiv dates (Ki-6272-74).[185] A new set of AMS dates (Poz-87462-64 and 66) changed the site's chronology: 4673-4407 calBCE, 2σ.[186] The interval (calculated with the Interval function of OxCal) is 179-537 years, 2σ, so there is an evident discrepancy between the two sets of dates.

Another apparent contradiction is related to the chronology of the Berezivska HES site (Trypillia B1, Central Ukraine). The site obtained Kyiv dates spanning between 4800 and 4401calBC (2σ). Some more AMS dates were obtained from the laboratories in Bern, Poznan, and Penn State University for the site.[187] They differ significantly (4341-4056 calBCE; 2σ) from the dates from the Kyiv laboratory. Romanian Cucuteni A3 sites were dated to this time slot too.[188]

Thus, the Kyiv dates and the 'new chronology' based on them systematically failed the cross-laboratory validation test in this

180 Burdo 2003.

181 Mantu 2000; Rassamakin 2012.

182 Gaskevych 2014.

183 Kotova, Videiko 2004.

184 Rassamakin 2012.

185 Burdo 2003.

186 Shatilo 2021.

187 Diachenko et al. 2024; Harper et al. 2023; Kiosak, Lobanova 2021; Lobanova 2024.

188 Popovici, Draşovean 2020.

particular instance. Therefore, we will exclude them from further modeling efforts.

The legacy dataset concerning the radiocarbon chronology of the P-ET horizon primarily comprises 25 conventional dates **[fig. 53]**. These dates exhibit a significant standard deviation, often involve charcoal samples (which may introduce the 'old wood' effect), and frequently yield results that are not directly relevant to the research objectives. Among these dates, 16 were conducted in the Kyiv laboratory in multiple series[189] and will not be considered in further modelling efforts. Recently, 35 AMS dates were obtained from inquiries at thirteen different sites **[ST 3-3]**.[190]

The typo-chronology of the Early Trypillia period is primarily defined by ceramic decoration styles[191] and bears a resemblance to the scheme developed by Hortensia and Vladimir Dumitrescu for its Romanian Precucuteni counterpart.[192] So, the dated sites can be categorised into a supposed earlier group (Rogojeni and Bernashivka, bearing pottery ornamented in Precucuteni II style) and a supposed later group (Cărbuna II, Cărbuna-Negrub, Mohylna-3, Puhach-2, Cărbuna I, Sabatynivka II, Isaiia-Balta Popii, Târgu Frumos-Pătule with pottery of Precucuteni III – Trypillia A3), primarily based on ceramic ornamentation. However, the AMS dates for these two groups of sites overlap. This observation remains consistent when considering previous dating efforts[193] and the dates from the subsequent typo-chronological stage, Trypillia B1/Cucuteni A3.[194] While the Kernel Density Estimate plots for each supposedly consecutive phase begin in the expected order, they exhibit significant overlap **[fig. 52]**. The fluctuations in the radiocarbon calibration curve between 4500 and 4300 cal BCE contribute to the overall calibration uncertainty.

OxCal software allows the modelling of both sequential and overlapping phases. We ran both models using the available AMS date set. While the model with partially simultaneous phases is valid, the model with sequential phases fails the chi-square validation. According to the model with partially simultaneous phases, the Precucuteni II – Trypillia A1-2 lasted during 4706-4407 calBCE, 2σ, modelled, the Precucuteni III – Trypillia A 3 during 4600-4399 calBCE, 2σ, modelled, and the end of the millennium (4350-4150 calBCE,

189 Gaskevych 2014; Kiosak et al. 2023c; Kiosak, Lobanova 2021; Rassamakin 2012; Shatilo 2021.

190 Diachenko et al. 2024; Harper et al. 2023; Vornicu 2017; Vornicu et al. 2018.

191 Videiko 2004; Zbenovich 1989.

192 Dumitrescu 1957; Dumitrescu 1963.

193 Popovici, Drașovean 2020; Rassamakin 2012.

194 Diachenko et al. 2024; Harper et al. 2023; Kiosak, Lobanova 2021; Mantu 2000.

2σ, modelled) is given to the next phase Cucuteni A3 – Trypillia B1 **[fig. 54]** **[models 3-1; 3-2; 3-3]** **[ST 3-3]**.

When we exclude dates obtained from charcoal samples, which may suffer from the potential 'old-wood' effect, and dates associated with questionable stratigraphic contexts (as is the case with the Bernashivka dates), there is room to consider a chronological separation of phases using the OxCal Sequential Phases Model: Trypillia A1-2 – 4701-4560 cal BCE (2σ); Trypillia A3 – 4584-4369 cal BCE (2σ); Trypillia B1 – 4379-4230 cal BCE (2σ) **[fig. 55]**. However, it is crucial to note that these Bayesian estimates are primarily a result of the preliminary selection of dates, and the provided chronological intervals should be approached cautiously and verified through enhanced stratigraphic controls and additional serial dating. Instead, it seems more likely that the ceramic styles used to define the supposed phases in the Early Trypillian typo-chronology appeared in a chronological order characterised by decreasing temporal increments, as suggested by archaeological seriation. Subsequently, these styles coexisted over an extended period.

Recent Bayesian analysis examined a set of ten radiocarbon dates from Precucuteni sites west of the Prut River in modern-day Romania as part of a broader analysis encompassing all published Precucuteni-Cucuteni dates.[195] Incorporating stratigraphic considerations, the authors concluded that structure L36 at the Poduri-Dealul-Ghindaru site (Precucuteni II), dated by a single charcoal sample (Bln-2804, 5820 ± 50 BP), likely existed in the timeframe of 4720-4701 cal BCE ('median date'). The subsequent stage, Precucuteni III, was evidenced in structures L31 and L8 at the same site as early as 4626-4609 cal BCE ('median date').[196] While relying on median dates is flawed,[197] these observations indirectly support the idea of an overlapping and gradually emerging Early Trypillian chronology, as previously presented.

The radiocarbon dates frequently conflict with established theories regarding the sequencing of typological groups in the Neolithic and Eneolithic periods in various regions, including the Balkans,[198] the Carpathian Basin,[199] central Germany,[200] and even later phases of the Trypillia culture in Ukraine.[201] In the Early Trypillian context,

195 Popovici, Draşovean 2020.

196 Popovici, Draşovean 2020, 371.

197 Stuiver, Polach 1977.

198 Biagi et al. 2005.

199 Oross, Siklósi 2012.

200 Müller 2004.

201 Diachenko et al. 2024.

these findings suggest that stylistic groups in pottery decoration do not necessarily align with the chronological positions of respective sites. They may instead reflect complex social processes and coexist over extended periods.

Early Trypillians expanded into the North Pontic Steppe, as indicated by the discovery of their pottery at riverside sites along the Southern Buh River.[202] New dates for the Puhach-2 site align with the emergence of settlements at Mohylna-3 and -5 and slightly precede sites like Hrebenniukiv Iar and Sabatynivka II. The Mykolyna Broiaka and Shumyliv-Cherniatka para-Neolithic sites provide a date within the same timeframe, suggesting the possibility of a chronological 'window of possibilities'[203] for contact between indigenous hunter-gatherers with pottery and early farmers of Trypillia A. However, it is too early to accept this hypothesis without conditions.

The expansion of Early Trypillians occurred in the 47-45th centuries BCE and was not a gradual process. They rapidly reached the banks of the Dniester and Southern Buh rivers as early farming groups propagated **[fig. 51]**. It is conceivable that it took no more than 3-4 generations of Trypillians to cover distances spanning several hundred kilometres. For instance, the interval between the earliest dates for the Poduri-Dealul-Ghindaru site in the Carpathians and the set of dates for the easternmost dated sites of Hrebeniukiv Iar (380 km apart) and Mohylna 3 (340 km apart) is 0-170 and 0-140 years, 2σ, respectively (modelled in OxCal with Interval query). Accounting for the potential 'old-wood' effect on the charcoal dates from the Berlin laboratory at Poduri-Dealul-Ghindaru, the diffusion could occur even faster. Therefore, it is plausible that the expansion of Early Trypillia occurred in a 'leap-frog' manner.[204]

To date the end of Neolithisation in southern Eastern Europe, let's examine the chronology of Trypillia B1. The cultural homogeneity of the Precucuteni – Trypillia A sites gave way to a variety of local cultural types, each associated with distinct social structures that likely evolved over time.[205] Moreover, unlike previous diffusion events, this period likely represents the spread of innovations within the Precucutenian cultural *milieu*, which retained many of its characteristic features until the very end of the Trypillia B1 period **[fig. 56]**.[206]

The Trypillia B1 ceramics from this period can be categorised based on their decoration methods into four main categories, which

202 Tovkailo 2005.

203 Haskevych 2021.

204 Forenbaher, Miracle 2005.

205 Burdo 2018.

206 Videiko 2004.

are further divided into groups and subgroups: ceramics with incised ornamentation, ceramics with relief-plastic decoration, often referred to as 'kitchen' or 'coarse' ware, ceramics without any ornamentation, painted pottery.[207] The collections often include so-called Steppe ware – pottery made using a different, non-Trypillian technology, typically tempered with crushed shells and featuring distinctive non-Trypillian ornamentation styles.[208] Additionally, there is some limited evidence of ceramic and lithic imports from the Gumelnița area.[209] So we can compare the set of AMS-dates recently obtained for Trypillia B1 with those for neighbouring cultural aspects: Cucuteni A3, Gumelniţa, Steppe mobile groups **[fig. 57]**.

Painted ware found in Trypillia B1 **[fig. 57: I]** sites corresponds to the pottery of Cucuteni A3 style.[210] The chronology of Cucuteni A is far from being definitive. The dates overlap considerably and present significant contradictions **[fig. 56]**.[211] The 'Kyiv' dating of the Trypillia B1 is irrelevant in the context of the absolute chronology of Romanian Cucuteni A sites; it appears too early. Instead, these dates align with those of the Precucuteni sites in Romanian Moldova.[212] Meanwhile, the 'AMS' date ranges for the Trypillia B1 find correspondence in the dataset for the western part of the Cucuteni-Trypillia cultural complex.[213] Specifically, they are slightly later than conventional dates Polyvaniv Yar III-1 (Trypillia B1 **[fig. 56: 27]**, earlier than dates for Scânteia (Cucuteni A3 **[fig. 56: 14]**), and two dates for the site of Putineşti III (Cucuteni A4 **[fig. 56: 13]**). They could also be synchronous with the site of Drăguşeni-Ostrov (Cucuteni A4 **[fig. 56: 15]**), four additional Scânteia dates, and Cucuteni A3 sites like Cuconeştii Vechi, Dumeşti, Hăbăşeşti, Leca Ungureni, Preuteşti-Haltă **[fig. 53]**. C. Bem suggested that Cucuteni A3 and A4 phases could partially overlap in the 4350-4050 years BCE.[214] The Sabatynivka group of Trypillia B1 **[fig. 56: 1]** data points to their probable coexistence in the 44th to 42nd centuries BCE.[215] Therefore, the AMS dates confirm the co-existence of Trypillia B1 and Cucuteni A3, as suggested by the comparative typology of painted pottery.

The shell-tempered pottery of the Trypillia B1 sites resembles the ceramic of the second stages of the Seredny Stog culture **[fig. 57: II]**,

207 Burdo 2018.

208 Burdo 2015; Lobanova, Kiosak 2020; Movsha 1961; Palaguta 1998.

209 Burdo 2015; Kiosak, Lobanova 2021; Sorochin 2001.

210 Sorochin 2002.

211 Popovici, Drașovean 2020.

212 Rassamakin 2012.

213 Lazarovici 2010.

214 Bem 2007, 241.

215 Kiosak, Lobanova 2021.

known as 'Skelia pottery'.[216] However, this cultural aspect features similar chronological uncertainties as the Trypillia B1.[217] Skelia settlements have been identified in the Dnieper Rapids and Northern Azov Sea regions, dating from the Kyiv laboratory, indicating a period of 4842-4242 cal BCE (2σ).[218] The IVth layer of the Strilcha Skelia site **[fig. 56: 9]**, which belongs to a later phase (Stog),[219] provides a *terminus ante quem* dating of 4488-4065 cal BCE (2σ), aligning with the chronological framework suggested by Kyiv dates for the Trypillia B1.

These findings contradict the series of dates obtained in other laboratories for Skelia phase burials, which are generally later and often located far from settlements in areas inhabited mainly by individuals from different cultural backgrounds. The synchronism of settlements and burials was proposed by Yu. Rassamakin and was further developed by N. Kotova.[220] Most burials are dated to 4488-4050 cal BCE (2σ). An exception is burial 46 from the Olexandrivsk necropolis (4698-4364 cal BCE, 2σ). The Giurgiuleşti cemetery provides an interesting case; the initial date encompassed 4588-4248 cal BCE (2σ), but recent series of dates narrowed the range for the burial field to 4484-4264 cal BCE (2σ **[fig. 58]**).[221] A similar chronological shift is expected for the Olexandria cemetery and the Chapli site. The date for the Vynohradne burial, belonging to a different later cultural tradition,[222] provides a *terminus ante quem* of 4241-3950 cal BCE (2σ). Therefore, while the dating of Skelia settlements requires re-evaluation, the phenomenon of Skelia burials seems to have persisted in the 44th to 42nd centuries BCE. This timeframe roughly corresponds to the 'AMS' dating of the Trypillia B1.

Notably, shell-tempered pottery resembling that of the Trypillia B1 sites has been found at Bereşti (Cucuteni A3), Izvoare, and Fedeleşeni (Cucuteni A4) in Romania,[223] as well as at Druța I, Duruitori Noi, Nezvisko, Jura, and Polyvaniv Yar III-1 (Moldova and Ukraine,).[224] Romanian researchers refer to these findings as 'Cucuteni C' pottery, associating it with the characteristic ceramics of the later phases of Cucuteni A-B and B. However, from the perspective of Seredny Stog pottery classification, the 'typical' Cucuteni C ceramic differs from

216 Kotova 2008.

217 Rassamakin 2017.

218 Kotova 2008.

219 Kotova 2008.

220 Kotova 2008; Rassamakin 2004.

221 Govedarica, Manzura 2016.

222 Rassamakin 2009.

223 Bem 2007, 58.

224 Palaguta 1998; Popova 2003.

the potsherds found at Cucuteni A3 sites,[225] including those of the Trypillia B1. The latter resembles Skelia pottery, with some elements from the subsequent Stog phase of the Seredny Stog culture (as defined by N. Kotova).

Interestingly, a similar situation regarding the shell-tempered pottery found in Gumelniţa culture contexts can be observed. This pottery type shares close similarities with Skelia phase complexes (or a separate culture) and is securely dated within the context of the Pietrele settlement **[fig. 56: 2]** to the time frame of 4450/4350-4270/4260 years BCE, with a focus on the latter half of the 44th century.[226] Another vessel type with a pointed bottom and stamp decoration from the same context is dated later, after 4300 years BCE. Thus, the dating of Skelia pottery in the Danube Valley and in the sites of Trypillia B1 appears roughly synchronous.

Some potsherds found in the Trypillia B1 sites **[fig. 57: III]** resemble those from Gumelniţa culture.[227] Gumelniţa culture has recently been dated to 4600-4250 years BCE.[228] A hypothesis suggests a potentially extended existence of the Gumelniţa culture based on findings from sites in the Lower Danube basin.[229] The earlier stages of Gumelniţa show evidence of interaction with the Precucuteni culture (Trypillia A), which predates the development of Cucuteni A – Trypillia B1.[230] Therefore, it is advisable to exclude the earliest dates for Gumelniţa A1 (4600-4450 years BCE) from our consideration. Trypillia B1 pottery was discovered within the contexts of later phases of Gumelniţa, specifically in stages A2-B1.[231]

A significant Cucuteni-Trypillia influence is evident in sites belonging to a particular variant of the Gumelniţa cultural block, known as the Bolhrad-Aldeni or Stoicani-Aldeni aspect.[232] It has been proposed that the latter represents a local variant of the Gumelniţa A1 phase. Notably, there are indications of Trypillia B1 pottery imports at the Bolhrad-Aldeni sites of Taraclia I and Novoselske I **[fig. 56: 22-23]**.[233] Recent radiocarbon dates from northern Muntenia **[fig. 56: 21]** suggest that the later phases of the Stoicani-Aldeni cultural aspect could

225 Reingruber, Rassamakin 2016; Tsvek, Rassamakin 2001-02.

226 Reingruber, Rassamakin 2016.

227 Burdo 2015; Kiosak, Lobanova 2021.

228 Hansen et al. 2012; Reingruber 2012; Reingruber, Rassamakin 2016.

229 Manolakakis 2017.

230 Sorochin 2001.

231 Frînculeasa 2016.

232 Subbotin 2013.

233 Subbotin 2013, 113.

have coexisted with the Gumelnița A2 phase and with Cucuteni A3.[234] Some of these dates obtained from Bolhrad-Aldeni sites align well with the 'AMS' chronology of the Trypillia B1, thus reinforcing the possibility of their coexistence, as indicated by the typological analysis of pottery 'imports' **[fig. 58]**.

Therefore, by integrating multiple investigative approaches, we can deduce that the Trypillia B1 thrived during the 44th to 42nd centuries BCE. Its sites have provided evidence of intercultural interactions extending in various directions. It appears it is partially synchronised with the Skelia phase of the Seredny Stog culture, Cucuteni A3-4, and Gumelnița A2-B1.

The new dates point to an explosive process of Trypillia A expansion, similar to the rapid LBK expansion[235] and ancient Neolithic migrations (FTN block, for example)[236] and suggest that similar social structures and factors that would have prompted the movement to new territories must be behind these processes.

On the contrary, taking into account the earlier formation of the Gumelnita and Cucuteni A2-3 cultural monuments, the above dating of Trypillia B1 suggests a long and gradual process of 'Eneolithisation' of the forest-steppe and steppe areas of southern Eastern Europe. The beginning of the Trypillia B1 was marked by the disintegration of the homogeneous community of the Early Trypillian – Precucuteni, which led to the emergence of a mosaic of local groups.[237] This process finds a close correspondence in dismantling the LBK and establishing a variety of post-linear cultural aspects in Central Europe.[238]

This type of process has been described by the term 'crisis' of the Middle Neolithic or post-LBK crisis[239] in Central Europe. Accordingly, the mirror term 'Late Neolithic crisis' seems more adequate to the archaeological reality in the Carpathian-Dnieper region. Early Trypillia falls within these crisis times, after which the Eneolithic – the hierarchical society of Cucuteni A – Trypillia B1 – emerges.

234 Frînculeasa 2016.

235 Dolukhanov, Shukurov 2004; Dolukhanov et al. 2005.

236 Biagi et al. 2005.

237 Burdo 2015; Palaguta 2007; Sorochin 2002.

238 Pavuk 2005.

239 Amkreutz; van de Velde 2018; Mathieson et al. 2018.

3.5 Conclusion

Early farmers appeared in the Carpathian-Dnieper region quite late – during the later stages of the Criş culture. The latter is unlikely to have survived beyond 5400 BCE. Moreover, the earliest LBK settlements appear only in the 53rd century BCE, at the pre-music-note stage. During the music note stage, the LBK settled in eastern Romania, Moldova, and western and central Ukraine.

The earliest evidence of domesticated animals and plants is associated with pit 21 at Sacarovca 1. A new radiocarbon date from a deer bone from this feature indicates that it existed around 5600-5500 BCE. Most likely, the 53rd century is indicated by two direct dates based on cultivated plant remains from the *Notenkopf* LBK Ratniv 2 settlement in western Ukraine. Instead, the cultivated plants of 53-51 centuries BCE obtained a series of direct dates from Kamyane Zavallia and Nicolaevca 5, two settlements of the LBK, *Notenkopf* phase on the Southern Buh and Central Moldova, respectively.

After the decline of the LBK, Precucuteni-Early Trypillian groups spread agriculture to Central Ukraine's regions that had previously been uninhabited by LBK groups. The Precucutenian expansion took place between the 47th and 45th centuries BCE.

The next stage of development is marked by the formation of the hierarchical Cucuteni-Trypillia society, which is already unanimously defined as Eneolithic. The Trypillia groups penetrated the most remote corners of the study area, bringing with them agriculture and cattle breeding. Their contemporaries, the steppe mobile groups of the Seredny Stog, seem to have been familiar with agriculture,[240] so the process of Neolithisation can be considered complete around 4400-4000 BCE in the region between the Carpathians and the Dnieper river.

240 Motuzaite Matuzeviciute 2020.

Figures

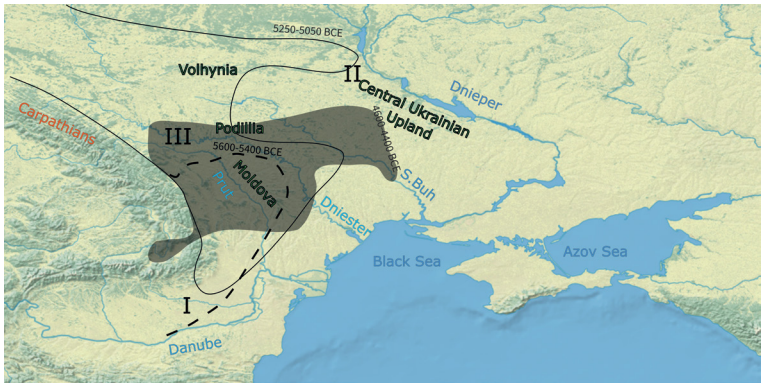

Figure 38 Multiple Neolithisations in the Carpathian-Dnieper region. I: extent of Criș spread; II: LBK expansion; III: early Trypillian dispersal. Topo: Natural Earth. Mapping by the Author

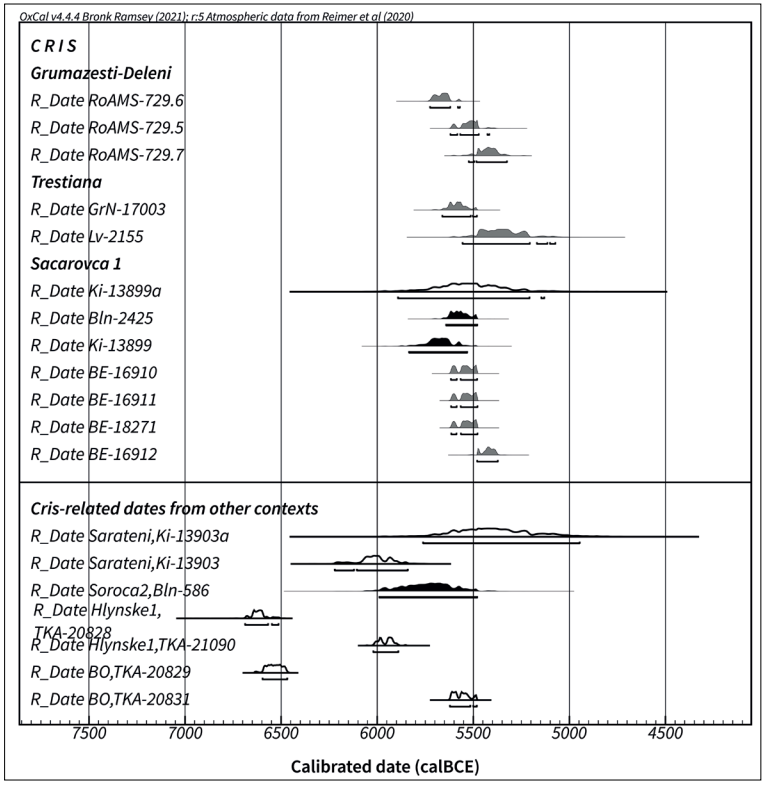

Figure 39 Radiocarbon dates for the Criș culture sites east of the Carpathians. Black: charcoal dates; grey: bone dates, empty: TOCC of potsherds dates. BO – Bazkiv Ostriv. Done in OxCal by the Author

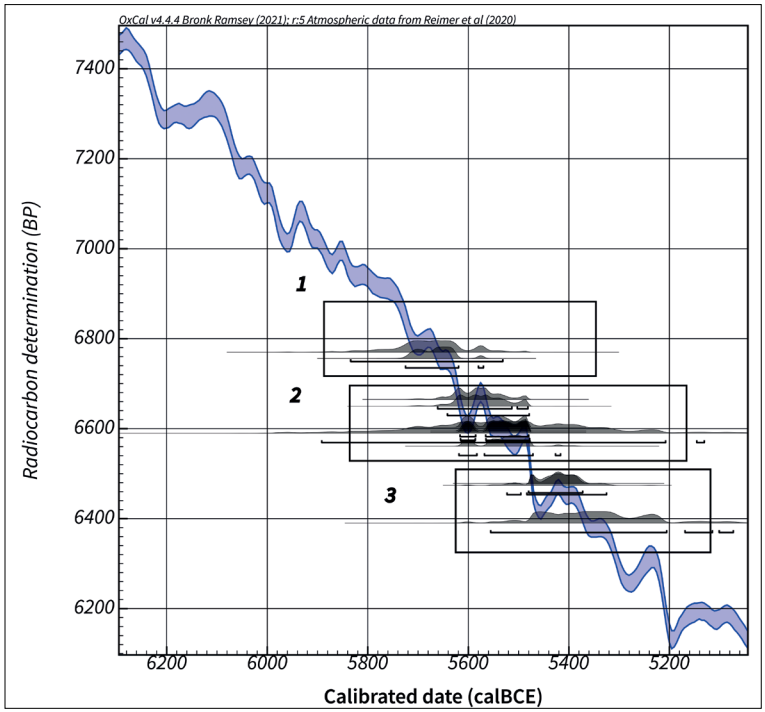

Figure 40 Radiocarbon dates for the Criș culture sites east of the Carpathians when plotted on a calibration curve. 1-3: chronological groups. Done in OxCal by the Author

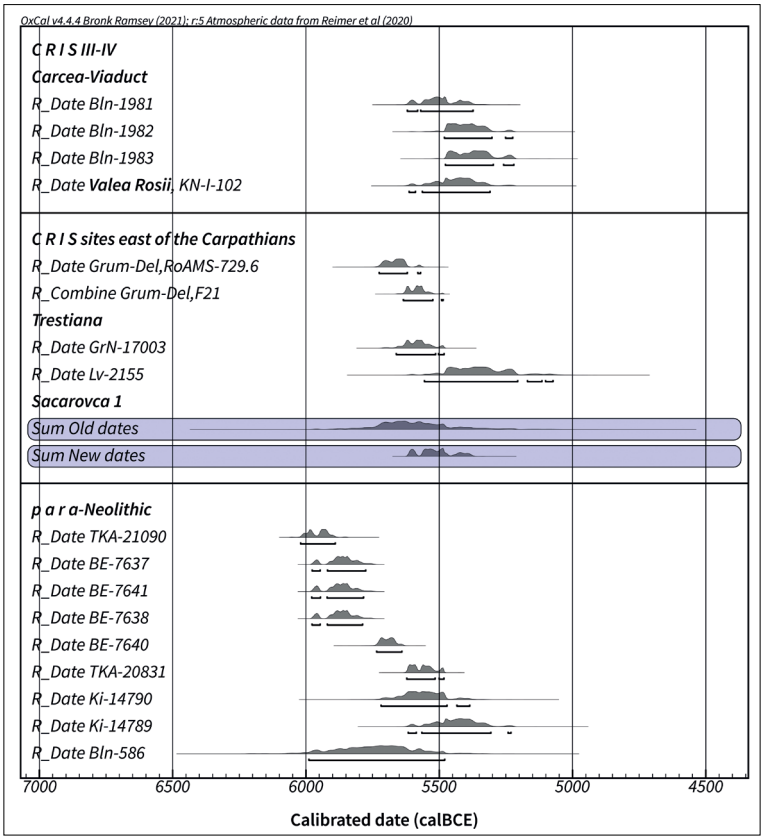

Figure 41 Comparison of radiocarbon dates for the sites of Criș east of the Carpathians (middle) with dates for the Late Criș sites elsewhere in Romania (above) and selected radiocarbon dates for Buh-Dniester para-Neolithic (below). ST 3-1. Done in OxCal by the Author

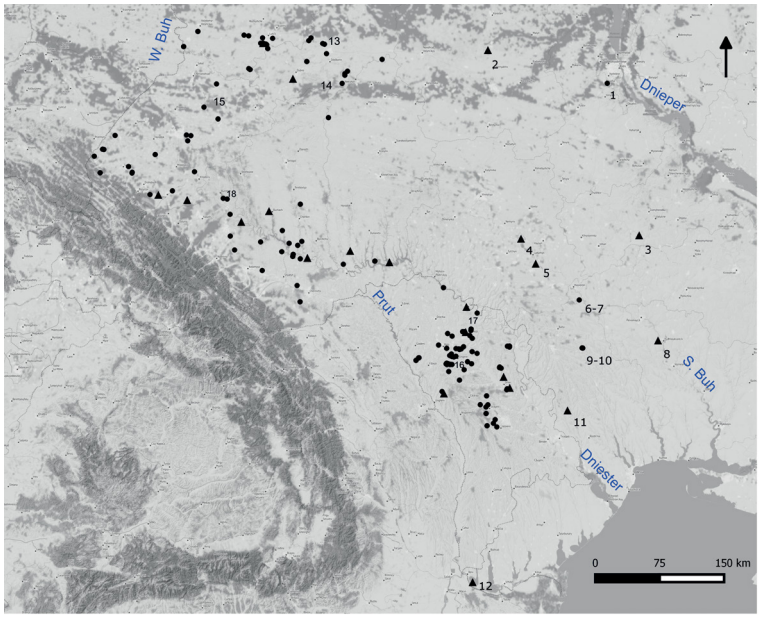

Figure 42 LBK sites east of the Carpathians. Circles: settlements; triangles: straw finds. 1: Vita Poshtova; 2: Fasova; 3: Dobrianka 3; 4: Bazkiv Ostriv; 5: Shchurivtsi-Porih; 6-7:- sites near Zavallia; 8: Gard; 9-10: sites near Ananiev; 11: Hirzheve; 12: Orlovka-Cartal; 13: Rivne, Rovantsi; 14: Mezhyrich; 15: Yosypivka; 16: Nicolaevca 5; 17: Floresti; 18: Bilshivtsi. Topo: Stamen Terrain. Mapping by the Author

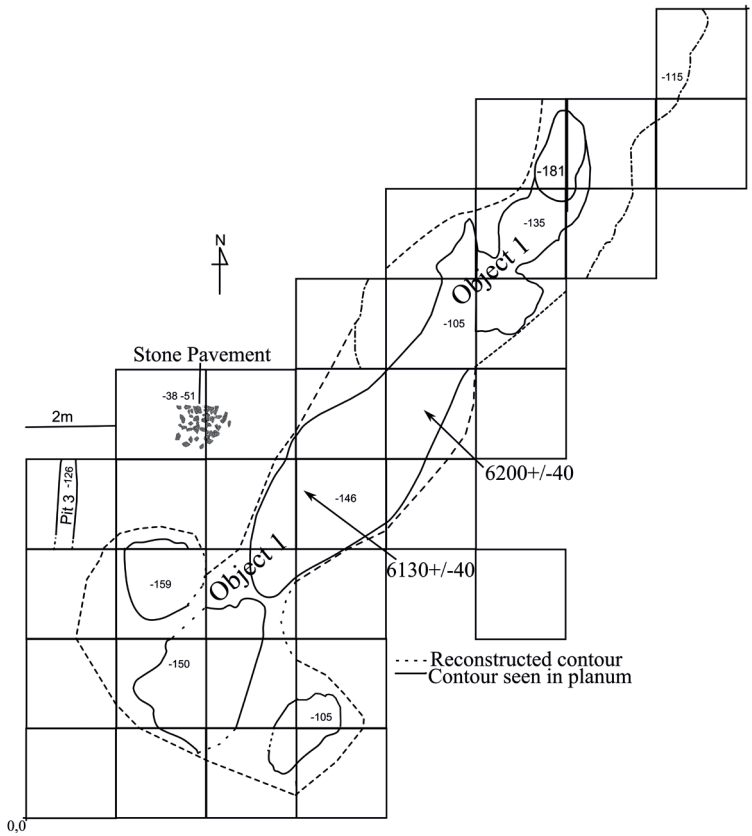

Figure 43 Plan of Trench 1. Kamyane-Zavallia. After Kiosak 2019

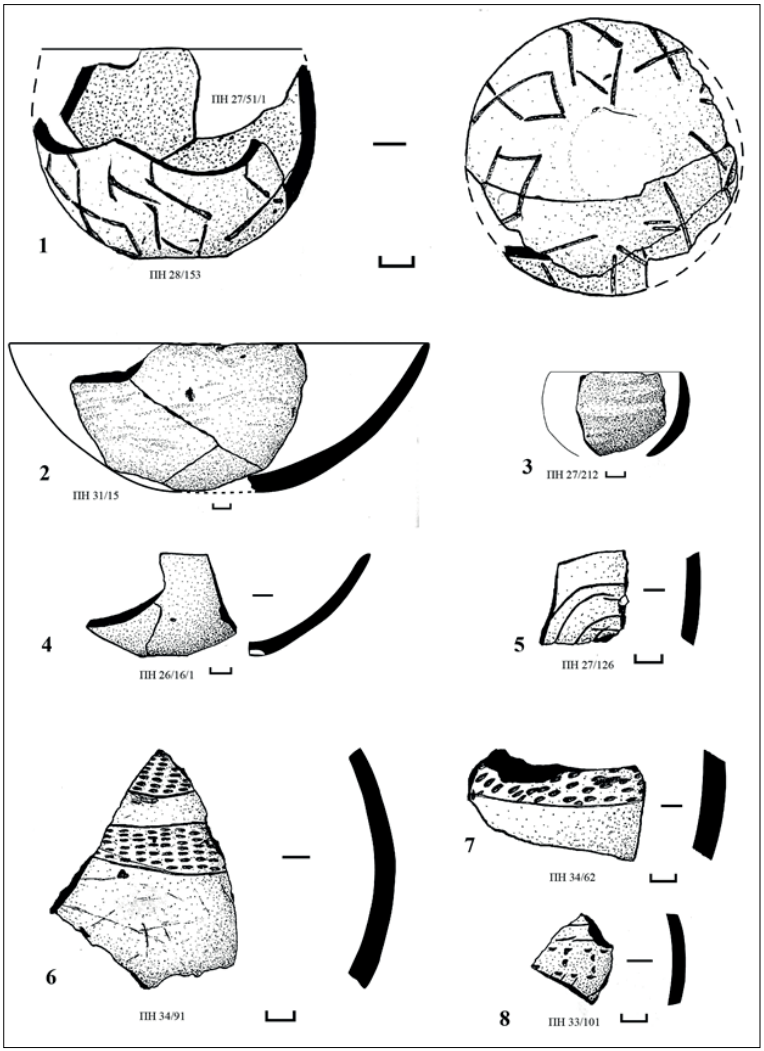

Figure 44 Kamyane-Zavallia. Samples of pottery. After Kiosak 2019

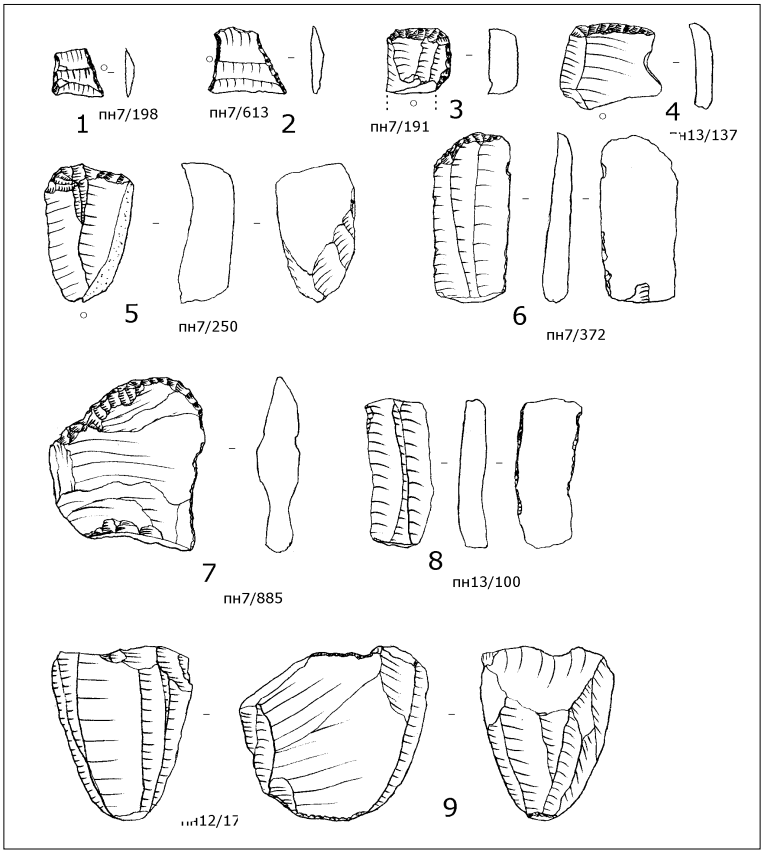

Figure 45 Kamyane-Zavallia. Samples of lithic inventory. After Kiosak 2019

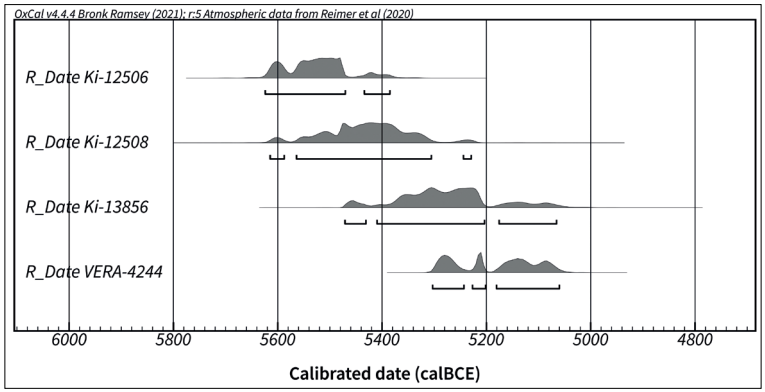

Figure 46 Radiocarbon dates. Rivne. Ki-12508 and VERA-4244 are dates of the same bone sample. **ST 3-2**. Done in OxCal by the Author

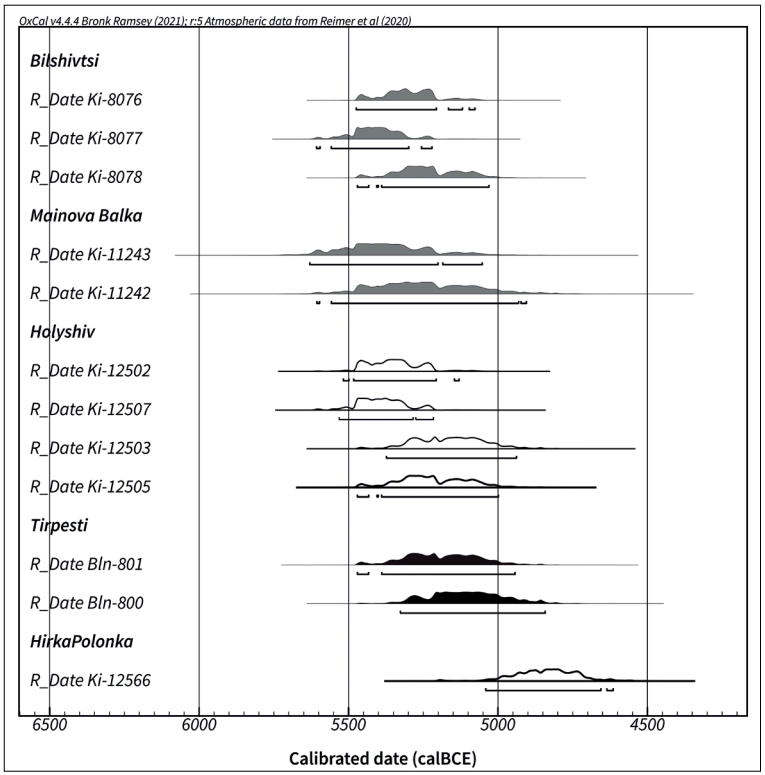

Figure 47 Conventional radiocarbon dates for LBK sites east of the Carpathians. Grey: animal bone, empty: TOCC of potherds, black: charcoal. **ST 3-2**. Done in OxCal by the Author

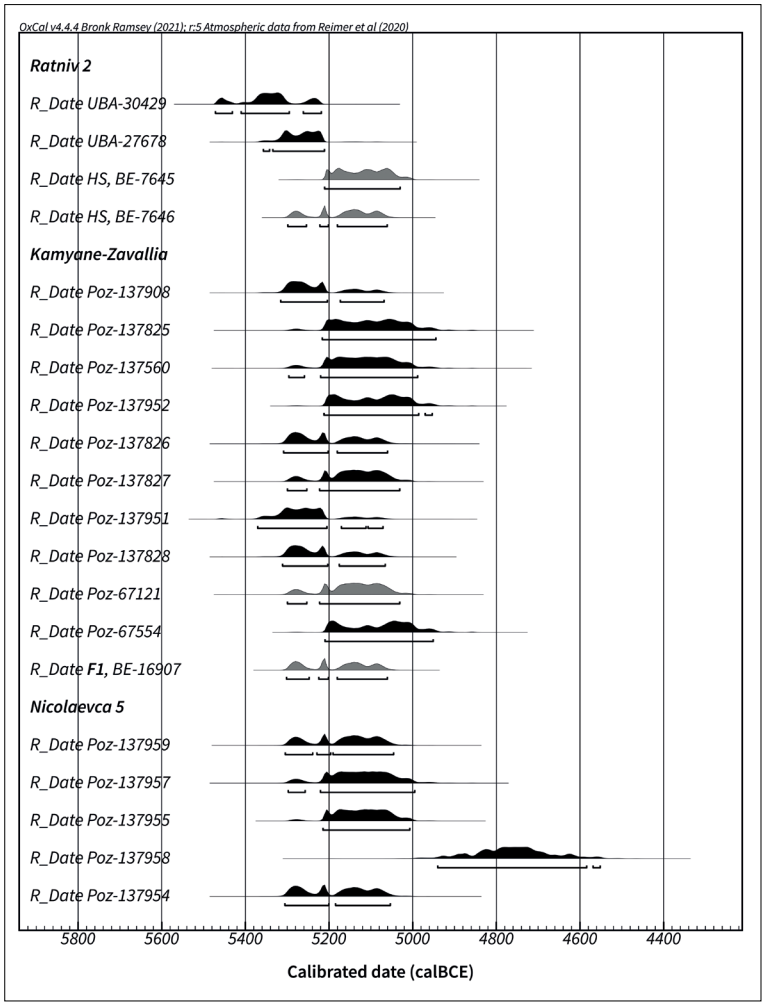

Figure 48 AMS radiocarbon dates for LBK sites east of the Carpathians. Grey: animal bone; black: charred remains of plants. HS: Hnyla Skelia; F1: Floresti 1. **ST 3-2**. Done in OxCal by the Author

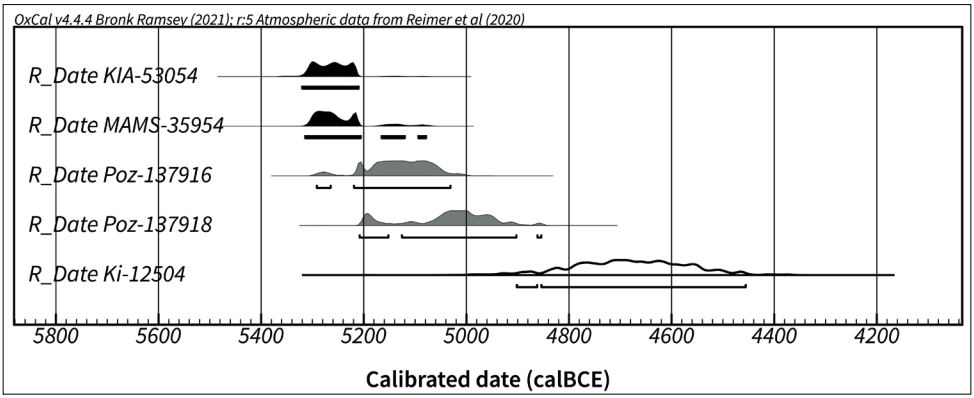

Figure 49 Rovantsi. Radiocarbon dates. Black: human bone; grey: animal bone; empty: TOCC of potsherd. **ST 3-2**. Done in OxCal by the Author

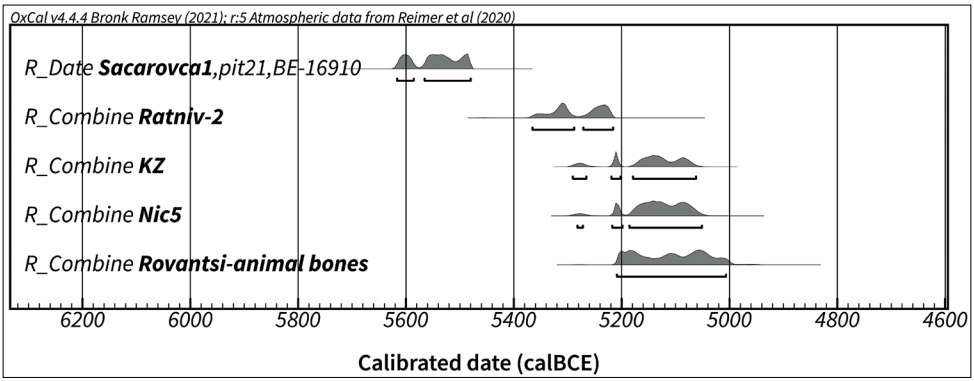

Figure 50 Radiocarbon chronology for the earliest cultivated plants of southern Eastern Europe. KZ: Kamyane-Zavallia; Nic5: Nicolaevca 5. **ST 3-1** and **3-2**. Done in OxCal by the Author

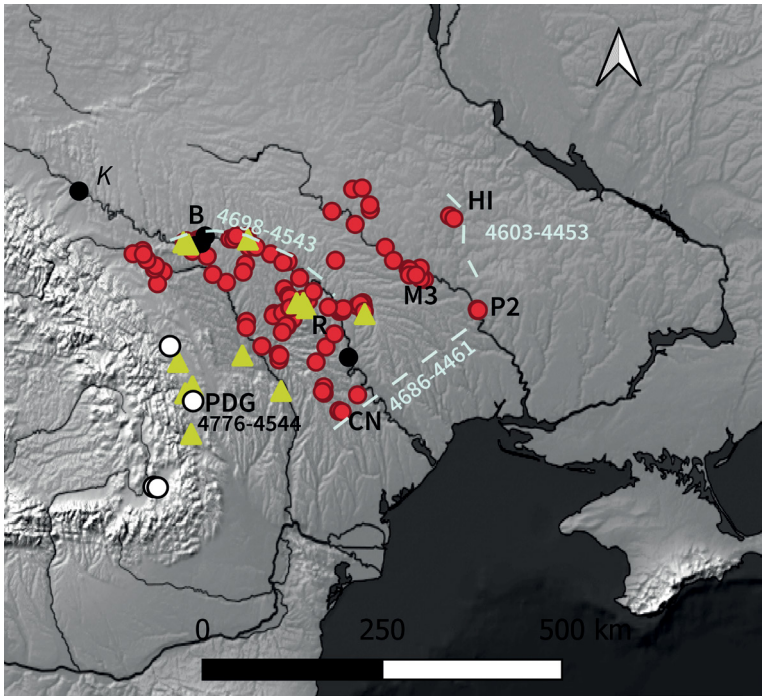

Figure 51 Map of Early Trypillia distribution indicating the calibrated relevant dates available to this moment (in years, BCE, 2σ). I, II. Distribution of Precucuteni I and II after Garvăn et al. 2009. White dots: Precucuteni I; yellow triangles: Precucuteni II – Trypillia A1-2 sites; red dots: Trypillia A3 and undefined early Trypillia sites; black dots: Trypillia A4 sites. PDG: Poduri-Dealul-Ghindaru; M3: Mohylna-3; B: Bernashivka; R: Rogojeni; CN: Cărbuna-Negrub; HI: Hrebenniukiv Iar; P2: Puhach-2; K: Kozyna. Topo: Natural Earth. Mapping by the Author

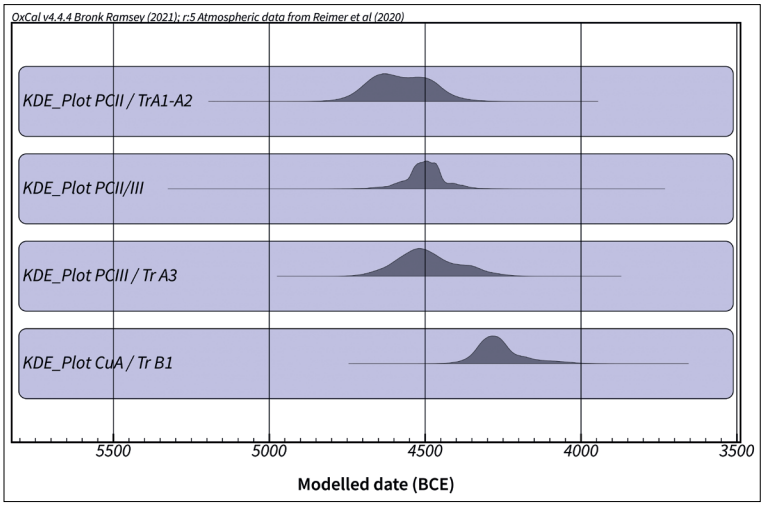

Figure 52 Modelling of the dates: KDE (Kernel Density Estimates) model plots (KDE-Model) according to OxCal. PCII/TrA1-A2 – Precucteni II, Trypillia A1-A2; PCII/III – Precucuteni II-III; PCIII/TrA3 – Precucteni III, Trypillia A3; CuA/TrB1 – Cucuteni A – Trypillia B1. Done in OxCal by the Author

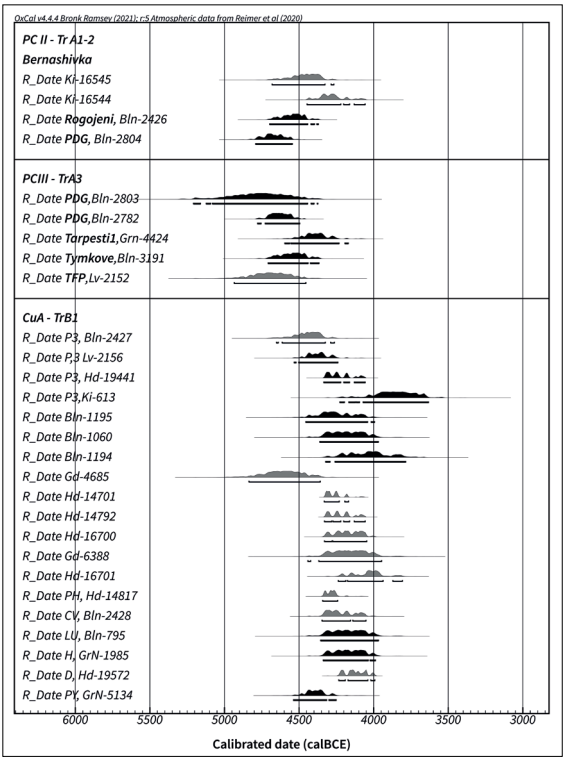

Figure 53 Legacy dates for Precucuteni –Cucuteni A/Early Trypillia and Trypillia B1. Black charcoal, grey: animal bones. PDG: Podul Dealul Ghindaru; TFP: Târgu Frumos-Pătule; P3: Putinești III; DO: Drăgușeni-Ostrov; PH: Preuteşti-Haltă; CV: CuconeștiiVechi; LU: Leca-Ungureni; H: Hăbășești; D: Dumești; PY: PolyvanivYar. **ST 3-3**. Done in OxCal by the Author

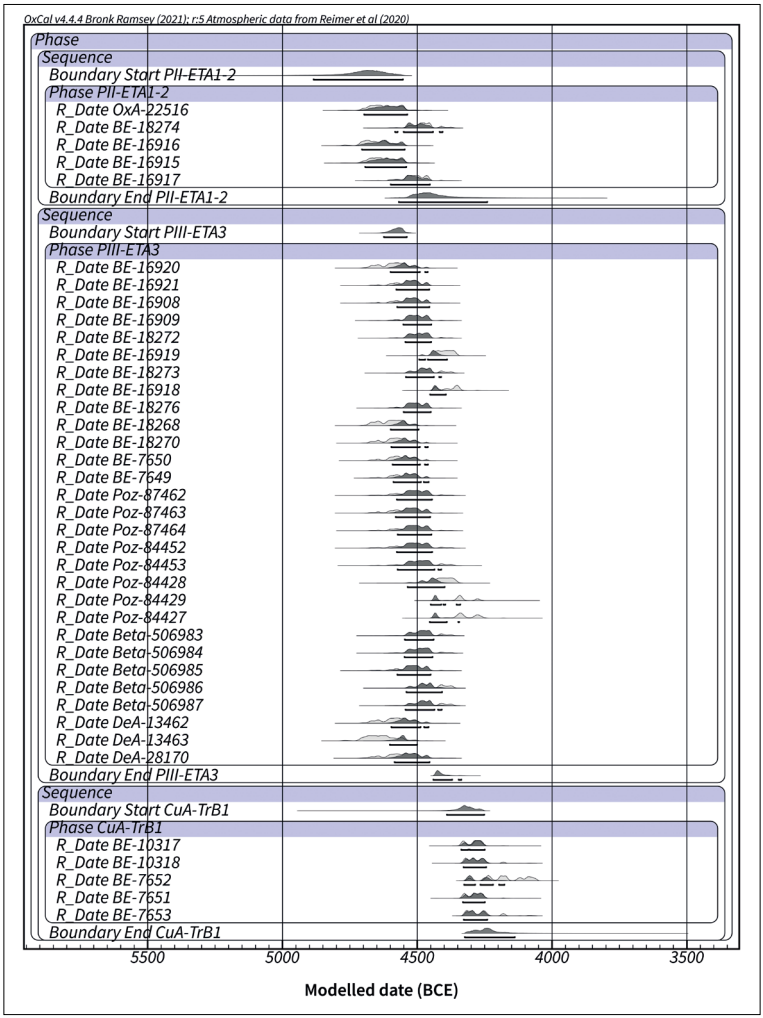

Figure 54 Modelling with overlapping phases. P – ET – Precucuteni – Early Trypillia, Cu – Cucuteni, Tr B1 – Trypillia B1. Model 3-1. Dates of Trypillia B1 are not shown in the graph for clarity sake. **ST 3-3**. Done in OxCal by the Author

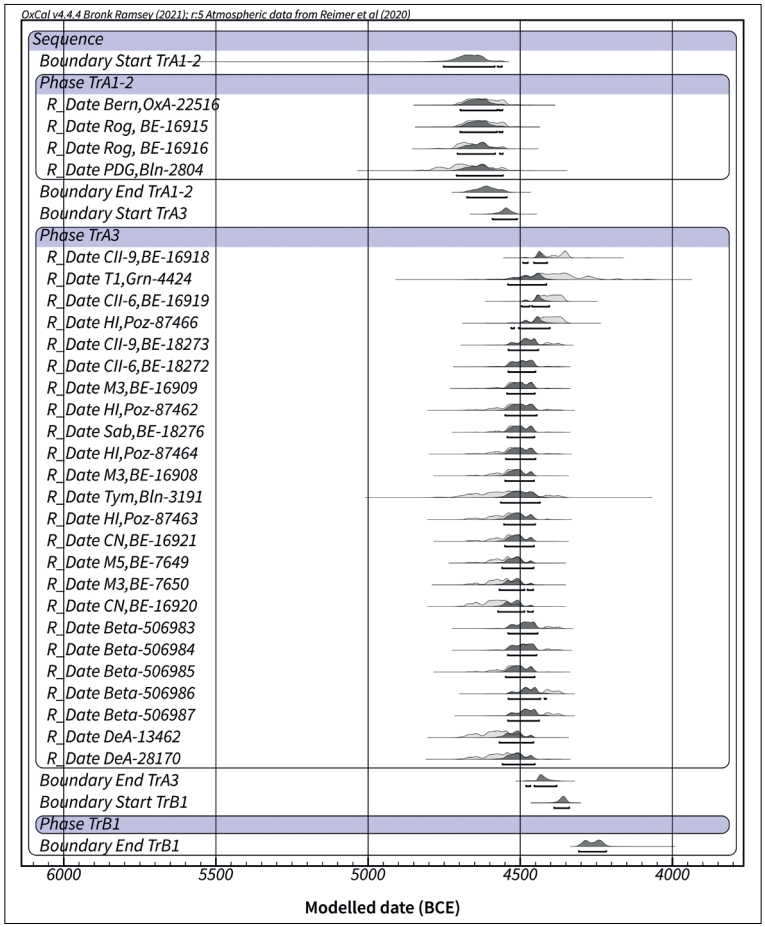

Figure 55 Precucuteni – Cucuteni A/Trypillia A – B1. Selected dates with sequential phases. **Model 3-3**. **ST 3-3**. Done in OxCal by the Author

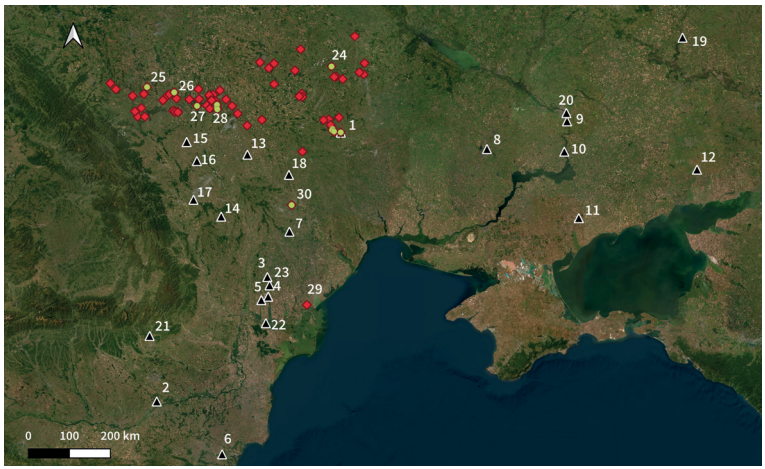

Figure 56 Trypillia B1 sites in the context. Diamonds: Trypillia B1 sites; diamonds with green circle: dated Trypillia B1 sites; triangles: relevant neighbouring sites. 1: the Sabatynivka group (Sabatynivka 1, Berezivska HES, Kamyane-Zavallia 1, Shamrai); 2: Pietrele; 3: Cealîc; 4: Bolhrad; 5: Vulcaneşti II; 6: RekaDevnia; 7: Cainari; 8: KryvyiRih; 9: StrilchaSkelia; 10: SerednyiStog; 11: Semenivka; 12: Rozdolne; 13: Putineşti III; 14: Scănteia; 15: Drăguşeni-Ostrov; 16: Truşeşti; 17: Hăbăşeşti; 18: Jura; 19: Olexandria; 20: Ihren VIII; 21: Mălăieştii de Jos; 22: Novoselske I; 23: Taraclia I; 24: Zarubyntsi; 25: Hlybochek; 26: Holoskiv; 27: Polyvaniv Yar; 28: Vasylivka and Voloshkove – Gorby; 29: Myrne; 30: Vadul-lui-Vodă. Topo: ESRI. Mapping by the Author

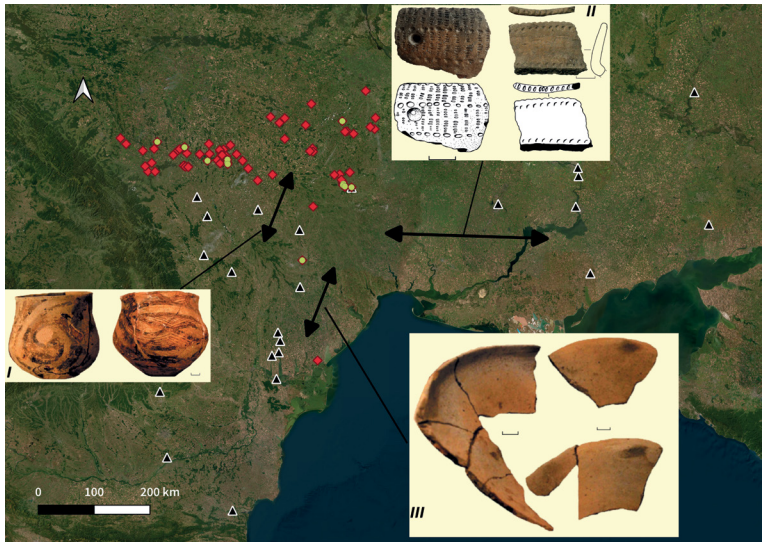

Figure 57 Contacts of Trypillia B1 sites of Central Ukraine: I: painted ware of Cucuteni A3 style (exemplified by finds from the Berezivska HES site, Kiosak, Lobanova 2021); II: shell-tempered ware from Skelia aspect (exemplified by finds from the Shamrai site, Kiosak, Lobanova 2021); III: burnished ware from Bolhrad-Aldeni aspect (exemplified by finds from the Berezivska HES site, Peresunchak 2015). Topo: ESRI. Mapping by the Author

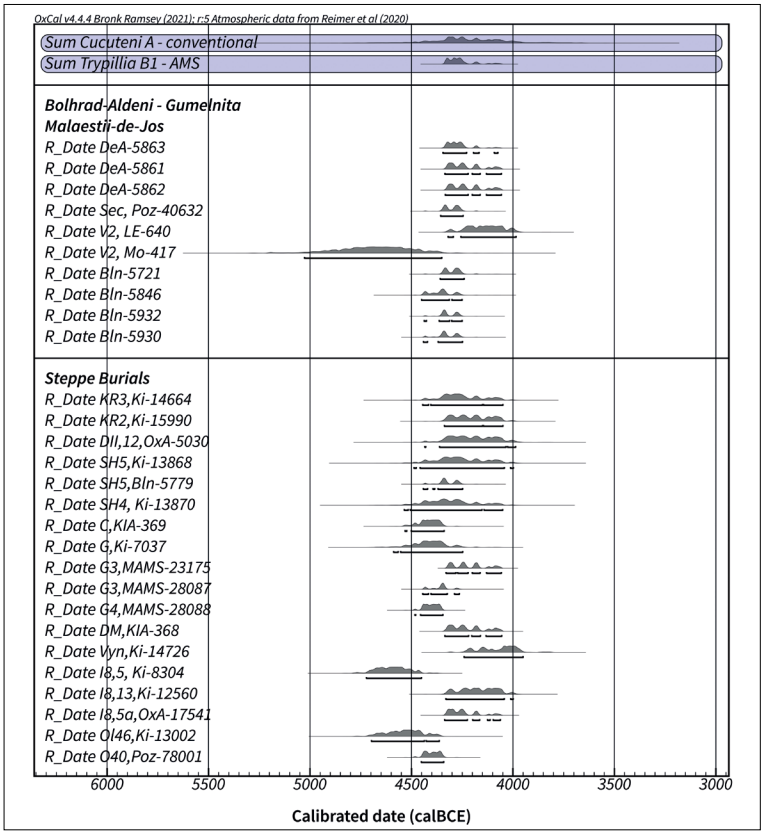

Figure 58 Chronology of Cucuteni A – Trypillia B1 in its context. KR3 – KryvyiRih, b.3, KR2 – KryvyiRih, b.2, DII, 12 –Dereivka II, b. 12, SH5 – Shakhtar 29/5, SH4 –Shakhtar 29/4, C – Cainari, G – Giurgiulesti, burials 3 and 4, DM – DeciaMuresului, b. 12, Vyn-Vynohradne 3/15, I8 – Ihren VIII, burials 5, 13 and 5a, O46 – Olexandrivs'k, b. 46, O40 – Olexandria, burial 40. Sec – Seciu, V2 – Vulcanești II. The dates Bln-5721, 5846, 5930 and 5932 are from Pietrele. **ST 3-4**. Done in OxCal by the Author

Supplementary Tables

ST 3-1 Radiocarbon dates for Cris in the region between Carpathians and Dnieper. Irrelevant dates in italics

Site name	Provenance	Lab. no.	Date BP	SD	Cultural aspect	Material	Calibration date range BC (1 sigma)	Calibration date range BC (2 sigmas)	Reference
Sarateni	cl	Ki-13903a	6470	200	?	TOCC potsherd	5620-5217	5760-4946	Covalenco 2017
Sarateni	cl	Ki-13903	7140	80	?	TOCC potsherd	6075-5911	6220-5840	Covalenco 2017
Sacarovca 1		Ki-13899a	6590	180	Cris IV	TOCC potsherd	5706-5366	5891-5130	Covalenco 2017
Sacarovca 1		Bln-2425	6650	50	Cris IV	charcoal	5624-5533	5641-5478	Covalenco 2017
Sacarovca 1		Ki-13899	6770	80	Cris IV	charcoal	5730-5571	5833-5531	Covalenco 2017
Sacarovca 1	object 21	BE-16910	6603	28	Cris IV	Fr-t of metacarpus	5610-5483	5616-5479	Kiosak et al. 2023
Sacarovca 1	object 44	BE-16911	6595	28	Cris IV	Fr-t of femur	5608-5481	5615-5477	Kiosak et al. 2023
Sacarovca 1	object 44	BE-18271	6592	27	Cris IV	Fr-t of a long bone	5606-5481	5614-5477	Kiosak et al. 2023
Sacarovca 1	object 46	BE-16912	6478	28	Cris IV	Fr-t of metacarpus	5476-5386	5479-5372	Kiosak et al. 2023
Soroca 2-1	cl	Bln-586	6825	150	PN	charcoal	5883-5568	5988-5479	Markevich 1974
Hlynske 1	Complex 1	TKA-20828	7080	30	Cris	TOCC potsherd	6006-5914	6019-5889	Haskevych et al. 2019
Bazkiv-Ostriv	Zone VIII, cl	TKA-20831	6625	25	Analogy to Cris by decoration	TOCC potsherd	5616-5532	5621-5481	Haskevych et al. 2019
Grumazesti-Delen	F21, Trench VIII, sq. 9-10	RoAMS-729.6	6756	40	Late Cris	Bos taurus, maxilla	5709-5627	5724-5569	Boroneant et al. 2019
Grumazesti-Delen	F21, Trench VIII, sq. 9-10, -1.75m	RoAMS-729.5	6561	41	Late Cris	Cervus elaphus, metacarpal	5552-5477	5618-5416	Boroneant et al. 2019
Grumazesti-Delen	M1, Trench IV, sq. 17-18, -1.2-1.4 m	RoAMS-729.7	6474	47	Late Cris	Homo sapiens, ulna	5476-5378	5522-5324	Boroneant et al. 2019
Trestiana		GrN-17003	6665	45	Cris III B		5629-5538	5660-5481	Mantu 2000
Trestiana		Lv-2155	6390	100	Cris III B		6472-5226	5555-5072	Mantu 2000
Seliste		No-index	6830	100	Cris				

ST 3-2 Radiocarbon dates for LBK in the region between Carpathians and Dnieper. Irrelevant dates in italics

Site name	Provenance	Lab. no.	Date BP	SD	Cultural aspect	Material	CalBC (1 sigma)	CalBC (2 sigmas)	Reference
Rivne I	*excavation area 2, sq. 54, pit 1, depth 1,6 m*	*Ki-12506*	*6570*	*60*	*Early LBK*	*Animal bone*	*5606-5480*	*5629-5385*	*Kovaliukh et al. 2007*
Rivne I	*sq. 38, sample 1*	*Ki-12508*	*6475*	*80*	*Early LBK*	*Animal bone*	*5510-5362*	*5612-5306*	*Kovaliukh et al. 2007*
Rivne I	*exc3, sq. 27*	*Ki-13856*	*6310*	*70*	*Early LBK*	*Animal bone*	*5366-5216*	*5469-5076*	*Kovaliukh et al. 2007*
Rivne I	sq. 3e, sample 2	VERA-4244	6230	31	Early LBK	Animal bone	5297-5080	5302-5070	Kiosak et al. 2023
Ratniv-II	fireplace 1	UBA-30429	6366	41	Notenkopf LBK	Emmerwheat	5462-5306	5470-5230	Motuzaite-Matuzeviciute, Telizhenko 2016
Ratniv-II	fireplace 1	UBA-27678	6299	33	Notenkopf LBK	Emmerwheat	5314-5228	5340-5214	Motuzaite-Matuzeviciute, Telizhenko 2016
Bilshivtsi	*lower layer*	*Ki-8076*	*6330*	*70*	*Notenkopf LBK*	*Animal bone*	*5374-5220*	*5475-5080*	*Kotova 2003*
Bilshivtsi	*Dig 1, hole 4*	*Ki-8077*	*6450*	*80*	*Notenkopf LBK*	*Animal bone*	*5481-5344*	*5606-5231*	*Kotova 2003*
Bilshivtsi	*lower layer*	*Ki-8078*	*6280*	*80*	*Notenkopf LBK*	*Animal bone*	*5360-5080*	*5466-5047*	*Kotova 2003*
Mainova Balka	*test-trench*	*Ki-11243*	*6430*	*140*	*Notenkopf LBK*	*Animal bone*	*5530-5230*	*5632-5062*	*Man'ko 2006*
Mainova Balka	*test-trench*	*Ki-11242*	*6310*	*150*	*Notenkopf LBK*	*Animal bone*	*5468-5077*	*5557-4910*	*Man'ko 2006*
Holyshiv	*Object 2, sq. 1a, h-5, sample 1*	*Ki-12502*	*6380*	*80*	*Notenkopf LBK*	*Potsherd*	*5468-5308*	*5507-5211*	*Kovaliukh et al. 2007*
Holyshiv	*Object 2, sq. 1a, h-5, sample 2*	*Ki-12507*	*6425*	*80*	*Notenkopf LBK*	*Potsherd*	*5473-5340*	*5528-5226*	*Kovaliukh et al. 2007*
Holyshiv	*Object 2*	*Ki-12503*	*6220*	*90*	*Notenkopf LBK*	*Potsherd*	*5300-5060*	*5458-4937*	*Kovaliukh et al. 2007*
Holyshiv	*Object 1, sq. 1b*	*Ki-12505*	*6270*	*90*	*Notenkopf LBK*	*Potsherd*	*5338-5072*	*5467-5011*	*Kovaliukh et al. 2007*
Târpesti-I	couche a ceramique rubanee	Bln-801	6245	100	Notenkopf LBK	Charcoal	5317-5060	5466-4961	Marinescu-Bîlcu 1971
Târpesti-I	couche a ceramique rubanee	Bln-800	6170	100	Notenkopf LBK	Charcoal	5288-4992	5327-4843	Marinescu-Bîlcu 1971
Girka Polonka		*Ki-12566*	*5950*	*80*	*Notenkopf LBK*	*Animal bone*	*4932-4728*	*5048-4617*	*Kovaliukh et al. 2007*
Hnidava-Rovantsi	*1968 excavations*	*Ki-12504*	*5825*	*90*	*Notenkopf LBK*	*Potsherd*	*4785-4559*	*4901-4463*	*Kovaliukh et al. 2007*
Hnyla Skelia	pit 1	BE-7645	6163	23	Notenkopf LBK	Animal bone	4986-4858	5000-4848	Kiosak et al. 2021
Hnyla Skelia	pit 1	BE-7646	6222	23	Notenkopf LBK	Animal bone	5000-4940	5041-4857	Kiosak et al. 2021
Kamyane-Zavallia	F2003	Poz-137908	6260	40	Notenkopf LBK	T. monococcum	5305-5208	5315-5068	Moskal-del-Hoyo et al 2023
Kamyane-Zavallia	F2003	Poz-137825	6150	50	Notenkopf LBK	T. monococcum	5206-5026	5215-4944	Moskal-del-Hoyo et al 2023
Kamyane-Zavallia	F2006	Poz-137560	6170	50	Notenkopf LBK	T. monococcum	5207-5050	5295-4987	Moskal-del-Hoyo et al 2023
Kamyane-Zavallia	F2006	Poz-137952	6140	40	Notenkopf LBK	Fallopia convolvulus	5206-5001	5211-4952	Moskal-del-Hoyo et al 2023
Kamyane-Zavallia	F2008	Poz-137826	6240	40	Notenkopf LBK	Triticum sp.	5301-5078	5308-5059	Moskal-del-Hoyo et al 2023
Kamyane-Zavallia	F2008	Poz-137827	6200	40	Notenkopf LBK	T. monococcum	5212-5065	5299-5030	Moskal-del-Hoyo et al 2023
Kamyane-Zavallia	F2009	Poz-137951	6290	50	Notenkopf LBK	Triticum sp.	5311-5214	5370-5070	Moskal-del-Hoyo et al 2023
Kamyane-Zavallia	F2009	Poz-137828	6250	40	Notenkopf LBK	T. monococcum	5304-5125	5370-5070	Moskal-del-Hoyo et al 2023
Kamyane-Zavallia	pit 1	Poz-67121	6200	40	Notenkopf LBK	Animal bone	5218-5070	5295-5045	Kiosak, Salavert 2018
Kamyane-Zavallia	pit 1	Poz-67554	6130	40	Notenkopf LBK	Animal bone	5206-4997	5211-4962	Kiosak, Salavert 2018
Nicolaevca 5	F3008	Poz-137959	6220	40	Notenkopf LBK	Cerealia indet.	5289-5070	5304-5045	Moskal-del-Hoyo et al 2023
Nicolaevca 5	F3022	Poz-137957	6180	50	Notenkopf LBK	Fallopia convolvulus	5210-5052	5297-4994	Moskal-del-Hoyo et al 2023
Nicolaevca 5	F3028	Poz-137955	6175	35	Notenkopf LBK	T. monococcum	5206-5058	5214-5006	Moskal-del-Hoyo et al 2023
Nicolaevca 5	*F3028*	*Poz-137958*	*5890*	*70*	*Notenkopf LBK*	*Chenopodium hybridum*	*4877-4680*	*4939-4551*	*Moskal-del-Hoyo et al 2023*
Nicolaevca 5	F3040	Poz-137954	6230	40	Notenkopf LBK	Fallopia convolvulus	5296-5073	5305-5053	Moskal-del-Hoyo et al 2023
Rovantsi	Pit 19	KIA-53054	6287	29	Notenkopf LBK	Human bone	5306-5216	5319-5209	Saile et al. 2021
Rovantsi	Pit 19	MAMS-35954	6263	29	Notenkopf LBK	Human bone	5302-5211	5313-5078	Saile et al. 2021
Rovantsi	Pit 21	Poz-137916	6190	35	Notenkopf LBK	Animal bone	5210-5068	5292-5032	Kiosak et al. 2023
Rovantsi	Pit 21	Poz-137918	6100	40	Notenkopf LBK	Animal bone	5202-4947	5209-4855	Kiosak et al. 2023
Floresti 1	Pit 18	BE-16907	6227	27	Notenkopf LBK	Animal bone	5293-5076	5301-5060	Kiosak et al. submt

ST 3-3 Precucuteni – Cucuteni A – Trypillia A1-3-B1 chronology in context

Site Name	Provenance	Phase	Lab. no.	Date BP	SD	Material	Calibration date range BC (1 sigma)	Calibration date range BC (2 sigmas)	Reference
Kyiv' dates									
Bernashivka	*Dwelling 5, 0.4-0.5 m deep*	*A2*	*Ki-6681*	*6510*	*55*	*frag. bone tool*	*5527-5378*	*5613-5362*	*Burdo, 2003*
Bernashivka	*Dwelling 6, 0.3-0.6 m deep*	*A2*	*Ki-6670*	*6440*	*60*	*animal bone*	*5474-5362*	*5517-5228*	*Burdo, 2003*
Okopy	*Dwelling 3, 0.3-0.6*	*A2*	*Ki-6671*	*6330*	*65*	*animal bone*	*5369-5215*	*5473-5081*	*Burdo, 2003*
Babshyn			*Ki-6686*	*6200*	*55*	*animal bone*	*5215-5051*	*5303-5000*	*Burdo, 2003*
Voronovytsia	*cultural layer, 0.45-0.6*	*A3*	*Ki-6677*	*6180*	*60*	*animal bone*	*5211-5045*	*5302-4952*	*Burdo, 2003*
Olexandrivka		*A3*	*Ki-11491*	*5930*	*80*	*animal bone*	*4928-4713*	*5025-4603*	*Burdo, 2003*
Olexandrivka		*A3*	*Ki-11492*	*5870*	*80*	*animal bone*	*4837-4614*	*4940-4539*	*Burdo, 2003*
Korman	*Excavation 1*	*A3*	*Ki-6675*	*6270*	*55*	*animal bone*	*5315-5128*	*5362-5058*	*Burdo, 2003*
Korman	*Excavation 1*	*A3*	*Ki-6676*	*6225*	*60*	*animal bone*	*5297-5065*	*5313-5010*	*Burdo, 2003*
Hrebeniukiv Yar	*pit 4*	*TrA3*	*Ki-6674*	*6165*	*55*	*bone*	*5210-5052*	*5292-4962*	*Burdo, 2003*
Hrebeniukiv Yar	*pit 4*	*TrA3*	*Ki-6673*	*6120*	*50*	*bone*	*5206-4982*	*5216-4913*	*Burdo, 2003*
Hrebeniukiv Yar	*dwelling 4*	*TrA3*	*Ki-6672*	*6040*	*65*	*bone*	*5018-4844*	*5206-4783*	*Burdo, 2003*
Sabatynivka II	*semi-dugout*	*TrA3*	*Ki-6680*	*6225*	*60*	*bone*	*5296-5076*	*5318-5026*	*Burdo, 2003*
Sabatynivka II	*semi-dugout*	*TrA3*	*Ki-6737*	*6100*	*55*	*bone*	*5205-4936*	*5212-4851*	*Burdo, 2003*
Hrenivka	*1948 excavation*	*TrA3*	*Ki-6683*	*5860*	*45*	*bone*	*4788-4689*	*4836-4606*	*Burdo, 2003*
Hrenivka	*1948 excavation*	*TrA3*	*Ki-6682*	*5800*	*50*	*bone*	*4716-4590*	*4782-4538*	*Burdo, 2003*
Conventional dates									
Bernashivka	Site ½ (pit)	TrA1-2	Ki-16545	5610	90	pig tooth	4535-4352	4680-4266	Rassamakin, 2012
Bernashivka	Site ½ (pit)	TrA1-2	Ki-16544	5450	70	animal bone	4360-4172	4445-4057	Rassamakin, 2012
Rogojeni		TrA1-2	Bln-2426	5700	55	charcoal	4605-4455	4696-4370	Rassamakin, 2012
Poduri-Dealul-Ghindaru	L36, 'sanctuary'	PCII	Bln-2804	5820	50	charcoal	4774-4605	4790-4545	Mantu, 2000
Tymkove		PCIII	Bln-3191	5700	70	charcoal?	4652-4458	4708-4371	Patokova et al. 1989
Poduri-Dealul-Ghindaru	L31	PCIII	Bln-2803	5880	150	charcoal	4932-4556	5206-4406	Monah 1987
Poduri-Dealul-Ghindaru	L8	PCIII	Bln-2782	5780	50	charcoal	4691-4558	4766-4499	Monah 1987
Târpesti I	1963	PCIII	Gm-4424	5540	85	charcoal	4484-4272	4582-4179	Vogel, Waterbalk 1972
Târgu Frumos-*Pătule*		PCIII	Lv-2152	5830	100	animal bone	4792-4554	4934-4462	Mantu 1998, tab. 7, nr. 7
AMS-dates									
Bernashivka	Site ½ (pit)	TrA1-2	OxA-22516	5772	30	charcoal	4680-4553	4707-4541	Rassamakin 2012
Bernashivka		TrA1-2	BE-18274	5647	26	animal bone	4531-4447	4542-4369	Novel
Bernashivka	Ploschadka 11	TrA1-2	PSUAMS-5111	5540	25	animal bone	4441-4345	4444-4340	Diachenko et al. 2024
Bernashivka	Ploschadka 11	TrA1-2	PSUAMS-5112	5485	30	animal bone	4355-4269	4440-4252	Diachenko et al. 2024
Rogojeni	Pit 4	TrA1-2	BE-16916	5801	27	animal bone	4682-4554	4704-4545	Novel
Rogojeni	Pit 4	TrA1-2	BE-16915	5775	27	animal bone	4707-4611	4719-4549	Novel
Rogojeni	Pit 3	TrA1-2	BE-16917	5682	27	animal bone	4540-4459	4600-4448	Novel
Cărbuna-Negrub	Test-trench	TrA3	BE-16920	5738	28	animal bone	4656-4536	4680-4497	Novel
Cărbuna-Negrub	Test-trench	TrA3	BE-16921	5702	27	animal bone	4581-4460	4646-4452	Novel
Cărbuna-Negrub	Ploschadka'	TrA3	Poz-112849	5770	40	animal bone	4680-4551	4716-4502	Diachenko et al. 2024
Mohylna-3	Soil section	TrA3	BE-16908	5699	26	animal bone	4549-4459	4607-4453	Novel
Mohylna-3	Soil section	TrA3	BE-16909	5679	27	animal bone	4539-4458	4599-4447	Novel
Cărbuna-2	Pit 6	TrA3	BE-18272	5666	26	animal bone	4530-4407	4539-4367	Novel
Cărbuna-2	Pit 6	TrA3	BE-16919	5577	27	animal bone	4440-4339	4444-4335	Novel
Cărbuna-2	Pit 9	TrA3	BE-18273	5640	26	animal bone	4534-4454	4580-4401	Novel
Cărbuna-2	Pit 9	TrA3	BE-16918	5529	28	animal bone	4444-4361	4453-4349	Novel
Cărbuna-2	Pit 1	TrA3	Poz-112848	5555	35	animal bone	4442-4351	4451-4340	Diachenko et al. 2024
Cărbuna-2	Pit 1	TrA3	Poz-112852	5485	35	animal bone	4357-4265	4442-4251	Diachenko et al. 2024
Cărbuna-1	*Test-trench*	*TrA3*	*Poz-112850*	*4970*	*35*	*animal bone*	*3781-3656*	*3909-3646*	*Diachenko et al. 2024*
Cărbuna-1	Test-trench	TrA3	Poz-112851	5530	40	animal bone	4441-4339	4450-4273	Diachenko et al. 2024
Sabatynivka-2		TrA3	BE-18276	5681	25	animal bone	4539-4458	4590-4447	Novel
Puhach-2	cultural layer	TrA3	BE-18268	5750	26	animal bone	4656-4543	4686-4503	Novel
Mykolyna Broiaka	cultural layer	TrA	BE-18270	5731	26	animal bone	4647-4505	4678-4493	Novel
Mohylna III	in the rubble of ploschadka	TrA3	BE-7650	5722	23	bone	4580-4501	4616-4466	Kiosak et al. 2021
Mohylna V	pit 1	TrA3	BE-7649	5712	22	bone	4599-4523	4677-4493	Kiosak et al. 2021
Hrebeniukiv Iar	pit, lowest level	TrA3	Poz-87462	5680	40	bone	4545-4453	4655-4369	Shatilo, 2021
Hrebeniukiv Iar	pit, lower fill, upper layer	TrA3	Poz-87463	5700	35	bone, cattle	4587-4457	4671-4449	Shatilo, 2021
Hrebeniukiv Iar	pit, lower fill, upper layer	TrA3	Poz-87464	5685	35	bone, cattle	4545-4455	4651-4406	Shatilo, 2021
Hrebeniukiv Iar	pit, upper pit fill	TrA3	Poz-87466	5585	35	bone, cattle	4446-4363	4492-4347	Shatilo, 2021
Hrebeniukiv Iar	pit, upper pit fill	TrA3	Poz-87468	5110	35	bone, cattle	3965-3807	3980-3797	Shatilo, 2021
Isaiia-Balta Popii	IIB layer	PCII/III	Poz-84452	5680	40	animal bone	4545-4453	4655-4369	Vornicu 2017, 192
Isaiia-Balta Popii	IIB layer, L14	PCII/III	Poz-84453	5660	40	animal bone	4537-4449	4601-4364	Vornicu 2017, 192
Târgu Frumos-Pătule		PCIII	Poz-84428	5590	40	animal bone	4450-4360	4497-4346	Vornicu et al. 2018, 161
Târgu Frumos-Pătule		PCIII	Poz-84429	5490	30	animal bone	4357-4270	4441-4255	Vornicu et al. 2018, 161
Târgu Frumos-Pătule		PCIII	Poz-84427	5480	40	animal bone	4357-4261	4442-4247	Vornicu et al. 2018, 161
Mentioned dates for Cucuteni A - Trypillia B1									
Putinești III		CuA-TrB1	Bln-2427	5595	80	animal bone	4494-4349	4650-4262.5	Mantu 1998
Putinești III		CuA-TrB1	Lv-2156	5520	70	charcoal	4445.5-4273.5	4531.5-4239	Wechler 1994
Putinești III		CuA-TrB1	Hd-19441	5379	32	charcoal	4325-4168.5	4332.5-4056.5	Lazarovici 2010
Putinești III		CuA-TrB1	Ki-613	5060	120	charcoal	3965.5-3708.5	4225-3632	Telegin 1985
Drăgușeni-Ostrov		CuA-TrB1	Bln-1195	5430	100	charcoal	4359-4059.5	4453-3993.5	Mantu 1998
Drăgușeni-Ostrov		CuA-TrB1	Bln-1060	5355	100	charcoal	4324.5-4052	4359-3968	Mantu 1998
Drăgușeni-Ostrov		CuA-TrB1	Bln-1194	5205	100	charcoal	4229-3819.5	4320-3784.5	Mantu 1998
Scânteia		CuA-TrB1	Gd-4685	5750	110	animal bone	4714.5-4457	4834.5-4357.5	Lazarovici 2010
Scânteia		CuA-TrB1	Hd-14701	5388	18	animal bone	4322.5-4240	4330-4167.5	Mantu 1998
Scânteia		CuA-TrB1	Hd-14792	5370	26	animal bone	4321.5-4080	4328.5-4056	Mantu 1998
Scânteia		CuA-TrB1	Hd-16700	5345	51	animal bone	4313-4057.5	4328.5-4045.5	Lazarovici 2010
Scânteia		CuA-TrB1	Gd-6388	5330	110	animal bone	4321.5-4044.5	4439.5-3946	Lazarovici 2010
Scânteia		CuA-TrB1	Hd-16701	5205	63		4216.5-3952.5	4236-3806	Lazarovici 2010
Preuteşti -Haltă		CuA-TrB1	Hd-14817	5423	26	bone	4330.5-4254	4340.5-4240.5	Mantu 1998
Cuconeştii Vechi		CuA-TrB1	Bln-2428	5390	60		4333.5-4071.5	4344.5-4050.5	Mantu 1998
Leca-Ungureni		CuA-TrB1	Bln-795	5345	100	wheat	4321.5-4050	4353.5-3967.5	Mantu 1998
Hăbăşeşti		CuA-TrB1	GrN-1985	5340	80	charcoal	4316.5-4051.5	4336.5-3987.5	Mantu 1998
Dumeşti		CuA-TrB1	Hd-19572	5280	27	animal bone	4224.5-4043.5	4232.5-3991	Lazarovici 2010
Polyvaniv Yar		CuA-TrB1	GrN-5134	5540	70	charcoal	4449-4334	4536-4251	Popova 2003
Sabatynivka I		*CuA-TrB1*	*Ki-7202*	*5805*	*65*	*animal bone*	*4720-4549.5*	*4825-4494.5*	*Burdo 2003*
Berezivska GES		*CuA-TrB1*	*Ki-7203*	*5760*	*55*	*animal bone*	*4681-4543.5*	*4723.5-4454.5*	*Burdo 2003*
Berezivska GES		*CuA-TrB1*	*Ki-7204*	*5710*	*60*	*animal bone*	*4649-4455.5*	*4709.5-4399*	*Burdo 2003*

Berezivska GES	Ber1	*CuA-TrB1*	PSUAMS-4644	5295	25	animal bone	4226-4049	437-3999	Harperetal. 2023
Berezivska GES	Ber1	*CuA-TrB1*	PSUAMS-4638	5285	25	animal bone	4225-4046	4233-3994	Harperetal. 2023
Berezivska GES	BerII	*CuA-TrB1*	PSUAMS-4637	5235	25	animal bone	4049-3984	4210-3964	Harperetal. 2023
Berezivska GES	BerII	*CuA-TrB1*	PSUAMS-4643	5220	25	animal bone	4943-3983	4211-3964	Harperetal. 2023
Berezivska GES		CuA-TrB1	BE-10317	5438	21	animal bone	4334.5-4259.5	4342.5-4249.5	Kiosaketal. 2020
Berezivska GES		CuA-TrB1	BE-10318	5406	21	animal bone	4326.5-4248	4333.5-4175	Kiosaketal. 2020
Berezivska GES		CuA-TrB2	Poz-160795	5450	40	animal bone	4345-4255	4360-4172	Lobanova 2024
Berezivska GES		CuA-TrB3	Poz-160796	5380	40	animal bone	4327-4079	4335-4055	Lobanova 2024
Berezivska GES		CuA-TrB4	Poz-160797	5370	40	animal bone	4324-4068	4331-4053	Lobanova 2024
Kamyane-Zavallia 1		CuA-TrB1	BE-7652	5346	21	animal bone	4246.5-4065	4317.5-4052.5	Kiosaketal. 2020
Kamyane-Zavallia 1		CuA-TrB1	BE-7651	5424	21	animal bone	4330-4255.5	4337-4246.5	Kiosaketal. 2020
Shamrai		CuA-TrB1	BE-7653	5394	21	animal bone	4324.5-4241.5	4332.5-4169.5	Kiosaketal. 2020
Voloshkovo-Gorby		CuA-TrB1	PSUAMS-4984	5435	25	animal bone	4335-4258	4342-4248	Diachenko et al. 2024
Voloshkovo-Gorby		CuA-TrB1	PSUAMS-5093	5415	20	animal bone	4328-4252	4335-4243	Diachenko et al. 2024
Voloshkovo-Gorby		CuA-TrB1	PSUAMS-5079	5360	20	animal bone	4316-4076	4323-4056	Diachenko et al. 2024
Vadul-lui-Voda		CuA-TrB1	Poz-119241	5370	40	animal bone	4324-4068	4331-4053	Diachenko et al. 2024
Glybochok		CuA-TrB1	Poz-142939	5360	35	animal bone	4319-4066	4327-4052	Diachenko et al. 2024
Glybochok		CuA-TrB1	Poz-142940	5340	40	animal bone	4247-4058	4322-4048	Diachenko et al. 2024
Ozhevo-Ostrov		CuA-TrB1	PSUAMS-5116	5320	25	animal bone	4233-4057	4243-4049	Diachenko et al. 2024
Ozhevo-Ostrov		CuA-TrB1	PSUAMS-5115	5295	20	animal bone	4225-4049	4234-4045	Diachenko et al. 2024
Ozhevo-Ostrov		CuA-TrB1	PSUAMS-5113	5285	25	animal bone	4225-4046	4233-3994	Diachenko et al. 2024
Ozhevo-Ostrov		CuA-TrB1	PSUAMS-5114	5225	40	animal bone	4154-3974	4226-3803	Diachenko et al. 2024
Goloskov 1		CuA-TrB1	Poz-140804	5160	40	animal bone	4041-3945	4150-3803	Diachenko et al. 2024
Vasylivka		CuA-TrB1	PSUAMS-4635	5115	20	animal bone	3964-3815	3975-3803	Diachenko et al. 2024
Zarubyntsi		CuA-TrB1	PSUAMS-4639	5275	25	animal bone	4223-3998	4230-3990	Harperetal. 2023
Vesely Kut		TrB1-B2	PSUAMS-4640	5230	25	animal bone	4047-3985	4218-3969	Harperetal. 2023
Vesely Kut		TrB1-B2	PSUAMS-4642	5225	25	animal bone	4045-3985	4215-3967	Harperetal. 2023

ST 3-4 Comparative material for Trypillia B1 chronology

Site Name	Cult-aspect	Lab. Number	Date BP	SD	Material	Calibration date range BC (1 sigma)	Calibration date range BC (2 sigmas)	Reference
Site		Lab N	Age, BP	+/-	Material			Reference
Mălăieştii de Jos	Bolhrad-Aldeni	DeA-5863	5410	34		4328.5-4247.5	4343.5-4073.5	Frinculeasa 2016
Mălăieştii de Jos	Bolhrad-Aldeni	DeA-5861	5382	35		4326.5-4169	4334-4056	Frinculeasa 2016
Mălăieştii de Jos	Bolhrad-Aldeni	DeA-5862	5377	34		4325-4083	4332-4056	Frinculeasa 2016
Seciu	Bolhrad-Aldeni	Poz-40632	5455	35		4343.5-4259.5	4355-4244.5	Frinculeasa 2016
Vulcăneşti II	Bolhrad-Aldeni	LE-640	5300	60		4233.5-4046.5	4318-3983.5	Subbotin 1983
Vulcăneşti II	Bolhrad-Aldeni	Mo-417	5810	150		4835-4462.5	5026-4349.5	Subbotin 1983
Pietrele	Gumelnita	Bln-5721	5452	37	charcoal	4343.5-4257.5	4357.5-4239.5	Reingruber, Rassamakin 2016
Pietrele	Gumelnita	Bln-5846	5503	49	charcoal	4440.5-4265.5	4449-4250	Reingruber, Rassamakin 2016
Pietrele	Gumelnita	Bln-5932	5473	32	charcoal	4350-4265	4436-4249.5	Reingruber, Rassamakin 2016
Pietrele	Gumelnita	Bln-5930	5478	36	charcoal	4353-4264.5	4440-4247.5	Reingruber, Rassamakin 2016
Settlements of Steppe Eneolithic								
Strilcha Skelia, III l.	Steppe Eneolithic	Ki-8172	5480	70	Animal bone	4440.5-4248	4486-4063.5	Kotova 2008
Strilcha Skelia, IV l.	Steppe Eneolithic	Ki-8173	5630	70	Animal bone	4534.5-4363.5	4655.5-4340	Kotova 2008
Semenivka	Steppe Eneolithic	Ki-7673	5525	70	Animal bone	4447-4328.5	4534.5-4241.5	Kotova 2008
Semenivka	Steppe Eneolithic	Ki-7672	5440	60	Animal bone	4349.5-4240	4441-4056	Kotova 2008
Semenivka	Steppe Eneolithic	Ki-7674	5655	60	Animal bone	4545.5-4368.5	4656-4352.5	Kotova 2008
Rozdol'ne	Steppe Eneolithic	Ki-8005	5630	90	Animal bone	4539.5-4359	4690.5-4330.5	Kotova 2008
Rozdol'ne	Steppe Eneolithic	Ki-8004	5825	80	Animal bone	4784.5-4553.5	4890.5-4459.5	Kotova 2008
Olexandria	Steppe Eneolithic	Ki-9447	5630	120	potsherd	4600-4347	4778.5-4247	Kotova 2008
Burials of Steppe Eneolithic	Steppe Eneolithic							
Chapli	Steppe Eneolithic	Ki-11079	5840	90	Human bone	4794.5-4552	4932-4459.5	Kotova 2008
Kryvyi Rih, b.3	Steppe Eneolithic	Ki-14664	5430	80	Human bone	4355-4071.5	4443-4048.5	Rassamakin 2009
Kryvyi Rih, b.2	Steppe Eneolithic	Ki-15990	5370	60	Human bone	4325-4064.5	4336.5-4048.5	Reingruber, Rassamakin 2016
Dereivka II, b. 12	Steppe Eneolithic	OxA-5030	5380	90	Human bone	4332.5-4059	4433-3985.5	Telegin 1986
Shakhtar 29/5	Steppe Eneolithic	Ki-13868	5440	100	Human bone	4437-4064.5	4486-3997	Rassamakin 2009
Shakhtar 29/5	Steppe Eneolithic	Bln-5779	5478	37	Human bone	4353.5-4263.5	4440.5-4247	Rassamakin 2009
Shakhtar 29/4	Steppe Eneolithic	Ki-13870	5480	100	Human bone	4446.5-4176.5	4534.5-4049.5	Rassamakin 2009
Cainari	Steppe Eneolithic	KIA-369	5580	50	Human bone	4446-4359	4530.5-4338	Govedarica 2004
Giurgiulesti	Steppe Eneolithic	Ki-7037	5560	80	Human bone	4488.5-4335	4587-4246.5	Govedarica, Manzura 2016
Giurgiulesti, b.3	Steppe Eneolithic	MAMS-23175	5370	26	Human bone	4321.5-4080	4328.5-4056	Govedarica, Manzura 2016
Giurgiulesti, b.3	Steppe Eneolithic	MAMS-28087	5504	31	Animal bone	4437-4328.5	4443-4263	Govedarica, Manzura 2016
Giurgiulesti, b.4	Steppe Eneolithic	MAMS-28088	5571	32	Human bone	4442.5-4358.5	4482-4344.5	Govedarica, Manzura 2016
Decia Muresului, b. 12	Steppe Eneolithic	KIA-368	5380	40	Human bone	4327-4079	4334.5-4054.5	Govedarica 2004
Vynohradne 3/15	Steppe Eneolithic	Ki-14726	5230	60	Human bone	4220-3966	4239.5-3949	Rassamakin 2009
Ihren VIII, b.5	Steppe Eneolithic	Ki-8304	5745	60	Human bone	4681-4504.5	4721-4449.5	Kotova 2008
Ihren VIII, b.13	Steppe Eneolithic	Ki-12560	5340	60	Human bone	4312.5-4054	4329-3998	Kotova 2013
Ihren VIII, 5a	Steppe Eneolithic	OxA-17541	5390	33	Human bone	4326.5-4173.5	4335.5-4061	Lillie et al. 2009
Olexandrivs'k, b. 46	Steppe Eneolithic	Ki-13002	5690	70	Human bone	4648.5-4446.5	4696-4362	Kotova 2008
Olexandria, b. 40	Steppe Eneolithic	Poz-78001	5555	35	Human bone	4442-4350.5	4450.5-4340	Rassamakin 2017
Olexandria, b.4	Steppe Eneolithic	Ki-104	5470	350	Human bone	4722.5-3819.5	5207.5-3631	Telegin 1986

Models

Model 3-1 Precucuteni – Cucuteni A / Trypillia A – B1. AMS dates with overlapping phases

```
Plot()
  {
    Phase()
    {
      Sequence()
      {
        Boundary("Start PII-ETA1-2");
        Phase("PII-ETA1-2")
        {
          R_Date("OxA-22516", 5772, 30);
          R_Date("BE-18274", 5647, 26);
          R_Date("BE-16916", 5801, 27);
          R_Date("BE-16915", 5775, 27);
          R_Date("BE-16917", 5682, 27);
          R_Date("PSUAMS-5111",5540,25);
          R_Date("PSUAMS-5112",5485,30);
        };
        Boundary("End PII-ETA1-2");
      };
      Sequence()
      {
        Boundary("Start PIII-ETA3");
        Phase("PIII-ETA3")
        {
          R_Date("BE-16920", 5738, 28);
          R_Date("BE-16921", 5702, 27);
          R_Date("BE-16908", 5699, 26);
          R_Date("BE-16909", 5679, 27);
          R_Date("BE-18272", 5666, 26);
          R_Date("BE-16919", 5577, 27);
          R_Date("BE-18273", 5640, 26);
          R_Date("BE-16918", 5529, 28);
          R_Date("BE-18276", 5681, 25);
          R_Date("BE-18268", 5750, 26);
          R_Date("BE-18270", 5731, 26);
          R_Date("BE-7650", 5722, 23);
          R_Date("BE-7649", 5712, 22);
          R_Date("Poz-87462", 5680, 40);
          R_Date("Poz-87463", 5700, 35);
          R_Date("Poz-87464", 5685, 35);
          R_Date("Poz-84452", 56 80 , 40);
          R_Date("Poz-84453", 5660, 40);
          R_Date("Poz-84428", 5590, 40);
          R_Date("Poz-84429", 5490 , 30);
          R_Date("Poz-84427", 5480 , 40);
```

```
            R_Date("Beta-506983",5650,30);
            R_Date("Beta-506984",5660,30);
            R_Date("Beta-506985",5690,30);
            R_Date("Beta-506986",5630,30);
            R_Date("Beta-506987",5640,30);
            R_Date("DeA-13462",5732,32);
            R_Date("De-13463",5788,31);
            R_Date("DeA-28170",5714,37);
            R_Date("Poz-112849",5770,40);
            R_Date("Poz-112848",5555,35);
            R_Date("Poz-112852",5485,35);
            R_Date("Poz-112851",5530,40);
         };
         Boundary("End PIII-ETA3");
      };
      Sequence()
      {
         Boundary("Start CuA-TrB1");
         Phase("CuA-TrB1")
         {
            R_Date("BE-10317", 5438, 21);
            R_Date("BE-10318", 5406, 21);
            R_Date("BE-7652", 5346, 21);
            R_Date("BE-7651", 5424, 21);
            R_Date("BE-7653", 5394, 21);
            R_Date("PSUAMS-4644",5295,25);
            R_Date("PSUAMS-4638",5285,25);
            R_Date("PSUAMS-4637",5235,25);
            R_Date("PSUAMS-4643",5220,25);
            R_Date("Poz-160795",5450,40);
            R_Date("Poz-160796",5380,40);
            R_Date("Poz-160797",5370,40);
            R_Date("PSUAMS-4984",5435,25);
            R_Date("PSUAMS-5093",5415,20);
            R_Date("PSUAMS-5079",5360,20);
            R_Date("Poz-119241",5370,40);
            R_Date("Poz-142939",5360,35);
            R_Date("Poz-142940",5340,40);
            R_Date("PSUAMS-5116",5320,25);
            R_Date("PSUAMS-5115",5295,20);
            R_Date("PSUAMS-5113",5285,25);
            R_Date("PSUAMS-5114",5225,40);
            R_Date("Poz-140804",5160,40);
            R_Date("PSUAMS-4635",5115,20);
            R_Date("PSUAMS-4639",5275,25);
         };
         Boundary("End CuA-TrB1");
      };
   };
};
```

Model 3-2 Precucuteni – Cucuteni A / Trypillia A – B1. AMS dates with sequential phases

```
Plot()
  {
    Sequence()
    {
      Boundary("Start 1");
      Phase("1")
      {
            R_Date("OxA-22516", 5772, 30);
            R_Date("BE-18274", 5647, 26);
            R_Date("BE-16916", 5801, 27);
            R_Date("BE-16915", 5775, 27);
            R_Date("BE-16917", 5682, 27);
            R_Date("PSUAMS-5111",5540,25);
            R_Date("PSUAMS-5112",5485,30);
      };
      Boundary("End 1");
      Boundary("Start 2");
      Phase("2")
      {
            R_Date("BE-16920", 5738, 28);
            R_Date("BE-16921", 5702, 27);
            R_Date("BE-16908", 5699, 26);
            R_Date("BE-16909", 5679, 27);
            R_Date("BE-18272", 5666, 26);
            R_Date("BE-16919", 5577, 27);
            R_Date("BE-18273", 5640, 26);
            R_Date("BE-16918", 5529, 28);
            R_Date("BE-18276", 5681, 25);
            R_Date("BE-18268", 5750, 26);
            R_Date("BE-18270", 5731, 26);
            R_Date("BE-7650", 5722, 23);
            R_Date("BE-7649", 5712, 22);
            R_Date("Poz-87462", 5680, 40);
            R_Date("Poz-87463", 5700, 35);
            R_Date("Poz-87464", 5685, 35);
            R_Date("Poz-84452", 56 80 , 40);
            R_Date("Poz-84453", 5660, 40);
            R_Date("Poz-84428", 5590, 40);
            R_Date("Poz-84429", 5490 , 30);
            R_Date("Poz-84427", 5480 , 40);
            R_Date("Beta-506983",5650,30);
            R_Date("Beta-506984",5660,30);
            R_Date("Beta-506985",5690,30);
            R_Date("Beta-506986",5630,30);
            R_Date("Beta-506987",5640,30);
            R_Date("DeA-13462",5732,32);
            R_Date("De-13463",5788,31);
            R_Date("DeA-28170",5714,37);
```

```
            R_Date("Poz-112849",5770,40);
            R_Date("Poz-112848",5555,35);
            R_Date("Poz-112852",5485,35);
            R_Date("Poz-112851",5530,40);
          };
        };
        Boundary("End 2");
        Boundary("Start 3");
        Phase("3")
        {
          R_Date("BE-10317", 5438, 21);
          R_Date("BE-10318", 5406, 21);
          R_Date("BE-7652", 5346, 21);
          R_Date("BE-7651", 5424, 21);
          R_Date("BE-7653", 5394, 21);
            R_Date("PSUAMS-4644",5295,25);
            R_Date("PSUAMS-4638",5285,25);
            R_Date("PSUAMS-4637",5235,25);
            R_Date("PSUAMS-4643",5220,25);
            R_Date("Poz-160795",5450,40);
            R_Date("Poz-160796",5380,40);
            R_Date("Poz-160797",5370,40);
            R_Date("PSUAMS-4984",5435,25);
            R_Date("PSUAMS-5093",5415,20);
            R_Date("PSUAMS-5079",5360,20);
            R_Date("Poz-119241",5370,40);
            R_Date("Poz-142939",5360,35);
            R_Date("Poz-142940",5340,40);
            R_Date("PSUAMS-5116",5320,25);
            R_Date("PSUAMS-5115",5295,20);
            R_Date("PSUAMS-5113",5285,25);
            R_Date("PSUAMS-5114",5225,40);
            R_Date("Poz-140804",5160,40);
            R_Date("PSUAMS-4635",5115,20);
            R_Date("PSUAMS-4639",5275,25);

        };
        Boundary("End 3");
      };
    };
```

Model 3-3 Precucuteni – Cucuteni A / Trypillia A – B1. Selected dates with sequential phases

```
Plot()
  {
    Sequence()
    {
      Boundary("Start TrA1-2");
      Phase("TrA1-2")
      {
        R_Date("Bern,OxA-22516", 5772, 30);
        R_Date("Rog, BE-16915", 5775, 27);
        R_Date("Rog, BE-16916", 5801, 27);
        R_Date("PDG,Bln-2804", 5820, 50);
      };
      Boundary("End TrA1-2");
      Boundary("Start TrA3");
      Phase("TrA3")
      {
        R_Date("CII-9,BE-16918", 5529, 28);
        R_Date("T1,Grn-4424", 5540, 85);
        R_Date("CII-6,BE-16919", 5577, 27);
        R_Date("HI,Poz-87466", 5585, 35);
        R_Date("CII-9,BE-18273", 5640, 26);
        R_Date("CII-6,BE-18272", 5666, 26);
        R_Date("M3,BE-16909", 5679, 27);
        R_Date("HI,Poz-87462", 5680, 40);
        R_Date("Sab,BE-18276", 5681, 25);
        R_Date("HI,Poz-87464", 5685, 35);
        R_Date("M3,BE-16908", 5699, 26);
        R_Date("Tym,Bln-3191", 5700, 70);
        R_Date("HI,Poz-87463", 5700, 35);
        R_Date("CN,BE-16921", 5702, 27);
        R_Date("M5,BE-7649", 5712, 22);
        R_Date("M3,BE-7650", 5722, 23);
        R_Date("CN,BE-16920", 5738, 28);
        R_Date("Beta-506983",5650,30);
        R_Date("Beta-506984",5660,30);
        R_Date("Beta-506985",5690,30);
        R_Date("Beta-506986",5630,30);
        R_Date("Beta-506987",5640,30);
        R_Date("DeA-13462",5732,32);
        R_Date("DeA-28170",5714,37);
      };
      Boundary("End TrA3");
      Boundary("Start TrB1");
      Phase("TrB1")
      {
        R_Date("Bln-1194", 5205, 100);
        R_Date("Ki-882", 5310, 160);
        R_Date("GrN-1985", 5330, 80);
```

```
    R_Date("Bln-795", 5345, 100);
    R_Date("BE-7652", 5346, 21);
    R_Date("Hd-15278", 5349, 40);
    R_Date("Bln-2766", 5350, 80);
    R_Date("Bln-1060", 5355, 100);
    R_Date("Hd-14792", 5370, 26);
    R_Date("Hd-15039", 5385, 37);
    R_Date("Hd-14701", 5388, 18);
    R_Date("Bln-2428", 5390, 60);
    R_Date("BE-7653", 5394, 21);
    R_Date("Bln-2805", 5400, 70);
    R_Date("BE-10318", 5406, 21);
    R_Date("Hd-15082", 5407, 20);
    R_Date("Bin-2802", 5420, 150);
    R_Date("Gd-4682", 5420, 150);
    R_Date("Hd-14817", 5423, 26);
    R_Date("BE-7651", 5424, 21);
    R_Date("Bln-1195", 5430, 100);
    R_Date("BE-10317", 5438, 21);
    R_Date("GrN-5134", 5440, 70);
    R_Date("Lv-2153", 5470, 90);
    R_Date("Bln-1535", 5485, 60);
    R_Date("Gd-5860", 5490, 80);
    R_Date("Hd-14109", 5497, 100);
    R_Date("Bln-2824", 5500, 60);
    R_Date("Lv-2156", 5520, 70);
    R_Date("Hd-15324", 5529, 29);
    R_Date("Bln-590", 5565, 100);
    R_Date("Hd-15401", 5575, 35);
    R_Date("Bln-2427", 5595, 80);
      R_Date("PSUAMS-4644",5295,25);
      R_Date("PSUAMS-4638",5285,25);
      R_Date("PSUAMS-4637",5235,25);
      R_Date("PSUAMS-4643",5220,25);
      R_Date("Poz-160795",5450,40);
      R_Date("Poz-160796",5380,40);
      R_Date("Poz-160797",5370,40);
      R_Date("PSUAMS-4984",5435,25);
      R_Date("PSUAMS-5093",5415,20);
      R_Date("PSUAMS-5079",5360,20);
      R_Date("Poz-119241",5370,40);
      R_Date("Poz-142939",5360,35);
      R_Date("Poz-142940",5340,40);
      R_Date("PSUAMS-5116",5320,25);
      R_Date("PSUAMS-5115",5295,20);
      R_Date("PSUAMS-5113",5285,25);
      R_Date("PSUAMS-5114",5225,40);
      R_Date("Poz-140804",5160,40);
      R_Date("PSUAMS-4635",5115,20);
      R_Date("PSUAMS-4639",5275,25);
};
```

```
        Boundary("End TrB1");
    };
};
```

4 The Neolithisation: A Micro-Regional Approach

Summary 4.1 The Neolithic in the Southern Buh Valley: Concept and Range. – 4.2 Looking for Interaction in Time. – 4.3 Looking for Interaction in Space.– 4.4 Conclusion.

As demonstrated in the previous chapters, the Neolithic early farming societies primarily emerged and expanded during the sixth millennium BCE in the Carpathian-Dnieper region. During these early stages, their dispersal mainly occurred through the migration of human groups, sometimes covering significant distances. These groups subsequently established themselves in new territories, cutting down forests, cleaning fields and building permanent settlements. However, these lands were inhabited by a local population: groups of fishers, hunters and gatherers equipped with pottery. What kind of influence local groups had on the process of Neolithisation? Had they interacted with newcomers, modifying their culture and adopting innovative traits from elsewhere? This question has been asked and will continue to be asked in relation to each region that has undergone Neolithisation. However, before examining these potential interactions, it is essential to establish with certainty whether these distinct human groups intersected in time and space: that there was a territory inhabited by both populations more or less during the same time. These spatial and temporal

'windows of possibilities' are necessary but insufficient prerequisites for any interaction.

This problem is directly related to the spatial aspect of the life of human societies. It is about how groups of people with different economic backgrounds use space. In this context, space becomes an economic resource and an independent factor of production, crucial in creating static and dynamic advantages for groups operating within it. In essence, it emerges as a fundamental element in determining the competitiveness of a local production system. Therefore, we propose to shift our attention to the example of a separate, well-studied, and relatively well-dated micro-region inhabited in the period under question. Thus, let us turn to the Southern Buh region (SBR).

4.1 The Neolithic in the Southern Buh Valley: Concept and Range

The Neolithic of the Southern Buh Valley was destined to play a special role in Ukrainian Neolithic studies. Here, V.M. Danilenko discovered and studied what he believed to be perhaps the earliest evidence of agriculture and cattle breeding in Ukraine.[1] Local ceramic hunter-gatherers have long been perceived as farmers and pastoralists under significant Balkan influence.[2] Now, it is known that their acquaintance with agriculture was limited or non-existent.[3] Instead, the first remains of domesticated plants have been found at LBK settlements.[4] Accordingly, modern ideas about the time and nature of the Neolithisation of the Southern Buh Valley have changed radically. After the decline of LBK, the Precucuteni-Early Trypillian groups densely populated the region by founding their settlements and leaving their traces (ceramics and lithic tools) at fishing camps near the river rapids.[5] Later, Trypillian groups settled the region, and their settlements showed abundant evidence of contact with the mobile population of the steppe, such as specific types of ceramics and bifacial dart points.[6]

The Southern Buh is a major river flowing down the Podillia highland into the Black Sea, roughly southeast. It is 860 km long and has a catchment of 63,700 km^2. The river flows through the physical and geographical zones of forest-steppe and steppe. Its catchment is

1 Danilenko 1969.

2 Haskevych et al. 2019.

3 Motuzaite Matuzeviciute 2020.

4 Moskal-del Hoyo et al. 2023.

5 Burdo 1997.

6 Kiosak, Lobanova 2021.

located within several geostructural regions. The upper part of the basin is located on the Volhynian-Podillian Upland, the middle part is within the Dnieper Upland, and the lower reaches belong to the Black Sea Lowland.[7]

In its upper reaches, the Southern Buh flows through open wetlands in low banks and has the character of a typical lowland river: slow, meandering and relatively narrow. In the middle reaches, from the mouth of Ikva River to the mouth of Bakshala River, the Southern Buh forms a deep valley, 200-600 m wide, with rising banks (up to 90 m), almost everywhere steep and rocky. Its waters are much faster than upstream.[8] Here, the Ukrainian Crystal Shield comes to the surface, thanks to which the Southern Buh is known for its rapids, rifts, and rapid flows in the riverbed. They have been attractive fishing locations since ancient times. In the lower reaches (below the mouth of Bakshala River), within the Black Sea Lowland, the valley and channel of the Southern Buh widen considerably. The width of the riverbed reaches 2 km, and the flow practically stops. Below the mouth of the Ingul River (the left tributary), the Buh Lyman begins, which has the form of an estuary. Further, the Buh estuary joins the Dnieper estuary to flow jointly into the Black Sea.[9]

The Southern Buh catchment serves as a natural corridor uniting the hilly landscapes of Podillia and the Dnieper uplands on one side and the steppe Black Sea lowland's much flatter terrain. River terraces are not typically visible along the Southern Buh River, with only occasional steep cliffs separating the narrow floodplain from the loess-covered hilly plateau above.

The SBR has been home to the communities, characterised by their pottery-equipped fisher-hunter-gatherer way of life, since at least 5600 BCE, possibly even earlier.[10] The para-Neolithic sites in this region endured until the early fifth millennium BCE, aligning closely with some radiocarbon dates from that period.[11] The SBR boasts over 40 noteworthy para-Neolithic sites, including Gard, Puhach, Sokiltsi 1, 2 and 6, Haivoron-Polizhok, Zavallia, Zhakchyk, Savran, and Melnychna Krucha. Among these, Melnychna Krucha stands out with its several stratigraphic units of para-Neolithic habitation. The earliest layer (SU2) has been dated to 5977-5651 cal BCE (2σ), while the subsequent unit (SU-R4) falls within the range of 4973-4836 cal BCE (2σ).[12] At Gard,

7 Marynych 1990.

8 Doroshkevych 2018.

9 Konikov 2007.

10 Kiosak et al. 2021b.

11 Gaskevych 2014; Haskevych et al. 2019.

12 Kiosak et al. 2021b.

two distinct para-Neolithic layers were uncovered: a lower layer characterised by pottery in the Pechera style and an upper layer featuring Savran-style pottery. However, radiocarbon dating yielded dates that contradicted the observed stratigraphy, appearing in reverse order.[13] Criş potsherds have been sporadically discovered at para-Neolithic sites, yet these sites lack evidence of agriculture and herding.

Early farmers arrived in the region approximately between 5250 and 5100 years BCE with the expansion of the LBK.[14] The earliest direct evidence of an agricultural economy, including remnants of wheat, barley, and domestic animal bones, emerges during the LBK period.[15] In the Southern Buh Valley, there are four LBK sites and four stray finds of LBK potsherds. Two of them, Kamyane-Zavallia and Hnyla Skelia **[fig. 60: 8, 10]**, have yielded evidence of settlement structures (pits), confirming them as LBK settlements,[16] while the other two, Syne Ozero **[fig. 60: 7]** and Zhakchyk 3 **[fig. 60: 13]**, are identified based on surface material.[17] Four LBK stray finds are reported from para-Neolithic sites of Gard, Dobrianka 3, Schurivtsi-Porih **[fig. 60: 1]**, and Bazkiv-Ostriv. LBK settlements of the SBR have twelve AMS dates available,[18] which can be calibrated to the period of 5300-4950 cal BCE (2σ).

Following the LBK period, the next wave of early farmers to enter the region were Precucutenian (Early Trypillian) groups.[19] These Precucutenian groups are represented by 25 settlements. Habitation structures have been confirmed through excavations (Haivoron, Sabatynivka 2, Danylova Balka, Hrenivka, and Hrebeniukiv Yar, **[fig. 60: 2, 17, 18, 21]**) or habitation structures were detected directly on the surface at sites like Mohylna 1-5 **[fig. 60: 11-12]**. Furthermore, Precucutenian artefacts have been discovered in para-Neolithic contexts at sites such as Haivoron-Polizhok, Gard, Gard 1 and 2, and Puhach 1 and 2. The chronology of these settlements is supported by nine AMS dates,[20] ranging from 4675 to 4448 cal BCE (2σ).

The next phase (Trypillia B1/Cucuteni A) boasts a network of 51 settlements.[21] The most notable among these settlements is the extensively excavated Berezivska HES **[fig. 60: 15]**, spanning an estimated

13 Tovkailo 2014.

14 Moskal-del Hoyo et al. 2023.

15 Salavert et al. 2020.

16 Kiosak 2017; Kiosak, Radchenko 2021.

17 Peresunchak 2018.

18 Kiosak et al. 2021b; Moskal-del Hoyo et al. 2023.

19 Burdo 1997; Zbenovich 1996.

20 Kiosak et al. 2021b.

21 Burdo 2015; Peresunchak 2012; Peresunchak 2015.

area of about 10 hectares.[22] Sabatynivka 1, Borysivka, Krasnostavka, etc., were also subject to excavation,[23] while the sites of Topoli, Kozachyi Yar I-II, Kamyane-Zavallia I, Shamrai and some others are known through test trenches and surface collections. Geomagnetic surveys have revealed that ditches surrounded dwelling areas at Kamyane-Zavallia I and Kozachyi Yar I.[24] Radiocarbon dating has placed these sites within 4339-4054 cal BCE (2σ).[25]

Thus, the SBR is situated on the periphery of the early farming expansion. Early farmers settled this area during various periods spanning from the sixth to the fourth millennium BCE.[26] As a result, the region has revealed at least three distinct chronological horizons of Neolithisation: LBK, Precucuteni, and Trypillia B1.

The environmental setting for this development is still insufficiently studied.

The palaeobotanical analysis yields significant insights, indicating that by the late seventh millennium BCE, the Southern Buh riverbank in the SBR was characterised by an alluvial deciduous forest dominated by ash, oak, and elm. This forest ecosystem endured throughout the LBK period, extending into the final quarter of the sixth millennium BCE.[27] At the LBK site of Kamyane-Zavallia, on-site evidence of cereal processing was discovered, with remnants of *Triticum cf. dicoccum*, *Triticum cf. monococcum*, and *cf. Hordeum* identified. Additionally, weed macroremains such as *Chenopodium album* and *Fallopia convolvulus* suggest the transformation of certain forest areas into arable fields by this period, affirming the establishment of an agricultural landscape in the SBR between 5250-5050 cal BCE.

Pollen data from several pollen cores (Troitske and Yelanets) closely align with the palaeobotanical observations.[28]

In the steppe region of the Southern Buh River valley, extensive research has been conducted on the Troitske bog over the years. M.I. Neustadt dated the sedimentary stratum he investigated to the early Holocene era, whereas O. Artiushenko suggested that the bog formation commenced during the late Pleistocene. More recently, L.G. Bezusko provided palynological data from the Troitske-II core, shedding further light on its characteristics,[29] sampled and dated in the 1980s.

22 Tsvek 2004.

23 Dobrovolskyi 1952.

24 Saile et al. 2016b; Saile et al. 2021.

25 Kiosak, Lobanova 2021.

26 Kiosak et al. 2021b.

27 Moskal-del Hoyo et al. 2023; Salavert et al. 2020.

28 Bezusko 2010; Kremenetski 1995.

29 Bezusko 2010.

As per the findings of the Ukrainian researcher, a twelve-meter sedimentary sequence began forming at the onset of the Atlantic Holocene, approximately 7,000 years ago (uncalibrated), when an ancient lake transitioned into a peat bog. This period was characterised by the prevalence of grasses and shrubs, particularly quinoa and forbs. Subsequently, the spore-pollen complex exhibited a similar structure with a gradual increase in the proportion of forbs, although some samples displayed notably high levels of *Artemisia*. Above this layer, there was a sediment layer exceeding one meter (170 cm) in thickness, where, despite a comparable ratio of pollen from various vegetation types, grasses assumed a more prominent role on average, and cereal pollen appeared for the first time, alongside isolated weed pollen grains. Radiocarbon dating yielded an age of 4960 ± 200 BP (IGAN-801, calibrated to 4320-3450 calBCE, 2σ) for this layer. The absence of additional radiocarbon dates and the wide standard deviation in the conventional date precludes a direct comparison between L.G. Bezusko's findings and the climate trends of the late Early to early Middle Holocene. Nonetheless, her observation regarding the prevalence of steppe vegetation in the vicinity of the Troitske bog during this period, coupled with the substantial growth of gully and floodplain forests, holds significant importance.[30]

The Yelanets 2 soil section is located on the territory of the Yelanets Steppe Nature Reserve (Mykolaiv oblast, Ukraine). The sediments are 1 m thick. The sediments in the section represent the Early (BO) to Late Holocene (SA) time interval.[31] The Early Holocene is dominated by pollen from steppe vegetation, with significant participation from grasses. Pollen from meadow vegetation, which existed in more humid areas, is also found. In the Middle Holocene, the role of meadow pollen and tree and shrub pollen increased significantly, and its content fluctuated throughout the period. The section is well-dated, but its small thickness is sufficient only for generalised vegetation characteristics.

The lower stretches of the Southern Buh river cut the Black Sea lowland, a geomorphological counterpart to the western expanse of the Great Eurasian Steppe. We may anticipate that the steppe zone experienced expansion and contraction during the Holocene.[32] However, there were areas with nearly constant steppe vegetation dominance, as evidenced by Troitske and Yelanets 2 cores. The SBR, from a purely geographical perspective, consistently represented a natural contact zone between populations from these two distinct environmental zones, namely steppe and forest-steppe.

30 Bezusko 2010.

31 Bezus'ko, Bezus'ko 2000.

32 Smyntyna 1999.

4.2 Looking for Interaction in Time

In the Southern Buh region, the radiocarbon chronology of early farmers is based on two datasets: conventional dates from the Kyiv radiocarbon facility, which appear to be notably earlier than other dates[33] and more recent AMS dates from the laboratories at LARA (University of Bern), Poznan, etc.[34] Due to the issues reported with the former dataset,[35] we will rely on the latter dataset. This dataset consists of 30 AMS dates, with twelve associated with two LBK sites, nine with four Early Trypillian sites, and nine with three Trypillia B1 sites **[fig. 61]**.

Bayesian modelling was conducted using OxCal software to explore the region's presumed episodic nature of human settlement. The Interval function estimates the gap between different sequential phases of occupation, each formed by the dates associated with a particular cultural aspect, with a certain probability. Notably, the interval between the LBK and Early Trypillian phases is quite pronounced, ranging from 222-637 years (with a likelihood of 95.4%) or 411-578 years (with a 68.3% probability). The second gap between the Early Trypillia and Trypillia B1 phases is comparatively shorter, spanning 34-256 years (95.4%) but most likely 118-220 years (68.3%). Of course, this observation does not mean complete depopulation for the entire Carpathian-Dnieper region.[36] For example, between the LBK and Trypillia A, early farmers densely inhabited the Lower Danube and the slopes of the Carpathians.[37] However, they were absent from the Southern Buh Valley.

Moreover, since the dates for each phase exhibit high consistency, we can consider them related to the same episode of human activity rather than treating each date as a potentially independent event, as in the previous model. Under this more straightforward approach **[fig. 61]**, the LBK phase lasted from 5213-5050 cal BCE (95.4%), the Early Trypillian phase ranged from 4603-4461 cal BCE (95.4%), and the Trypillia B1 phase spanned 4331-4243 (95.4%). The calibration of LBK dates extends across the entire duration of the notorious late sixth-millennium plateau, a known challenge for dating LBK.[38]

It is important to note that the Early Trypillian sites in the SBR region correspond to the later typological phases of this cultural aspect

33 Kiosak et al. 2023c.

34 Kiosak et al. 2021b.

35 Gaskevych 2014; Kiosak et al. 2023c.

36 Kiosak, Radchenko 2023.

37 Garvăn et al. 2009.

38 Lenneis, Stadler 1995.

and should follow the earlier sites of Precucuteni I-II and Trypillia A1-2.[39] The same is true for Trypillia B1 sites, which align with the Cucuteni A3 stage, while preceding sites of Cucuteni A1-2 are located to the west, on the hilly slopes of the Carpathians.[40] Consequently, continuous development occurred in other areas while the SBR region experienced population influx and depopulation.

As shown in Chapter 2, the para-Neolithic groups mainly existed in two time periods: 5900-5400 BCE and 5050-4700 BCE. While the first group of dates does not correspond to any early agricultural settlements in the SBR and, thus, is not interesting from the point of view of looking for coexistence, the second group, on the contrary, may indicate potential overlap with the dates for early farmers.

Therefore, we added a phase with the dates of the second para-Neolithic time block to the model in Oxcal (six dates). Two models were created: overlapping and sequential [**models 4-1; 4-2**]. The sequential model fails validation by the χ^2 criterion. Some dates converge poorly with the model in general; however, there is enough time to separate LBK, para-Neolithic and Early Trypillia. Namely, LBK dates mostly fell in the timeslot before 5000 years, while para-Neolithic dates post-date this margin. Para-Neolithic dates mostly fell into timeslot before 4550 BCE, while Early Trypillian dates mostly concentrated after this conventional boundary **[fig. 62]**. So, these three cultural aspects could exist in sequence without meeting each other. On the other hand, the model with overlapping phases has even better indices. Accordingly, the coexistence of the para-Neolithic groups with the LBK, especially with the Early Trypillia, is likely **[fig. 63]**. Nevertheless, despite this observation, the calibration errors are pretty large, and there is still time to separate the early farmers and hunter-gatherers. For this purpose, there is a sufficiently long gap between the decline of the LBK and the arrival of the early Trypillians.

In this analysis, the representativeness of the radiocarbon record remains a significant concern, as it is far from being comprehensive for the SBR. Nevertheless, the observed punctuated pattern of early farmers' presence[41] in the region cannot be ignored. While the gaps could potentially be addressed by expanding the dataset, it is likely that both gaps genuinely reflect the fluctuations in early farmer activities in the region during these two specific time intervals. Noteworthy, ceramic hunter-gatherers' activities are particularly well represented in the dataset during the absence of early farmers in the region: before the expansion of LBK and after the demise of LBK until the expansion of Precucuteni.

39 Garvăn et al. 2009.

40 Sorochin 2002.

41 Kiosak, Radchenko 2023.

4.3 Looking for Interaction in Space

Let us focus on archaeological sites' spatial distribution to uncover continuity and discontinuity patterns.

In the SBR region, the settlement patterns do not precisely overlap when viewed through a diachronic lens. There are no instances of LBK sites being resettled during Early Trypillian times, nor are there cases of Early Trypillian sites being reused during Trypillia B1. Some para-Neolithic sites yielded finds of LBK potsherds and Early Trypillian artefacts.

While some reports mention the discovery of Trypillian artefacts in earlier contexts,[42] there are no instances of true interstratification where an earlier site is found beneath a later one. Such stratified sites have been documented in other regions[43] but are notably absent from the SBR.

A. Topographic Position

To quantify this pattern, distances to the nearest neighbour from a different cultural aspect were considered. On average, Early Trypillian settlements are approximately 8.98 kilometres away from their nearest LBK neighbours (ranging from 1.81 to 19.86 kilometres). At the same time, LBK sites are typically closer to Trypillia B1 sites, with an average distance of 6.27 kilometres (ranging from 0.64 to 17.67 kilometres). The distance between Trypillia A and B1 sites is notable, ranging from a minimum of 2.71 kilometres to a maximum of 11.94 kilometres, with an average of 6.9 kilometres. The para-Neolithic sites are sometimes situated very close to early farming sites, with numerical proximity more in line with Trypillia B1 sites, even though the para-Neolithic predates the duration of the middle stage of Trypillian culture in the Southern Buh valley.[44]

Catchment analysis for early farmers typically operates within a 1-5 kilometre radius of the site.[45] Considering the distances between the sites mentioned above, some sites from different periods fall within this range of their nearest neighbour from another cultural aspect. For example, Early Trypillian sites in the Mohylna area are located within 1.25-4 kilometres of the Zhakchyk III site, which yielded LBK finds. In some cases, Trypillia A and B1 settlements were in close proximity, with sites like Tashlyk and Berezivska HES being

42 Burdo 2015.

43 Passek, Chernysh 1963.

44 Burdo 2015; Haskevych et al. 2019.

45 Diachenko, Menotti 2012.

separated by 3.28 kilometres, while Sabatynivka II and Sabatynivka I were 2.71 kilometres apart. Trypillia B1 sites are sometimes found in close proximity to LBK sites, such as Kamyane-Zavallia and Kamyane-Zavallia I, with a distance of 650 meters between them. However, these sites are separated by a gap of 600-800 years in terms of human activity, and the later sites are usually located in somewhat different topographic positions.[46]

Some para-Neolithic sites are located in close proximity to early farming sites. For instance, LBK sites like Hnyla Skelia and Kamyane-Zavallia were on the western bank of the Southern Buh, while just a few kilometres downstream on the opposing eastern bank, there were para-Neolithic sites of Zavallia and Zhakchyk, though these para-Neolithic sites remain undated. The site of Haivoron-Polizhok stands near the Early Trypillian settlement of Haivoron and yielded some Early Trypillian potsherds. The para-Neolithic site of Zhakchyk was recovered near the Trypillia B1 settlement of Berezivska HES.

The spatial distribution of sites also varies in terms of their landscape positioning. LBK sites are typically located along the banks of the Southern Buh River (in three cases) or inland on a bank of the Mohylianka River (a first-order tributary of the former). They are situated on fertile, flat, low terraces just a few meters above the floodplain or on high plateaus sloping down to the river. Typically, there is some distance between the site and the closest water source, ranging from 50 to 250 meters. These sites are presently situated on 'deep chernozems with a little humic content'. While numerical data for LBK settlements in SBR are still insufficient, we can refer to the sites from the nearest region of intense settlement of LBK – namely, the Republic of Moldova, as presented by O. Larina (1999). Her study of 53 LBK settlements between the Prut and Dniester rivers exemplifies this. Most LBK sites (81%) are situated away from watercourses, primarily on terraces (65%) or terrace slopes (35%). Only a few settlements (15%) are nestled within large river valleys, with none on islands. LBK communities favoured locations with ample flat space nearby, likely for agriculture.

In contrast, Trypillia A sites show a significantly different spatial pattern in the SBR. Most sites are located inland on small tributaries of the first and second order. There are exceptions, with two cases situated on the bank of the Southern Buh, and the site of Krasnenke was found on an island. The distance to the closest water source ranges from zero (for sites on an island) to 300 meters. Most sites are situated on deep chernozems with a little humus content, while a single site is in a sandy area near the bank of the Southern Buh. One site, Mohylna 3, revealed buried soil under Trypillian dwelling debris,

46 Kiosak, Radchenko 2023.

suggesting a fertile, humic-rich horizon similar to chernozems was present during the Trypillian period. Early Trypillian potsherds are often found in the para-Neolithic sites, sometimes hundreds of pieces. Namely, they were found in Shumyliv-Cherniatka, Haivoron-Polizhok, Gard, Gard 3 and 4, and Puhach 1-2 from the SBR.

Trypillia B1 sites, on the other hand, are situated along the banks of the Southern Buh or inland (most sites). Geomorphologically, they are found on high plateaus or terraces rising 3-6 meters above the floodplain. They can be immediately adjacent to watercourses or slightly inland (250 meters from the river). Around a third of these sites are located on the modern-day 'deep chernozem with a reduced humic content', while the others are on regraded chernozems. These regraded chernozems represent soils that were formerly under forests and are in the process of acquiring the qualities of typical chernozems. Thus, Trypillia B1 sites were detected in different pedological contexts, closer to existing forests and wooded areas.

Despite extensive forest management in the region since the late eighteenth century,[47] there are naturally forested areas with limited human interference, primarily in the higher portions of the plateau and steep slopes of deep Pleistocene gullies. Most Trypillia B1 sites are located in such areas, suggesting that the people of Trypillia B1 actively sought a more wooded landscape. Palaeopedological analysis conducted at the Sabatynivka I site (situated on deep chernozems with reduced humic content) revealed a typical soil with a shorter humic horizon, similar to the so-called 'southern chernozems'.[48]

In summary, there are apparent differences in the spatial patterns of each early farming cultural aspect that settled in the SBR region, encompassing qualitative (distance) and quantitative distinctions, such as varying topographic positions and underlying soils selected by early farmers during different phases of colonisation. However, there is still potential for continuity in cultural landscapes in certain parts of the region.

In contrast, the para-Neolithic settlement pattern, as described by V.M. Danilenko, V.I. Marchevici, and M.T. Tovkailo, is very different.[49] Analysis of 50 sites along the Southern Buh valley and its tributaries reveals a preference for riverside locations (60%), often close to rapids or cliffs. A significant proportion (88%) are found along the banks of large rivers like the Southern Bug and Ingul, with some on river islands or elevated terraces. Most recorded para-Neolithic sites are situated in floodplain elevations or terraces. Many sites were recorded

47 Kordt 1931.

48 Lobanova et al. 2021.

49 Danilenko 1969; Markevich 1974; Tovkailo 2005.

on islands, for example Haivoron-Polizhok was found on the Solhutiv island, while another site, Melnychna Krucha, stood on a promontory that could have been an island in prehistory. Several sites, Zavallia, Gard 3-4 etc., were located in a higher position (40-50 meters above the river) at the valley's edge.[50] Many sites are near rapids, directly on riverbanks, or less than 50 meters from the watercourse, along the large Southern Buh River.

These distinctions imply differing spatial organisations: early farming settlements focus on agricultural expanses along small rivers and creeks, while hunter-gatherer sites favour proximity to major rivers, likely for fishing and river-related activities. This suggests that LBK communities sought arable land, while para-Neolithic populations prioritised access to water resources. These variances hint at diverse mobility cycles and economic strategies within the same geographical region, where competition for resources was limited due to partially overlapping economic needs.

B. Buried Soils

Another aspect worth considering is the soils on which early farmers and hunter-gatherers lived and worked. We would expect significant differences based on a general understanding of these two economic systems. The diachronic aspect should also be considered: soils are a historical phenomenon. They are born, evolve, are transformed into other soils, and disappear due to erosion. Accordingly, the above comparison of modern soils, on which the sites of both entities (para-Neolithic and early farmers) were found, may not be sufficient. Fortunately, in the SBR, the Holocene sedimentation was often so extensive that sometimes ancient Holocene soils were buried under later sediments and were available for direct study. Pedological analyses conducted by Zh.M. Matviishyna at several sites[51] revealed that when preserved, buried soils belonged to several morphological types similar to those found in the region today.

The buried soils were revealed in several sites of early farmers. The soil analysis at Kamyane-Zavallia, the only LBK site studied in this manner **[fig. 63: 12]**, unveiled traces of the buried soil. The contemporary soil is a fertile chernozem characterised by a light clay loam morphology. Micromorphological analysis hinted at the faint presence of buried soil at a depth corresponding to the anticipated walking surface (-50 to -85 cm). This buried soil, appearing dark grey or blackish and loose with blocky-granular texture, displayed

50 Danilenko 1969.

51 Matviishyna, Kushnir 2018; Matviishyna, Doroshkevych 2019.

a humic-clayish cover around each sand grain, indicating fertility akin to the present-day local soil. Thus, we face a fertile, humic, short-profiled soil developed on loess. This arable soil likely existed during or slightly after the LBK habitation.[52]

At the Mohylna 3 site **[fig. 63: 14]**, Early Trypillian farmers utilised a fertile soil transitional to kastanozems, indicative of arid conditions during its formation. The buried soil was notably rich in humus and organic carbon.[53]

During the Trypillia B1 period (4400-4200 BC), farmers constructed settlements on mollic fluvisol formed on sandy alluvial deposits or chernozem formed on alluvial silts. These buried soils boasted thick humus horizons, signifying fertility.[54] Later stages of Trypillia in nearby regions of the Dnieper River basin also utilised chernozem soils.[55] At Sabatynivka 1 **[fig. 63: 15]**, chernozem development was halted by a late fifth millennium BCE erosional event, a chronology potentially applicable to Mohylna 3 and Kamyane-Zavallia 1.[56]

In contrast, ceramic hunter-gatherers settled on different soil types. Their remains were discovered above silty alluvial deposits at Melnychna Krucha **[fig. 63: 6]** and within marshy-fluvial layered sediments at Mykolyna Broiaka **[fig. 63: 7]**.[57] Although modern soils at both sites are suitable for agriculture, those available during the sixth to fifth millennia BC appeared unsuitable, prompting human settlement along riverbanks, likely for fishing, hunting, and gathering.

Chernozem was reconstructed by Zh.M. Matviishyna for the 'Neolithic' period layers at Dobrianka 1 and 3 **[fig. 63: 1]** in the Velyka Vys river valley.[58] However, taphonomic complexities and diverse dating results suggest that these chernozems might have formed later, incorporating materials from the 'Neolithic' cultural layer.[59]

The Gard **[fig. 63: 8]** site presented a sequence extending approximately 3 meters deep. The lower layer, a para-Neolithic layer rich in lithic tools and pottery,[60] featured a H(p) horizon of mollic fluvisol that developed from the parent material of alluvial sandy loam under conditions of periodic flooding. The upper layer contained the 'Late

52 Kiosak, Matviishyna 2023.

53 Kiosak, Matviishyna 2023.

54 Lobanova et al. 2021.

55 Dreibrodt et al. 2022; Matviishyna et al. 2014.

56 Kiosak, Lobanova 2021; Lobanova et al. 2021.

57 Kiosak, Matviishyna 2023.

58 Matviishyna, Parkhomenko 2007.

59 Kiosak 2019b.

60 Tovkailo 2014.

Neolithic' layer with abundant hunter-gatherer ceramics and Trypillia A potsherds,[61] which was formed in subaerial conditions, suggesting some limited agricultural suitability.[62] At the Lidyna Balka site **[fig. 63: 8]**, the para-Neolithic layer corresponded to gleyic mollic fluvisol, which was subjected to excessive moisture.[63]

Thus, our findings regarding buried soils from hunter-gatherer sites support the pronounced difference with early farmers. Among the seven reported cases, four revealed para-Neolithic remains corresponding to the soils, which developed in moist conditions, often due to seasonal flooding. Such soils are hardly suitable for agriculture. Limited agricultural activities (gardening) were possible on the soil of the upper horizon of Gard. Additionally, in two instances where chernozems were identified alongside artefacts of ceramic hunter-gatherers, doubts arose regarding the reliability of the chronology due to taphonomic factors. Thus, the chronology of these soils remains uncertain. In contrast, every early farming site under investigation exhibited fertile soil: three instances of various chernozems and one instance of mollic fluvisol, characterised by rich humus content and a well-developed profile.

C. Visibility Analysis

Visibility often serves as a proxy for confirming the inclusion of particular objects within a shared settlement pattern with other sites.[64] To assess the spatial dynamics of interactions between settlements and to examine the relationship between specific settlements in their respective chronological contexts with their surrounding environments, we conducted least cost path and viewshed analyses with the QGIS geospatial software, using open data from the Shuttle Radar Topography Mission[65] for the sites of particularly densely settled Middle Southern Buh region **[fig. 60]**.

We systematically considered mutual visibility for chronologically proximate sites belonging to the same archaeological culture. Specifically, for sites from the LBK, we assessed their mutual visibility with other LBK sites and those from the para-Neolithic **[fig. 65]**. Para-Neolithic sites were examined with LBK and Trypillia A sites **[figs 66-67]**, whereas Trypillia B1 settlements were only evaluated

61 Tovkailo 2014.

62 Matviishyna et al. 2015.

63 Matviishyna et al. 2015.

64 Brughmans, Brandes 2017.

65 Kiosak, Radchenko 2023.

within their group [fig. 68]. Our analysis compared mutual visibility with the least cost paths between sites.[66]

Upon comparing and analysing the acquired results, a discernible pattern emerges, characteristic of each early farming occupation. Each phase of early farming occupation had a 'core area'. This core area represents a confined territory where multiple settlements enjoy direct visibility and/or significantly shorter distances between them. Conversely, there exists a group of sites that lack such direct visibility and are often positioned at considerable distances beyond a specific threshold. The terrain between sites with mutual visibility can be termed 'shared territory'. Even if these sites were not contemporaneous, there could be a continuity of land use by inhabitants who had shifted their settlements slightly. It is conceivable that these 'core areas' depicted cultural landscapes characterised by cleared forests, cultivated fields, and pastures. While empirical research is necessary to validate this hypothesis, spatial analysis data hint towards this possibility.

The pattern of settlements with a 'core area' and dispersed sites finds similarities in spatial patterns well-documented in Western Europe.[67] These patterns are often interpreted as a result of the diachronic development of pioneering communities establishing new sites during demographic growth and subsequent expansion. However, the critique of this 'micro-regional demic diffusion' idea has led to other models suggesting the parallel development of multiple communities in more than one region.[68] The interpretation of these patterns will depend mainly on the chronological sequencing of sites, necessitating further research, including serial AMS dating and typochronological studies of material culture.

Different trends are observed among para-Neolithic sites in the region despite their lack of direct visibility with one another. If, between the agricultural settlements, there is a certain area of land that can theoretically be available for cultivation, then between the para-Neolithic sites, there is a river. Their distribution is characterised by a linear pattern that tends to the riverbanks, while early agricultural settlements are also located deeper inland, covering certain areas of common viewshed. The proximity of Trypillia A's Haivoron and the para-Neolithic Haiviron-Polizhok sites, along with the proximity of Zavallia and Zhakchyk to Hnyla Skelia (an LBK site on the opposite side of the Southern Buh River), may carry significance. However, the absence of clear chronological information complicates interpretation.

66 Kiosak, Radchenko 2023.

67 Zimmermann et al. 2004; Zimmermann et al. 2009.

68 Bickle, Hofmann 2009.

Analysing settlements of the same culture concurrently sheds light on distinct localisation patterns, revealing diverse modes of habitation and interaction with the cultural landscape in the daily lives of prehistoric populations in the area. Occasionally, para-Neolithic sites were situated near LBK or Early Trypillia sites, which might have been contemporaneous with the para-Neolithic in the Southern Buh valley. Nevertheless, mutual visibility was largely absent. For instance, LBK sites along the western bank of the Southern Buh could be observed from the para-Neolithic site Zavallia. However, the latter primarily comprised surface finds without evidence of prolonged human presence.[69] Similarly, the Zhakchyk site was close to the Trypillia B1 site of Berezivska HES;[70] however, this likely indicates subsequent occupation of a similar location along the Southern Buh River. The dates of Trypillia B1 postdate those of the local para-Neolithic sites. Therefore, even if para-Neolithic groups were contemporary with early farmers, these fishers, hunters, and gatherers equipped with pottery remained largely unseen by the latter.

4.4 Conclusion

Every time prehistoric agriculturalists inhabited the region, a distinct settlement pattern emerged. Various interpretations can elucidate this observation: changing climate, evolving preferences of early farmers for suitable land, the settlement patterns of local para-Neolithic groups with an extractive economy limiting the options of early farmers, intentional avoidance, and varying starting points of development. We have proposed **a discontinuous model** for the Neolithisation of the Southern Buh region to account for the empirical data in radiocarbon dating and settlement patterns.[71] Thus, phases of Neolithisation were probably separated by periods of retreat and demise of early farming communities.

Comparing the available radiocarbon dating records with settlement data reveals significant regional demographic fluctuations. Continuous settlement patterns did not link successive periods of Neolithic colonisation. Spatial analysis reinforces the radiocarbon data, highlighting an interrupted presence of groups engaged in agriculture in the SBR region. The exact nature of this 'de-Neolithisation processes' poses an intriguing problem to solve. The interrupted population of the region indicates that early farmers on the periphery of their distribution were susceptible to environmental changes, and it

69 Gaskevych 2005.

70 Tsvek 2004.

71 Kiosak, Radchenko 2023.

took several attempts to establish sustainable farming in the fertile soils of Central Ukraine.

In the Southern Buh Region (SBR) region, there is a scarcity of overlapping settlements from different early farming cultural phases. Mutual visibility is quite limited between consecutive occupation periods. LBK sites were distant from Early Trypillian settlements, and the latter were separated from Trypillia B1 sites. The 'core areas' of LBK and Early Trypillia, as well as Early Trypillia and Trypillia B1, do not intersect, indicating interruptions in the development of cultural landscapes. Each early farming group essentially 'tamed' the SBR region independently, irrespective of the accumulated landscape features of their predecessors. A 600-800-year gap between LBK and Trypillia B1, even with the partial overlap of their 'core areas', makes it highly improbable that LBK's features persisted until the time of Trypillia B1.

If this hypothesis is substantiated, it could offer a novel perspective on Neolithisation. The conventional notion of uninterrupted 'progress' is an inadequate representation of the actual processes of establishing productive economies. These processes involved setbacks and 'retreats' of early farming areas. The depopulation of the SBR region during the early fifth millennium BCE aligns with the 'Middle Neolithic' crisis, a period marked by a decline in early farming populations across various Central European territories.[72]

The region's indigenous fishers, hunters, and gatherers seem to have actively responded to fluctuations in early farming groups. Several para-Neolithic sites have been dated to approximately 4950-4750 years BCE. Melnychna Krucha R4, for example, contained para-Neolithic pottery and was dated to 4973-4836 (2σ) cal BCE. AMS dates ranging from 5211-4491 cal BCE were obtained from potsherds with a similar style to those found at Melnychna Krucha.[73] Other para-Neolithic sites in the Dniester valley revealed similar patterns. Thus, after the disappearance of LBK, there was a resurgence of fishers, hunters, and gatherers with para-Neolithic ceramic vessels. Adaptations based on an extractive economy seemed to have successfully 'regained terrain', at least temporarily.

At the same time, the chronological analysis indicates that there is a rather significant period when the last hunter-gatherer sites and early Trypillian settlements could have existed simultaneously in the SBR, around 4700-4550 BCE. The spatial analysis identifies several micro-regions where early farmers' sites directly border on hunter-gatherer camps: near the town of Haivoron, the Early Trypillian settlement and the Haivoron-Polizhok site **[fig. 67: 1]**, in the

72 Amkreutz; van de Velde 2018.

73 Haskevych et al. 2019.

area of the LBK settlement of Hnyla Skelia **[fig. 65: 2]**, and around the cluster of para-Neolithic sites near Gard.[74] The multi-criteria assessment indicates different uses of space by early farmers and their hunter-gatherer neighbours. The former settled micro-regions both along the banks of the main river (the Southern Buh) and quite far inland. The latter camped along the main river, mostly near rapids and on islands. The former were looking for areas with fertile soil, while the latter's camps gravitated towards places convenient for fishing, even if the soil around them was not at all favourable for growing plants. Therefore, early farmers and hunter-gatherers could coexist, even in the same region, without significant contact between them – their economic strategies were too different.

74 Tovkailo 2005.

Figures

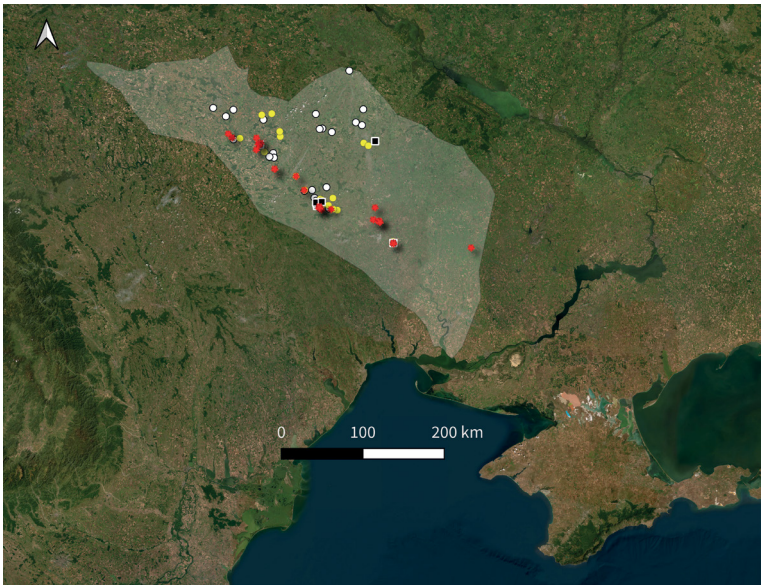

Figure 59 Definition of the region of study. Grey line encircles the catchment of the Southern Buh River. Red stars: para-Neolithic sites; dark squares: LBK sites and stray finds; yellow dots: Precucuteni sites and stray finds; empty dots: Trypillia B1 sites. MSB – Middle Southern Buh region, see fig. 60. Topo: ESRI. Mapping by the Author

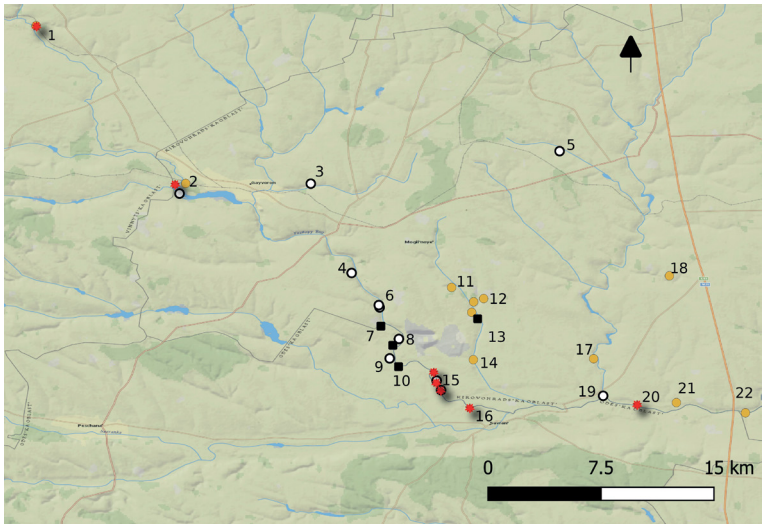

Figure 60 The sites of the Middle Southern Buh region, MSB in fig. 59. Topo: Stamen Terrain. Red stars: para-Neolithic sites; black squares: LBK settlements; yellow dots: Precucuteni – Early Trypillia sites; empty dots: Trypillia B1 sites. 1: Schurivtsi-Porih; 2: Haivoron, Haivoron-Polizhok; 3: Topoli; 4: Dovhyi Iar; 5: Mechyslavka; 6: Kozachyi Yar 1-2; 7: Syne Ozero; 8: Kamyane-Zavallia, Kamyane-Zavallia 1; 9: Shamrai; 10: Hnyla Skelia; 11: Mohylna 1; 12: Mohylna 2-5; 13: Zhakchyk 3; 14: Tashlyk; 15: Zavallia, Zhakchyk, Vovcha gatka, Berezivska HES; 16: Savran; 17: Sabatynivka 2; 18: Danylova Balka; 19: Sabatynivka 1; 20: Melnychna Krucha; 21: Hrenivka; 22: Krasnenke. Topo: Stamen Terrain. Mapping by the Author

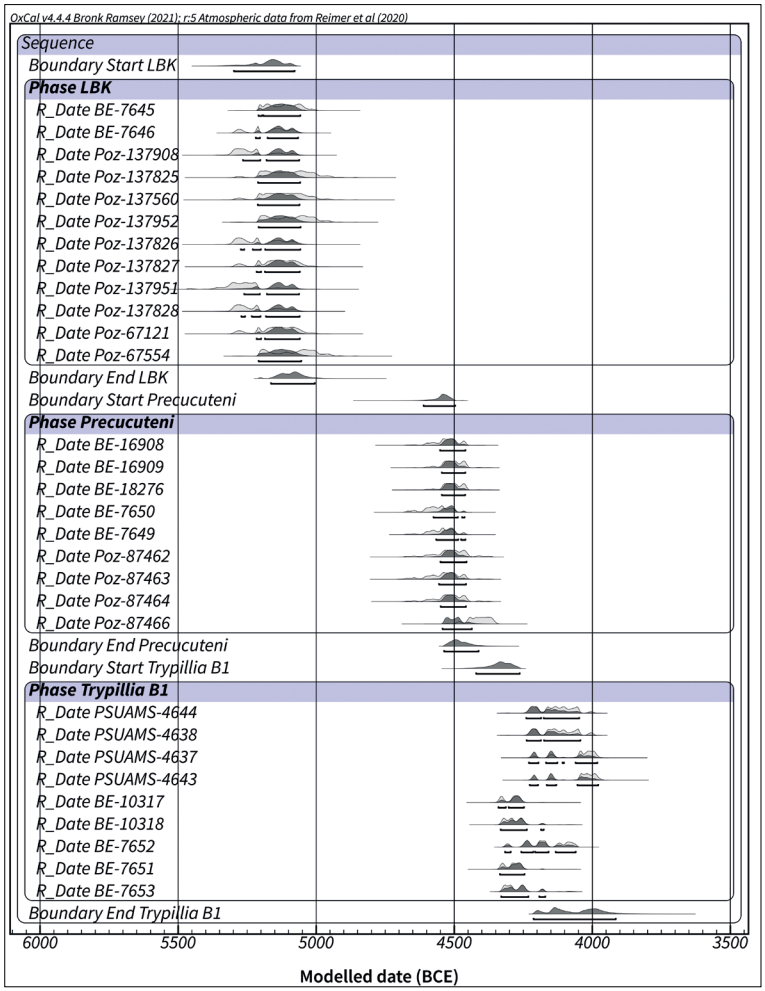

Figure 61 Modeled radiocarbon dates. The figure done by OxCal software with IntCal20 calibration curve of Reimer et al. 2020. Phase 1: LBK; 2: Precucuteni – Trypillia A; 3: Trypillia B1. For details on the calibrated dates, see Kiosak et al. 2021, **ST4-1**. Done in OxCal by the Author

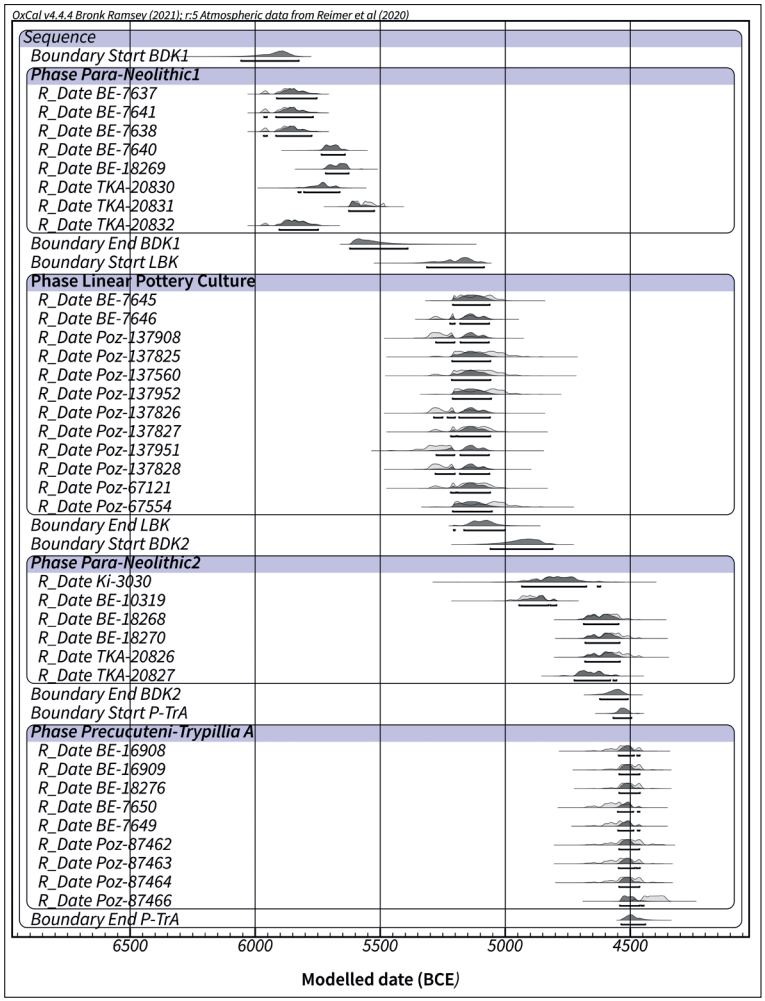

Figure 62 Southern Buh region. Radiocarbon dates modelled with sequential phases. BDK1: para-Neolithic, first temporal block; LBK: Linear Pottery Culture; BDK2: para-Neolithic, second temporal block; P-TrA: Precucuteni – Early Trypillia. Dates: **ST 4-1**. Code: **Model 4-2**. Done in OxCal by the Author

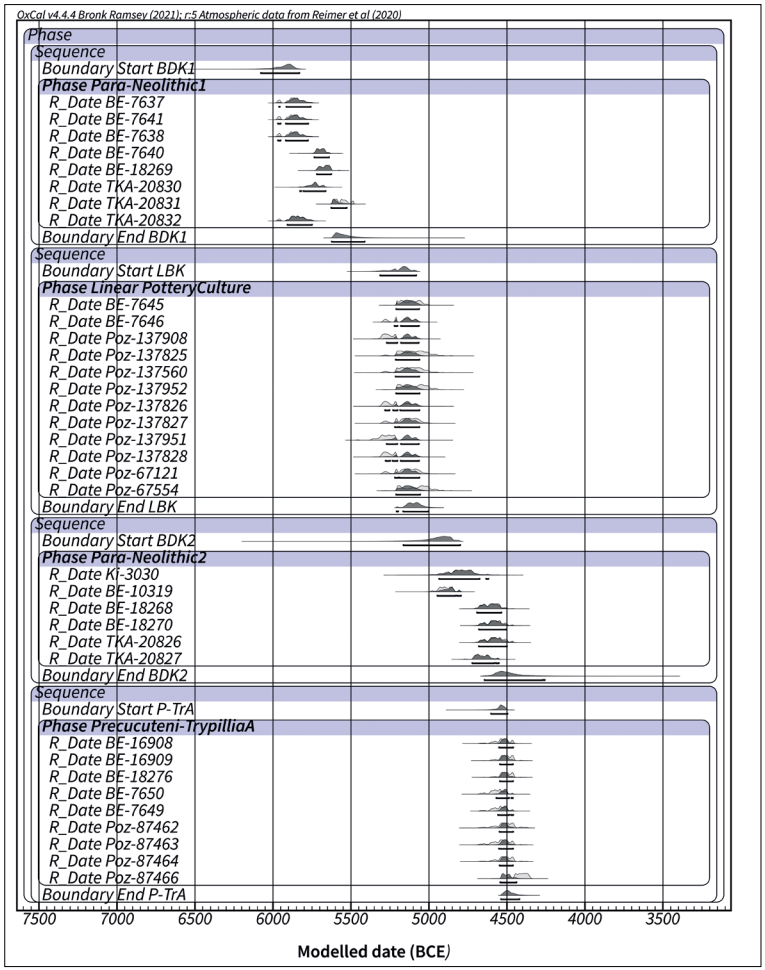

Figure 63 SBR. Radiocarbon dates modelled with overlapping phases. BDK1: para-Neolithic, first temporal block; LBK: Linear Pottery Culture; BDK2: para-Neolithic, second temporal block; P: Tr A – Precucuteni – Early Trypillia. Code: **Model 4-1**. Dates: **ST 4-1**. Done in OxCal by the Author

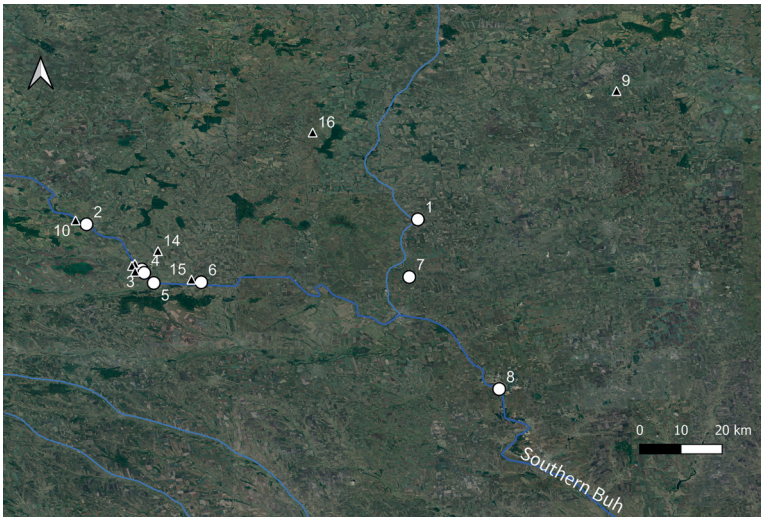

Figure 64 Sites which yielded information on Holocene soils in the Southern Buh valley. White dots: early farmers; black triangles: para-Neolithic sites. 1: Dobrianka 1-3; 2: Haivoron-Polizhok; 3: Zavallia; 4: Zhakchyk; 5: Savran; 6: Melnychna Krucha; 7: Mykolyna Broiaka; 8: Gard, Lidyna Balka; 9: Likareve; 10: Haivoron; 11: Kamyane-Zavallia 1; 12: Kamyane-Zavallia; 13: Shamrai; 14: Mohylna 3; 15: Sabatynivka 1; 16: Nebelivka. Topo: Google Earth. Mapping by the Author

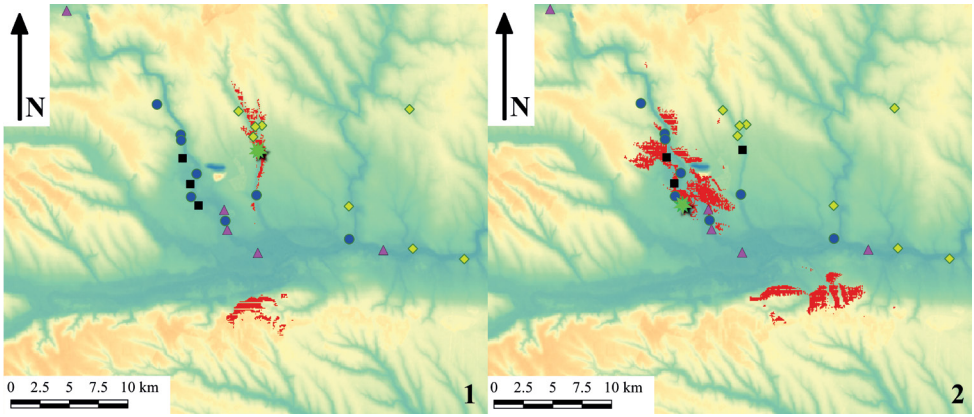

Figure 65 The viewshed analysis areas (red) of the Linear Pottery Culture sites in order to check for mutual visibility. LBK sites are marked with black squares, para-Neolithic sites are purple triangles, Trypillia A sites are marked with yellow rhombs, and Sabatynivka group sites are marked with blue circles. The observation points are marked with green star. 1: Zhakchyk III; 2: Hnyla Skelya. The viewshed of Hnyla Skelia (2) marks the 'core area' of LBK in the Southern Buh region. Topo: Natural Earth. Mapping by Simon Radchenko

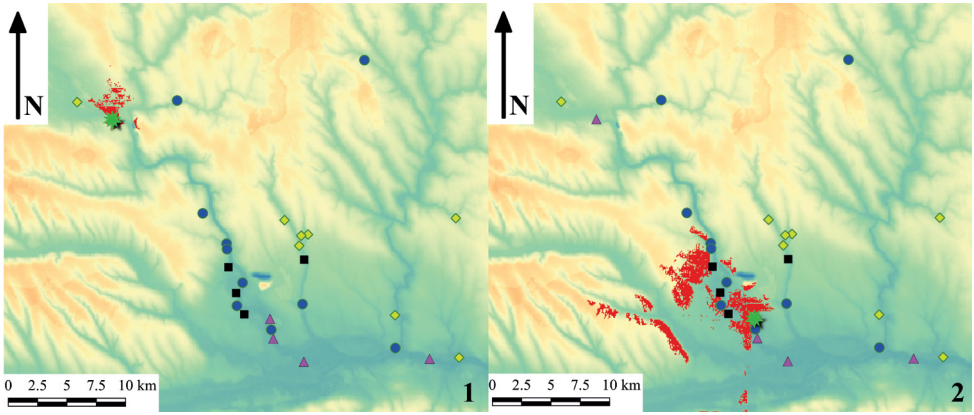

Figure 66 The viewshed analysis areas (red) of the para-Neolithic sites in order to check for mutual visibility. LBK sites are marked with black squares, para-Neolithic sites are purple triangles, Trypillia A sites are marked with yellow rhombs, and Sabatynivka group sites are marked with blue circles. The observation points are marked with green star. 1: Haivoron-Polizhok; 2: Zavallia. Note that even the para-Neolithic site with the highest visibility (2) has no mutual visibility with other para-Neolithic sites. Topo: Natural Earth. Mapping by Simon Radchenko

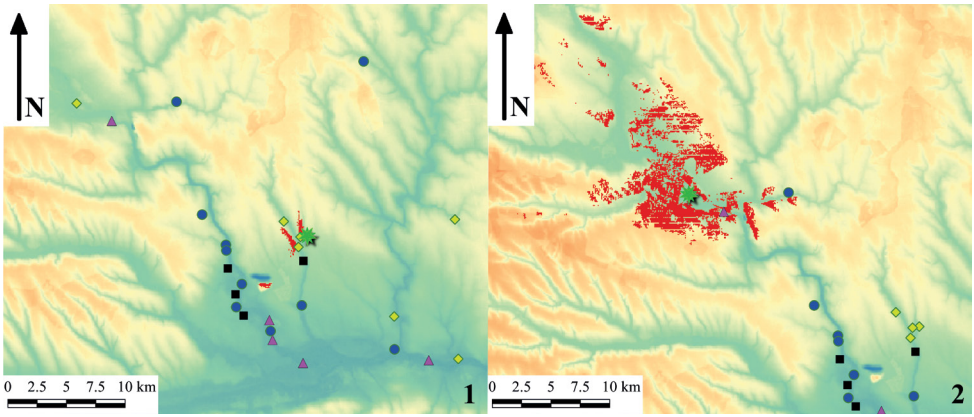

Figure 67 The viewshed analysis areas (red) of the Trypillia A sites in order to check for mutual visibility. LBK sites are marked with black squares, para-Neolithic sites are purple triangles, Trypillia A sites are marked with yellow rhombs, and Sabatynivka group sites are marked with blue circles. The observation points are marked with green star. 1: Mohylna III; 2: Haivoron. Topo: Natural Earth. Mapping by Simon Radchenko

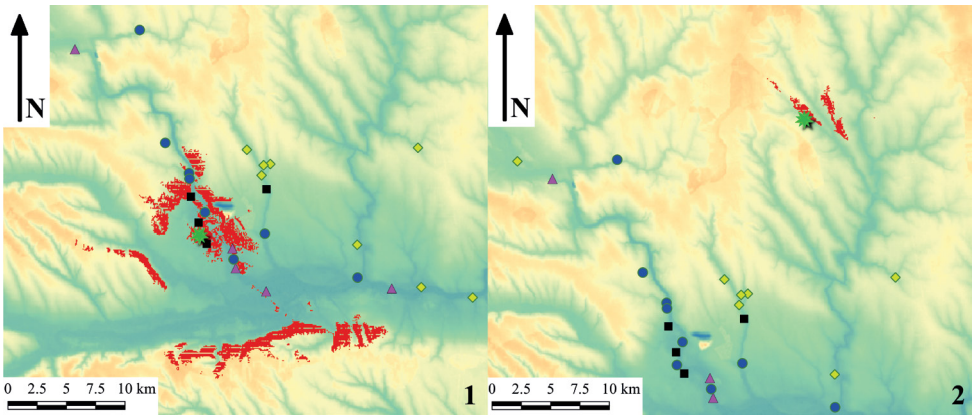

Figure 68 The viewshed analysis areas (red) of the Trypillia B sites in order to check for mutual visibility. LBK sites are marked with black squares, para-Neolithic sites are purple triangles, Trypillia A sites are marked with yellow rhombs, and Sabatynivka group sites are marked with blue circles. The observation points are marked with green star. 1: Shamrai; 2: Mechyslavka. Topo: Natural Earth. Mapping by Simon Radchenko

Supplementary Table

Table 4-1 Relevant dates for Southern Buh region divided into phases

Site Name	Provenance	Lab. Number	Date BP	SD	Cultural aspect	Material	CalBC (1 sigma)	CalBC (2 sigmas)	Reference	
BDK1										
Melnychna Krucha	SU2	BE-7637	6980	24	Unknown	Bone	5980-5900	5990-5880	Kiosak et al. 2021	
Melnychna Krucha	SU2	BE-7641	6986	24	Unknown	Bone	5872-5778	5888-5748	Kiosak et al. 2021	
Melnychna Krucha	SU2	BE-7638	6985	22	Unknown	Antler	5773-5724	5835-5714	Kiosak et al. 2021	
Melnychna Krucha	SU2	BE-7640	6812	24	Unknown	Bone	5762-5716	5806-5675	Kiosak et al. 2021	
Mykolyna Broiaka	House 1, 280 cm deep	BE-18269	6762	27	Savran?	Animal bone	5708-5631	5719-5625	Kiosak et al. subm	
Bazkiv Ostriv	vessel 1	TKA-20830	6855	30	Samchyntsi	pottery paste	5769-5707	5807-5666	Treated as unreliable by D.	Excl
Bazkiv Ostriv	vessel 22	TKA-20831	6625	25	Skybentsi	pottery paste	5613-5534	5621-5514	Haskevych et al. 2019.	Incl
Bazkiv Ostriv	vessel 21	TKA-20832	6970	25	Skybentsi	pottery paste	5891-5810	5972-5769	Treated as unreliable by D.	Incl
LBK										
Hnyla Skelia	pit 1	BE-7645	6163	23	Notenkopf LBK	Animal bone	4986-4858	5000-4848	Kiosak et al. 2021	
Hnyla Skelia	pit 1	BE-7646	6222	23	Notenkopf LBK	Animal bone	5000-4940	5041-4857	Kiosak et al. 2021	
Kamyane-Zavallia	F2003	Poz-137908	6260	40	Notenkopf LBK	T. monococcum	5305-5208	5315-5068	Moskal-del-Hoyo et al 2023	
Kamyane-Zavallia	F2003	Poz-137825	6150	50	Notenkopf LBK	T. monococcum	5206-5026	5215-4944	Moskal-del-Hoyo et al 2023	
Kamyane-Zavallia	F2006	Poz-137560	6170	50	Notenkopf LBK	T. monococcum	5207-5050	5295-4987	Moskal-del-Hoyo et al 2023	
Kamyane-Zavallia	F2006	Poz-137952	6140	40	Notenkopf LBK	Fallopia convolvulus	5206-5001	5211-4952	Moskal-del-Hoyo et al 2023	
Kamyane-Zavallia	F2008	Poz-137826	6240	40	Notenkopf LBK	Triticum sp.	5301-5078	5308-5059	Moskal-del-Hoyo et al 2023	
Kamyane-Zavallia	F2008	Poz-137827	6200	40	Notenkopf LBK	T. monococcum	5212-5065	5299-5030	Moskal-del-Hoyo et al 2023	
Kamyane-Zavallia	F2009	Poz-137951	6290	50	Notenkopf LBK	Triticum sp.	5311-5214	5370-5070	Moskal-del-Hoyo et al 2023	
Kamyane-Zavallia	F2009	Poz-137828	6250	40	Notenkopf LBK	T. monococcum	5304-5125	5370-5070	Moskal-del-Hoyo et al 2023	
Kamyane-Zavallia	pit 1	Poz-67121	6200	40	Notenkopf LBK	Animal bone	5218-5070	5295-5045	Kiosak, Salavert 2018	
Kamyane-Zavallia	pit 1	Poz-67554	6130	40	Notenkopf LBK	Animal bone	5206-4997	5211-4962	Kiosak, Salavert 2018	
BDK2										
Puhach-2	Cultural layer	Ki-3030	5920	60	Savran	Charcoal	4877-4717	4961-4618	Tovkailo 2014	
Melnychna Krucha	SU-R4	BE-10319	6008	21	Unknown	Bone	4880-4795	4930-4780	Kiosak et al. 2021	
Puhach-2	cultural layer	BE-18268	5750	26	Savran	animal bone	4656-4543	4686-4503	Kiosak et al. subm	
Mykolyna Broiaka	cultural layer	BE-18270	5731	26	Savran	animal bone	4647-4505	4678-4493	Kiosak et al. subm	
Shumyliv-Cherniatka		TKA-20826	5725	30	Savran	from the vessel	4608-4515	4683-4491	Haskevych et al. 2019.	
Shumyliv-Cherniatka		TKA-20827	5805	25	Savran	pottery paste of the	4709-4615	4723-4558	Haskevych et al. 2019.	
P-ET										
Mohylna-3	Soil section	TrA3	BE-16908	5699	26	animal bone	4549-4459	4607-4453	Kiosak et al. subm	
Mohylna-3	Soil section	TrA3	BE-16909	5679	27	animal bone	4539-4458	4599-4447	Kiosak et al. subm	
Sabatynivka-2		TrA3	BE-18276	5681	25	animal bone	4539-4458	4590-4447	Kiosak et al. subm	
Mohylna III	in the rubble of ploschadka	TrA3	BE-7650	5722	23	bone	4580-4501	4616-4466	Kiosak et al. 2021	
Mohylna V	pit 1	TrA3	BE-7649	5712	22	bone	4599-4523	4677-4493	Kiosak et al. 2021	
Hrebeniukiv Iar	pit, lowest level	TrA3	Poz-87462	5680	40	bone	4545-4453	4655-4369	Shatilo, 2021	
Hrebeniukiv Iar	pit, lower fill, upper layer	TrA3	Poz-87463	5700	35	bone, cattle	4587-4457	4671-4449	Shatilo, 2021	
Hrebeniukiv Iar	pit, lower fill, upper layer	TrA3	Poz-87464	5685	35	bone, cattle	4545-4455	4651-4406	Shatilo, 2021	
Hrebeniukiv Iar	pit, upper pit fill	TrA3	Poz-87466	5585	35	bone, cattle	4446-4363	4492-4347	Shatilo, 2021	
Cucuteni A - Trypillia B1										
Berezivska HES	Ber1	*CuA-TrB1*	PSUAMS-4644	5295	25	animal bone	4226-4049	437-3999	Harper et al. 2023	
Berezivska HES	Ber1	*CuA-TrB1*	PSUAMS-4638	5285	25	animal bone	4225-4046	4233-3994	Harper et al. 2023	
Berezivska HES	BerII	*CuA-TrB1*	PSUAMS-4637	5235	25	animal bone	4049-3984	4210-3964	Harper et al. 2023	
Berezivska HES	BerII	*CuA-TrB1*	PSUAMS-4643	5220	25	animal bone	4943-3983	4211-3964	Harper et al. 2023	
Berezivska HES		*CuA-TrB1*	BE-10317	5438	21	animal bone	4334.5-4259.5	4342.5-4249.5	Kiosak et al. 2020	
Berezivska HES		*CuA-TrB1*	BE-10318	5406	21	animal bone	4326.5-4248	4333.5-4175	Kiosak et al. 2020	
Kamyane-Zavallia 1		*CuA-TrB1*	BE-7652	5346	21	animal bone	4246.5-4065	4317.5-4052.5	Kiosak et al. 2020	
Kamyane-Zavallia 1		*CuA-TrB1*	BE-7651	5424	21	animal bone	4330-4255.5	4337-4246.5	Kiosak et al. 2020	
Shamrai		*CuA-TrB1*	BE-7653	5394	21	animal bone	4324.5-4241.5	4332.5-4169.5	Kiosak et al. 2020	

Models

Model 4-1 Overlapping phases for the Southern Buh region (SBR)

```
Plot()
  {
    Phase()
    {
      Sequence()
      {
        Boundary("Start BDK1");
        Phase("BDK1")
        {
          R_Date("BE-7637",6980,24);
          R_Date("BE-7641",6986,24);
          R_Date("BE-7638",6985,22);
          R_Date("BE-7640",6812,24);
          R_Date("BE-18269",6762,27);
          R_Date("TKA-20830",6855,30);
          R_Date("TKA-20831",6625,25);
          R_Date("TKA-20832",6970,25);
        };
        Boundary("BDK1");
      };
      Sequence()
      {
        Boundary("Start LBK");
        Phase("LBK")
        {
          R_Date("BE-7645",6163,23);
          R_Date("BE-7646",6222,23);
          R_Date("Poz-137908",6260,40);
          R_Date("Poz-137825",6150,50);
          R_Date("Poz-137560",6170,50);
          R_Date("Poz-137952",6140,40);
          R_Date("Poz-137826",6240,40);
          R_Date("Poz-137827",6200,40);
          R_Date("Poz-137951",6290,50);
          R_Date("Poz-137828",6250,40);
          R_Date("Poz-67121",6200,40);
          R_Date("Poz-67554",6130,40);
        };
        Boundary("End LBK");
      };
      Sequence()
      {
        Boundary("Start BDK2");
        Phase("BDK2")
        {
          R_Date("Ki-3030",5920,60);
```

```
            R_Date("BE-10319",6008,21);
            R_Date("BE-18268",5750,26);
            R_Date("BE-18270",5731,26);
            R_Date("TKA-20826",5725,30);
            R_Date("TKA-20827",5805,25);
          };
          Boundary("End BDK2");
        };
        Sequence()
        {
          Boundary("Start Precucuteni");
          Phase("Precucuteni")
          {
            R_Date("BE-16908",5699,26);
            R_Date("BE-16909",5679,27);
            R_Date("BE-18276",5681,25);
            R_Date("BE-7650",5722,23);
            R_Date("BE-7649",5712,22);
            R_Date("Poz-87462",5680,40);
            R_Date("Poz-87463",5700,35);
            R_Date("Poz-87464",5685,35);
            R_Date("Poz-87466",5585,35);
          };
          Boundary("End Precucuteni");
        };
      };
    };
```

Model 4-2 SBR with sequential phases

```
Plot()
  {
    Sequence()
    {
      Boundary("Start BDK1");
      Phase("BDK1")
      {
        R_Date("BE-7637",6980,24);
        R_Date("BE-7641",6986,24);
        R_Date("BE-7638",6985,22);
        R_Date("BE-7640",6812,24);
        R_Date("BE-18269",6762,27);
          R_Date("TKA-20830",6855,30);
          R_Date("TKA-20831",6625,25);
          R_Date("TKA-20832",6970,25);

      };
      Boundary("End BDK1");
      Boundary("Start LBK");
      Phase("LBK")
      {
        R_Date("BE-7645",6163,23);
        R_Date("BE-7646",6222,23);
        R_Date("Poz-137908",6260,40);
        R_Date("Poz-137825",6150,50);
        R_Date("Poz-137560",6170,50);
        R_Date("Poz-137952",6140,40);
        R_Date("Poz-137826",6240,40);
        R_Date("Poz-137827",6200,40);
        R_Date("Poz-137951",6290,50);
        R_Date("Poz-137828",6250,40);
        R_Date("Poz-67121",6200,40);
        R_Date("Poz-67554",6130,40);
      };
      Boundary("End LBK");
      Boundary("Start BDK2");
      Phase("BDK2")
      {
        R_Date("Ki-3030",5920,60);
        R_Date("BE-10319",6008,21);
        R_Date("BE-18268",5750,26);
        R_Date("BE-18270",5731,26);
        R_Date("TKA-20826",5725,30);
        R_Date("TKA-20827",5805,25);
      };
      Boundary("End BDK2");
      Boundary("Start Precucuteni");
      Phase("Precucuteni")
      {
```

```
        R_Date("BE-16908",5699,26);
        R_Date("BE-16909",5679,27);
        R_Date("BE-18276",5681,25);
        R_Date("BE-7650",5722,23);
        R_Date("BE-7649",5712,22);
           R_Date("Poz-87462",5680,40);
           R_Date("Poz-87463",5700,35);
           R_Date("Poz-87464",5685,35);
           R_Date("Poz-87466",5585,35);

      };
      Boundary("End Precucuteni");
    };
};
```

5 Conclusion

The Mesolithic population of the Carpathian-Dnieper region was actively 'neolithising', converting to agriculture as people were able to convert to a new religion, according to most accounts on the subject until recently. However, a critical analysis of the available data allows us to question this optimistic picture. First, the refined chronology of Mesolithic lithic industries shows that some could not have participated in Neolithisation because they date back several centuries or even millennia before it began. First of all, it concerns the Kukrek elements in Neolithic industries. The concept of Kukrek is vague enough to find its traces in virtually any Stone Age complex in the region. However, when we define it more narrowly, 'classical Kukrek' became an industry of the late ninth to eighth millennium BCE. The similarity of the Late Mesolithic sites of the Kukrek cultural tradition to it may not indicate an innate connection between them. Instead, it is quite clear that the well-defined complexes of the Kukrek cultural tradition date to the third quarter of the seventh millennium BCE, just before the '8200 cal BP' climatic event, which quite clearly separates them from the first groups with ceramic ware.

The first hunter-gatherers with ceramic vessels appeared over a wide area from the northern Caspian coast to the north-western Black Sea coast in a very short period within the first half of the sixth millennium BCE, possibly in its first quarter. While it is generally

understood that ceramics came to the hunter-gatherers from the east, in the long run from the Far East, its specific source – Central Asia, Trans-Urals – remains unclear. The models of the spread of ceramic ware as an innovative idea may need to be corrected. Carriers of pottery may have brought this innovation with them. Specific types of pottery often symbolised their identities, so the reception of pottery technology as a favourable innovation seems to be too simple an explanation for this rapid spread.

From a chronological point of view, there were the para-Neolithic groups in the valleys of Dnieper, Southern Buh and Dniester when early farmers started their expansion to the region east of the Carpathians. These para-Neolithic sites are classified into 'Buh-Dniester' and 'Surskyi' cultures. In both cases, speaking about actual complexes of material culture is difficult. 'Surskyi' is instead a definition of pottery type, while 'Buh-Dniester' is a combination of several styles of ceramic ware with unclear chronological relations. As an archaeological classification unit, the 'Buh-Dniester culture' is inconvenient and includes sites from at least two separate chronological blocks: 1. the first half of the sixth millennium BCE, possibly also its third quarter, and 2. the very end of the sixth millennium – the first quarter of the fifth millennium BCE. There is no convincing evidence that the para-Neolithic groups of the Buh and Dniester were introduced to agriculture and cattle breeding in the sixth millennium BCE. All the evidence cited earlier has now been called into question by the latest analyses with improved methodology or for reasons of homogeneity of archaeological complexes, which was often dubious in the excavations of the twentieth century. Thus, we can still only guess whether the local population were hunter-gatherers in the 'phase of availability' because, despite the presence of agriculture and cattle breeding in the vicinity, it is not known whether the indigenous groups took advantage of it.

Numerous finds of para-Neolithic ceramics at the sites of early farmers and discoveries of Criş, LBK and Early Trypillian sherds at the sites of hunter-gatherers mostly come from cultural layers. They thus may be the result of several successive episodes of habitation, not a coexistence of two groups at the same site. These imports, then, are not evidence of contact. At the very least, each such case deserves in-depth analysis and the search for new evidence of the cohabitation of farmers and foragers.

The first reliable information about early farmers in the region relates to groups of the Criş culture in its later stages. Thus, Neolithisation took place overland from the inner Balkans, either through the Carpathian passes or south of the Carpathians. Other early Neolithic sites belonged to pre-music note LBK. They were discovered in western Ukraine, thus indicating a dispersal from Central Europe to the north of the Carpathians.

The cultivated plants uncovered at the sites mentioned above are consistent with the typical crop selection of the European Neolithic, comprised of plants originating from West Asia. In this context, there is a notable emphasis on a limited variety of crops, with hulled wheat predominating. The Criş culture groups introduced a set of cultivated plants with West Asian origins to the forest-steppe region of Moldova by at least 5600-5500 BCE, while LBK people further propagated these crops in the territories of modern-day Moldova and Ukraine by 5250-5050 BCE.

The palaeobotanical findings of cultivated plants in Criş and LBK sites are both abundant and diverse. Compared to the claims of similar discoveries from para-Neolithic contexts, the latter seem to be pale imitations. Efforts to identify remains of cultivated plants at para-Neolithic sites through flotation techniques have largely been unsuccessful. Only wild plants were found, or the domesticated plants discovered were intrusions from later periods in the site's stratigraphy. The evidence of para-Neolithic acquaintance with agriculture comes from imprints of remains of cultivated plants on potsherds and daub. However, such imprints are scarce, and the species set varies from one site to another. Recent advances in analysis methodology have cast doubts on the precision of imprint identification. Although it is often assumed that para-Neolithic groups, even in the absence of their agriculture, could have acquired agricultural products through interactions with early farmers, it's crucial to emphasise that, as of now, there is no concrete evidence to support this concept.

The next stage of archaeological periodisation, the Eneolithic, in the region of study, comes with the forming of the Cucuteni-Trypillia cultural block. The latter results from the spread of Early Trypillian (Precucutenian) groups from the Carpathians to the Ukrainian and Moldovan forest-steppe. This migration episode was dated to the 47th-45th centuries BCE. The newly obtained dates indicate a rapid and expansive process of the Early Trypillia dispersal, resembling the swift expansion of the LBK culture and ancient Neolithic migrations, such as the FTN block spread in the inner Balkans. This suggests that similar social structures and motivating factors that drove these movements to new territories likely played a role in these processes.

Considering the earlier establishment of the Gumelnita and Cucuteni A2-3 cultural complexes, the dating of Trypillia B1 implies a gradual and prolonged process of 'Eneolithisation' in the forest-steppe and steppe regions of southern Eastern Europe. This process bears similarities to the dismantling of the LBK culture and the emergence of various post-linear cultural elements in Central Europe. This phenomenon has been described as the post-LBK 'crisis' in Central Europe. Accordingly, the term 'Late Neolithic crisis' better suits the archaeological context in the Carpathian-Dnieper region. The Early Trypillia period falls within these times of crisis, after which the

Eneolithic period, characterised by the hierarchical society of Cucuteni A and Trypillia B1, emerges.

These processes took a concrete shape at the microregional level. Early agricultural colonisation occurs in discrete microregions surrounded by non-settled territories. In the LBK studies, the term *Siedlungskammer* was coined to account for these spatial units. Such microregion (Middle Southern Buh region) was situated at the fringe of the early farming expansion: in the Southern Buh river valley, Central Ukraine, some 200 km from the Black Sea. Early farmers settled it on several occasions during the sixth-fifth millennia BCE. Each phase of early farming occupation featured a 'core area', encompassing a small territory where multiple settlements shared direct visibility and notably shorter distances between them. Conversely, another group of sites lacked counterparts in terms of direct visibility and were usually situated at a considerable distance beyond the defined threshold. The landscape between sites with mutual visibility constituted a 'shared territory', even if these sites were not contemporary, there could be continuity in utilising already cleared patches of land by inhabitants who had relocated their settlements slightly. These 'core areas' likely represented cultural landscapes with cleared forests, arable fields, and pastures. While direct empirical research is required to confirm this, spatial analysis data indicate this direction.

Although, in some cases, the sites of para-Neolithic groups have been found only a few kilometres from early farmers' settlements, they occupied very different positions in the landscape and had distinctly different settlement patterns. Modelling radiocarbon dates at the micro-regional level indicates that in a particular micro-region, SBR, para-Neolithic groups lived when there were no early farmers: before the spread of the LBK, and after it, before the Early Trypillian expansion. Thus, if there were contacts between para-Neolithic groups and early farmers, they took place not at the micro-regional level, but at distances of 100 km or more.

However, a distinct settlement pattern emerged whenever prehistoric agriculturalists settled in the region. There are several potential explanations for this observed phenomenon:

1. climate changes may have played a role;
2. early farmers might have had varying preferences for suitable land patches to settle on;
3. local para-Neolithic groups with an extractive economy might have had a different settlement pattern that influenced the choices of early farmers;
4. intentional avoidance of certain areas could also have impacted the settlement pattern;
5. different starting points in development may have contributed to the diversity.

This model, characterized by repeated influxes of early farming groups followed by periods of retreat, can be described as a 'discontinuous model of Neolithisation'. While it is particularly evident in the archaeological finds from the Southern Buh Valley, there is strong evidence to suggest that this model was typical of many 'frontier' situations in the early farming world of Eastern and Northern Europe. The cultural landscapes once created were abandoned, and building a field system and delimiting living space should be started repeatedly. This phenomenon of abandonment of a specific already settled region can be called de-Neolithisation.

Interpretations mentioned above carry equal likelihood at the moment. Understanding the precise nature of the de-Neolithisation processes presents a fascinating challenge to unravel. The sporadic population of the region indicates that early farmers on the periphery of their distribution were susceptible to environmental changes. Establishing sustainable farming on the fertile soils of Central Ukraine and Moldova required multiple attempts.

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Abbreviations

AMS	Accelerated mass spectrometry
KDE	Kernel density estimate
LBK	Linear Pottery Culture, Linienbandkeramik
MSB	Middle Southern Buh Region
SBU	Southern Buh Region
ST	Supplementary table
SU	Stratigraphic unit
BCE	Before Common Era
Cal	Calibrated
2σ	Within 95.4% confidence interval

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This book forms part of contemporary research on the interaction between migratory early farmers of Anatolian origin and European hunter-gatherers. In southern Eastern Europe, these two ways of life coexisted for thousands of years, resulting in a wide variety of configurations and patterns. Therefore, this part of the prehistory of southern Eastern Europe is of general European importance, providing comparative material for the study of Neolithisation and offering a different perspective to illuminate the possible variants of historical development and better identify the social structures behind the differences.

Dmytro Kiosak is a prehistorian and archaeologist specialising in the Mesolithic and Neolithic periods of southern Eastern Europe. He completed his undergraduate studies at the University of Ferrara, Italy, in 2008, followed by a doctoral degree from Odessa I.I. Mechnikov National University, Ukraine, in 2020. In 2021, he was awarded the title of Professor by the latter. He has co-authored the work *Paleoecology and Cultural Dynamics of the Holocene in the Northwestern Black Sea Region* (2011), and he is the author of the monograph *Lithic Industries of Early Farmers between the Carpathians and Dnieper: Social Context and Organization of Production* (2019) as well as over 50 peer-reviewed papers. This book reflects research conducted during a Marie Skłodowska-Curie project at Ca' Foscari University of Venice from 2021 to 2023.

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