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.

DOI 10.30687/978-88-6969-851-4/001

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 micro-stratigraphic 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

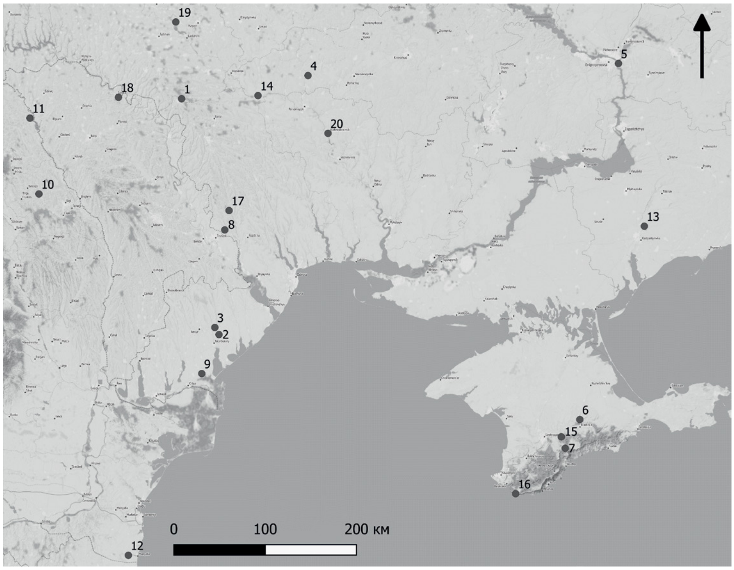

Figure 2 Relevant hunter-gatherer sites in the Carpathian-Danube region and surrounding areas. 1. Tsarynka (Tsarinka); 2. Bilolissia (Belolesie); 3. Ciilighider; 4 . Dobrianka III; 5 . Ihren 8 (Igren); 6. Vyshenne 1; 7. Shpan-Koba; 8. Hrebenyky (Grebeniki); 9. Myrne (Mirnoe); 10. Erbiceni; 11. Ripiceni-Izvor; 12. Albeşti; 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

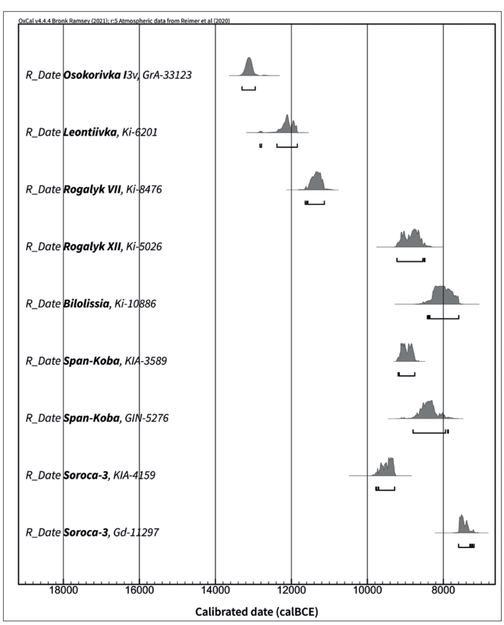

Figure 3
Legacy dates for the Early Mesolithic in southern Ukraine and Moldova. **ST 1-1**.
Done in OxCal by the Author (here and thereafter OxCal 4.4.4 by Bronk Ramsey 2021, calibration curve IntCal20 by Reimer et al. 2020)

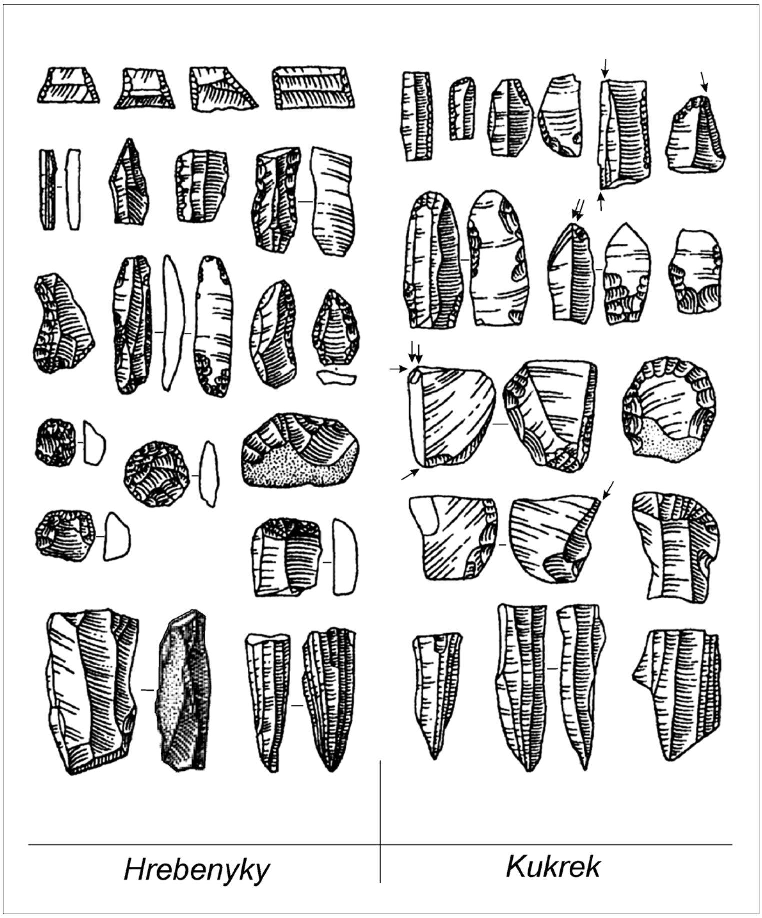

Figure 4 Kukrek versus Hrebenyky tool types as seen by Stanko 1972 with changes

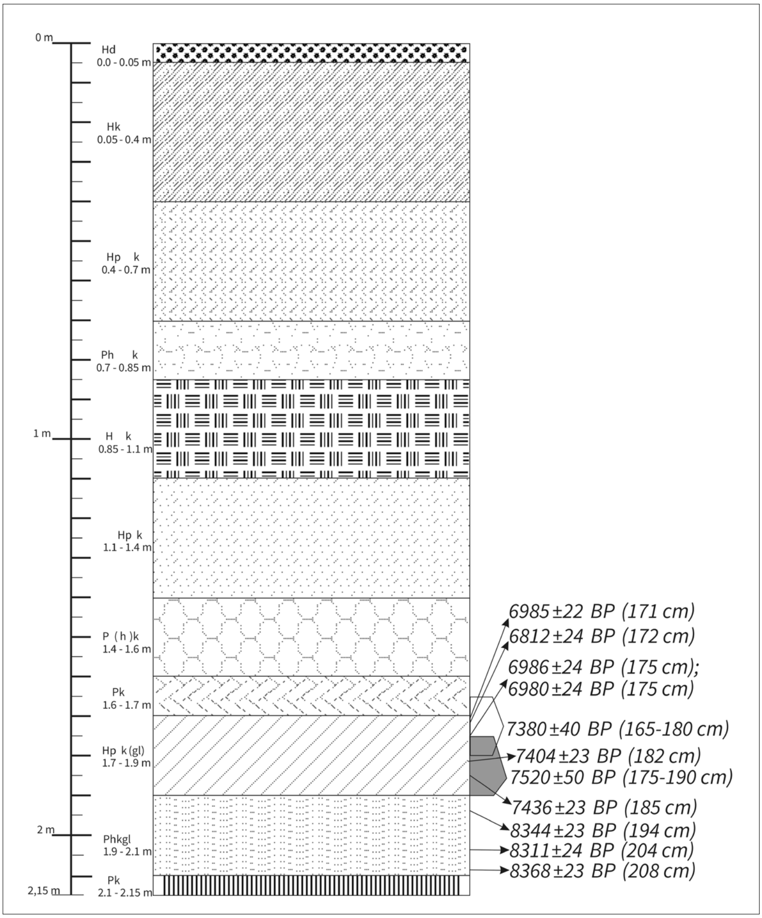

Figure 5 The schematic soil sequence of Melnychna Krucha with the position of radiocarbon-dated samples. Drawing by the Author after description by Zh. Matviishyna

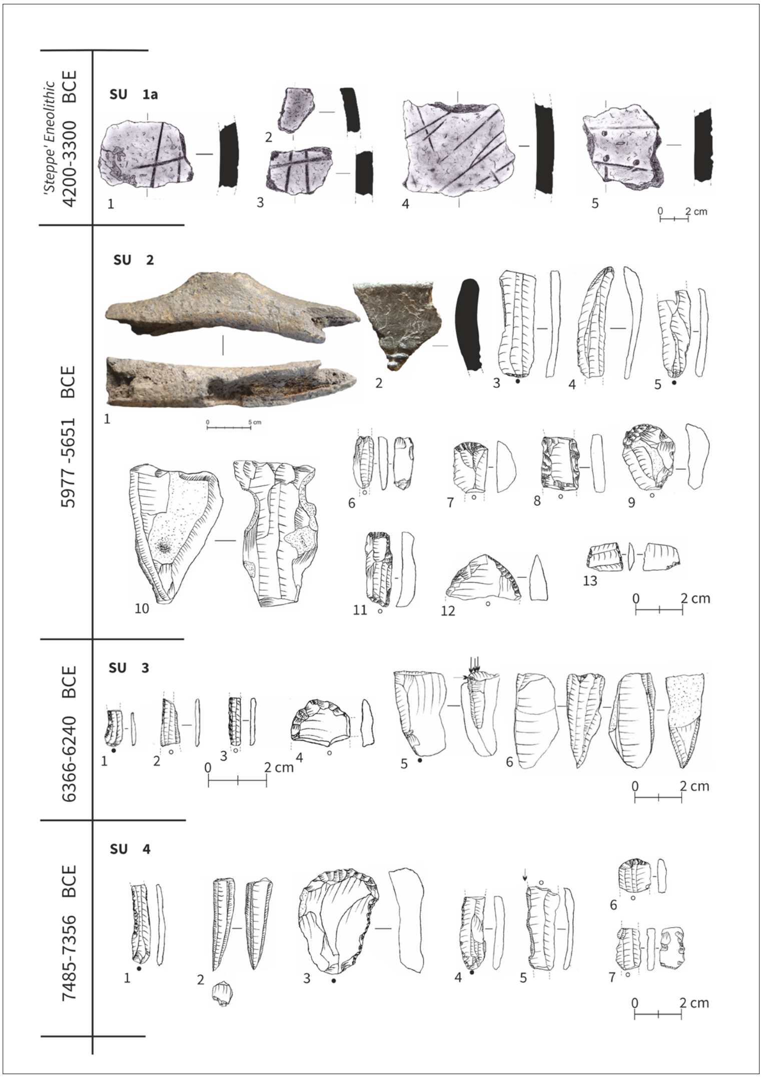

Figure 6 The archaeological sequence of Melnychna Krucha. Drawing by the Author

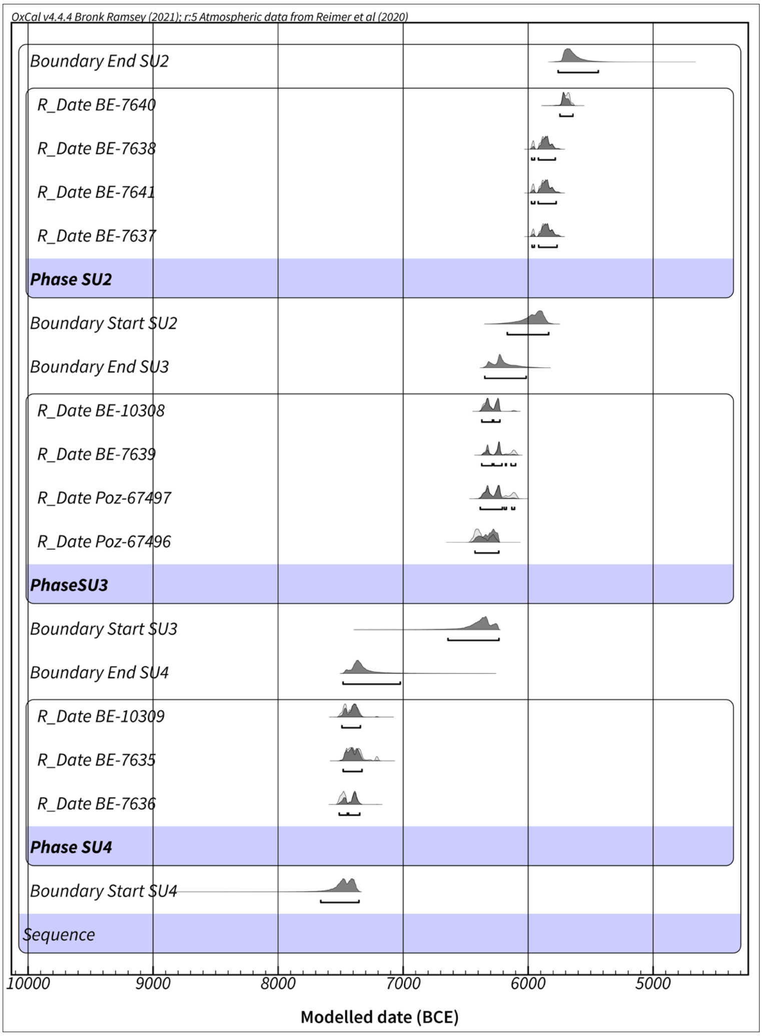

Figure 7 Modelled radiocarbon dates for Melnychna Krucha. **ST 1-2**. Done in OxCal by the Author

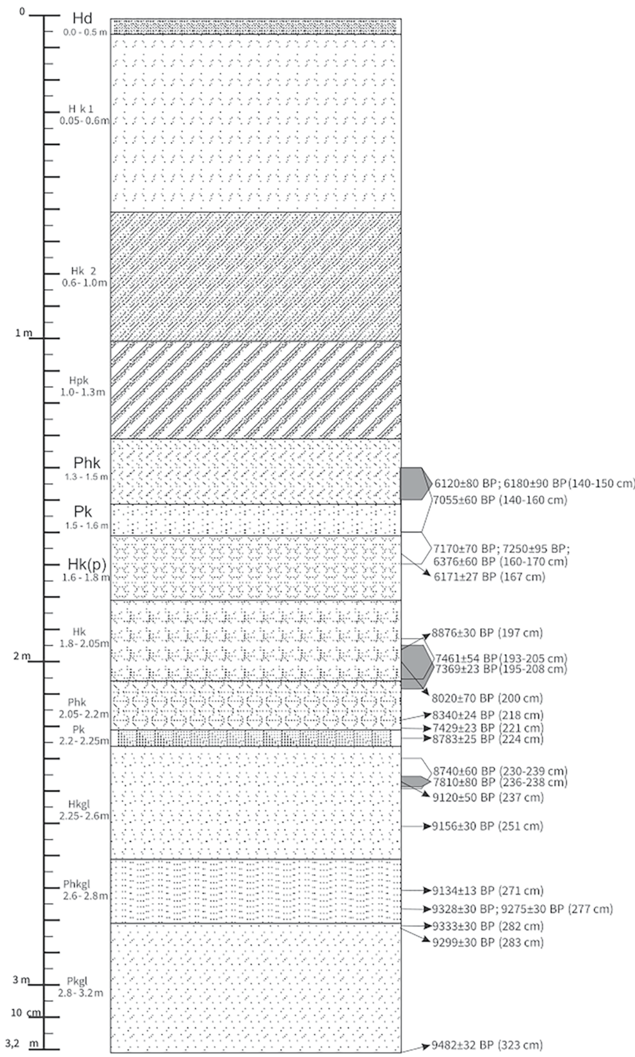

Figure 8 The schematic soil sequence of Kamyana Mohyla 1 with the relative position of radiocarbon-dated samples. Description of soil sequence: see text. Elaborated by the Author after the description of Zh. Matviishyna, with radiocarbon dates kindly provided by W. Tinner, S. Szidat and N. Kotova

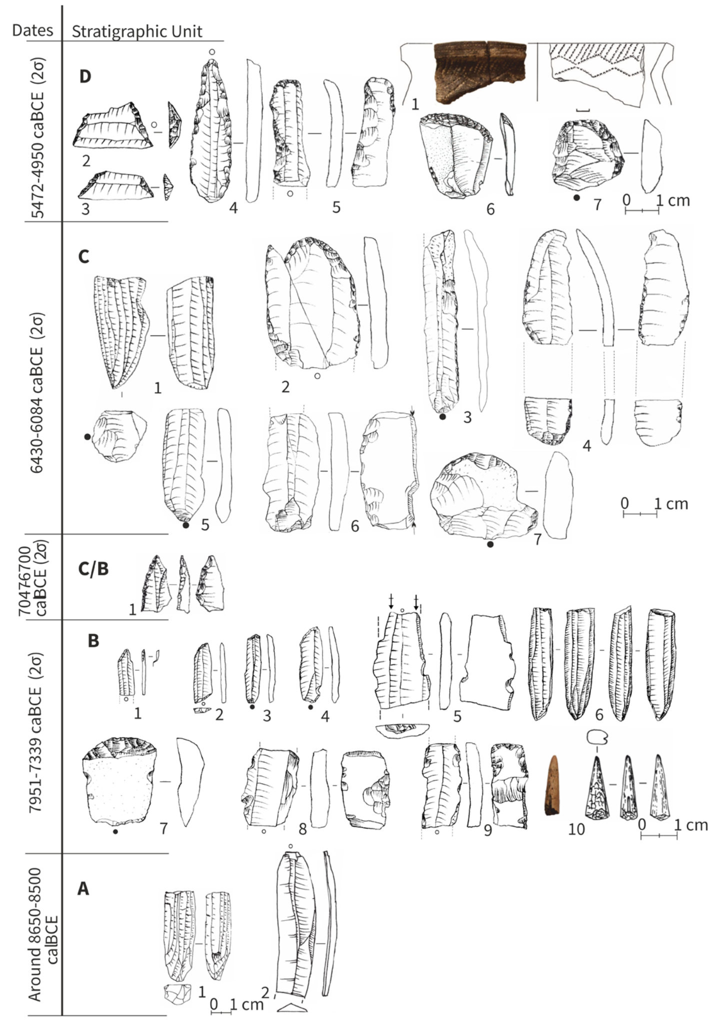

Figure 9 The archaeological sequence of Trench 2 of Kamyana Mohyla 1. D1, 6 after Kotova et al. 2017, B10 after Kiosak et al. 2022. Drawing by the Author

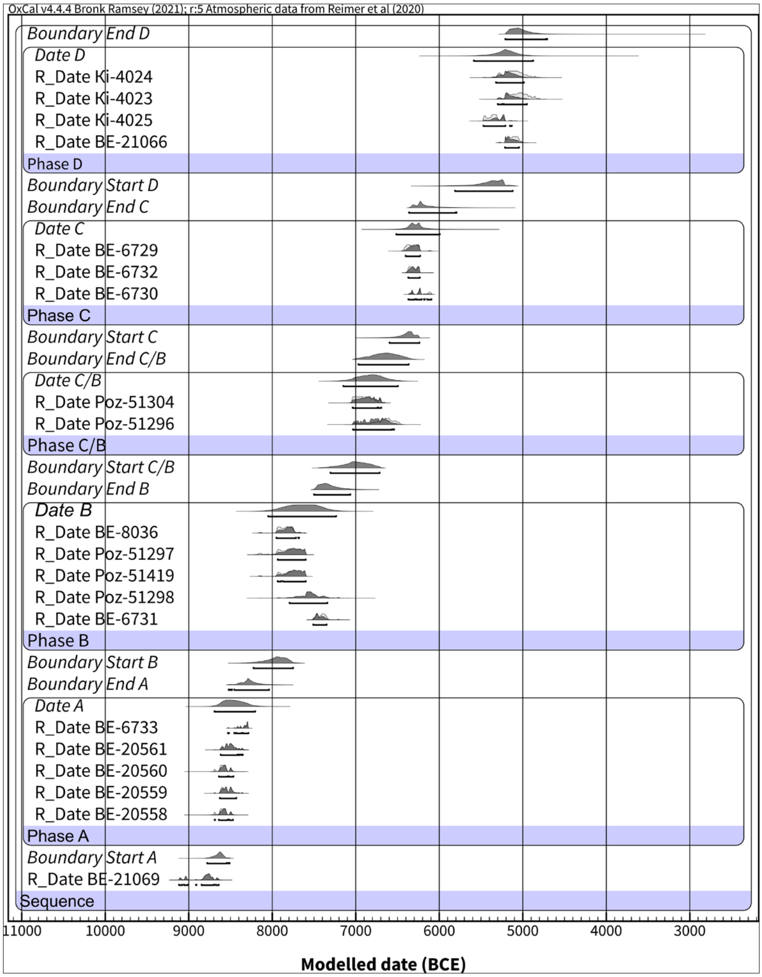

Figure 10 Modelled radiocarbon dates for Kamyana Mohyla 1. **ST 1-3**. Model 1-2. Done in OxCal by the Author

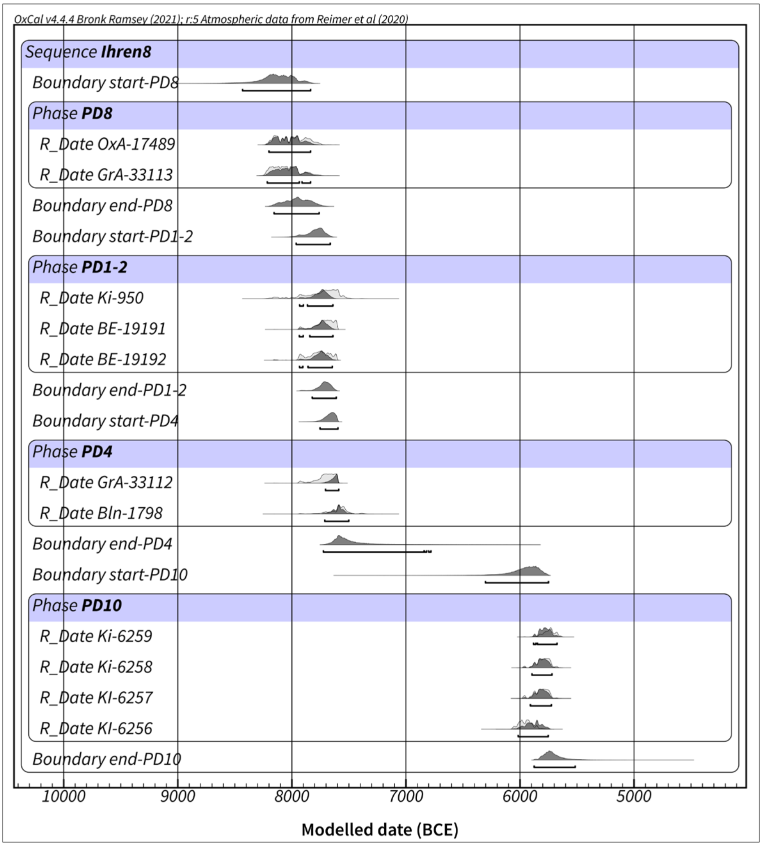

Figure 11 The modelled sequence of Ihren 8. **ST 1-4**. Model 1-4. Done in OxCal by the Author

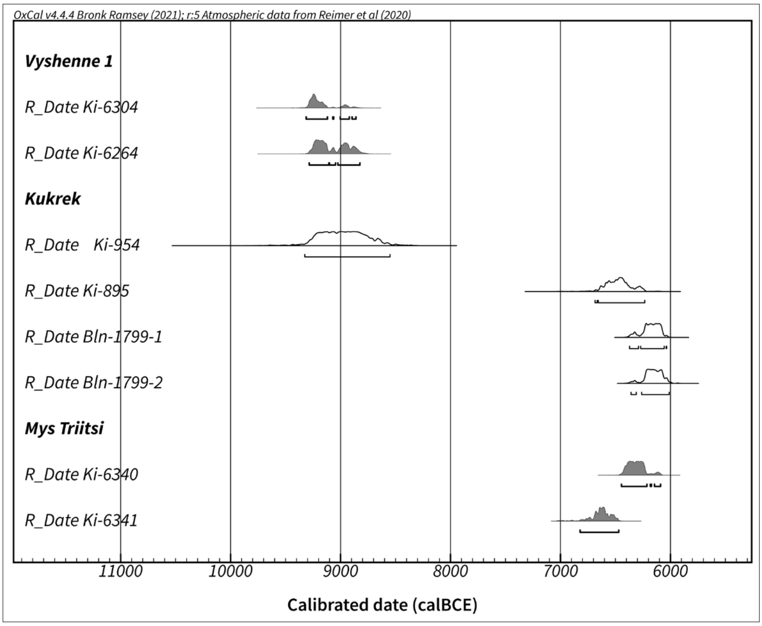

Figure 12 The legacy dates for Kukrek sites in the Southern Ukraine and Moldova. Grey: dates from animal bones; white: dates from shells of freshwater molluscs. **ST 1-5**. Done in OxCal by the Author

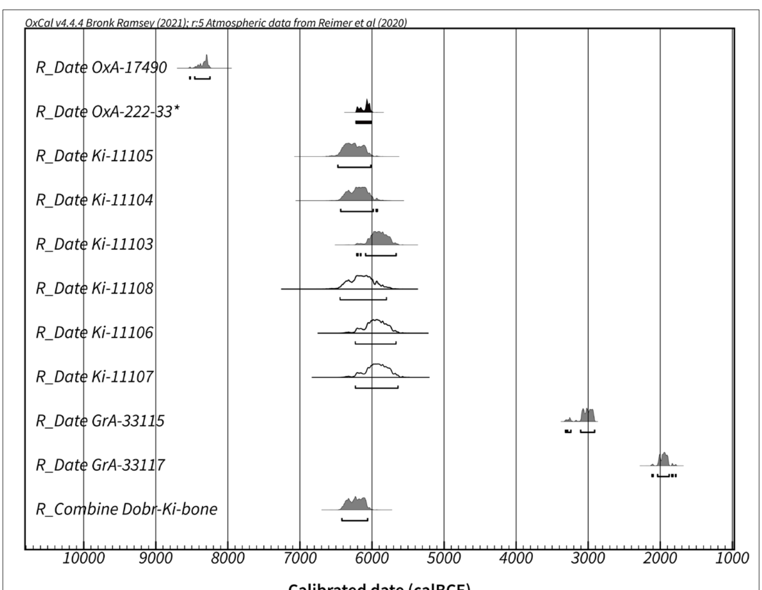

Figure 13 Dobrianka 3. The radiocarbon dates: grey: animal bones; black: human bone; white: potsherds. Dobr-Ki-bone: the combination of dates Ki-11105 and Ki-11104. **ST 1-6**. Done in OxCal by the Author

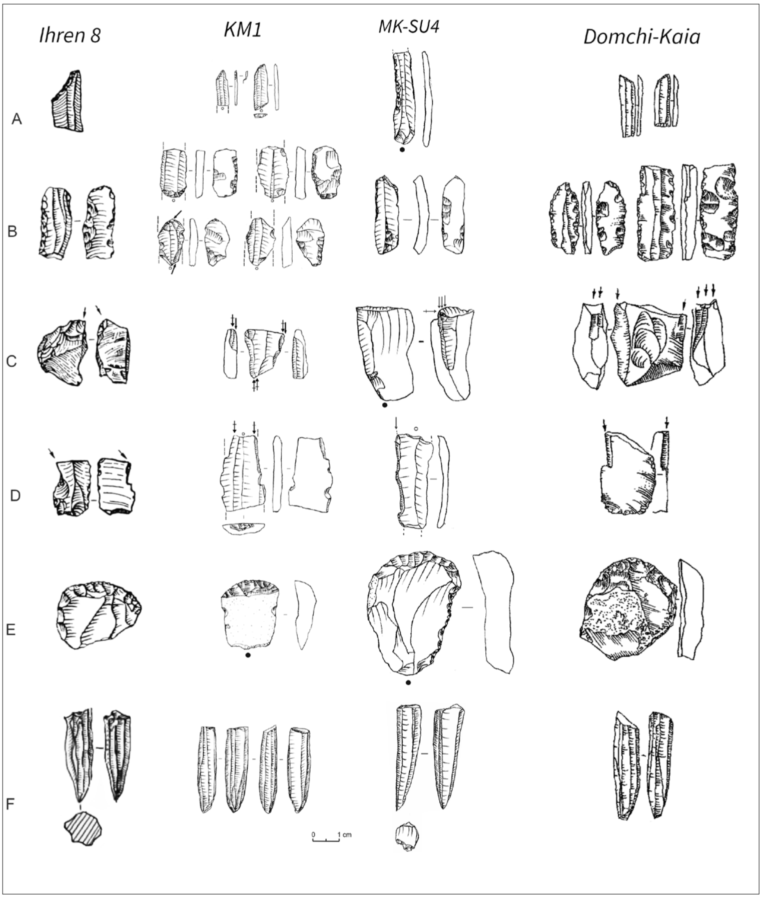

Figure 14 Comparison of the lithic assemblages of *Kukrek sensu stricto*. After Kiosak et al. 2023 with modifications. A. obliquely truncated bladelets (in case of MK-SU4 – its proximal fragment); B: so called 'Kukrek inserts'; C: 'Kukrek burins' (multiple burins on flakes); D. simple burins on blades (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

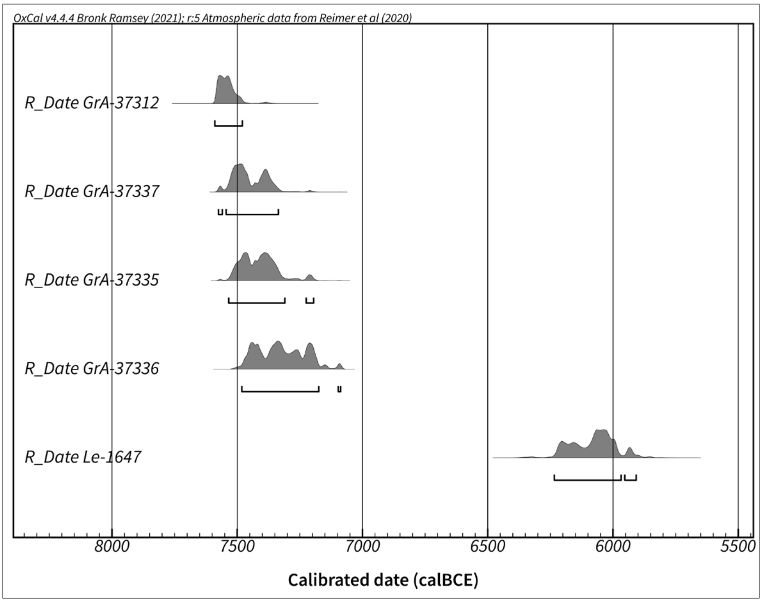

Figure 15 Myrne site. Radiocarbon dates. After Biagi, Kiosak 2010. Done in OxCal by the Author

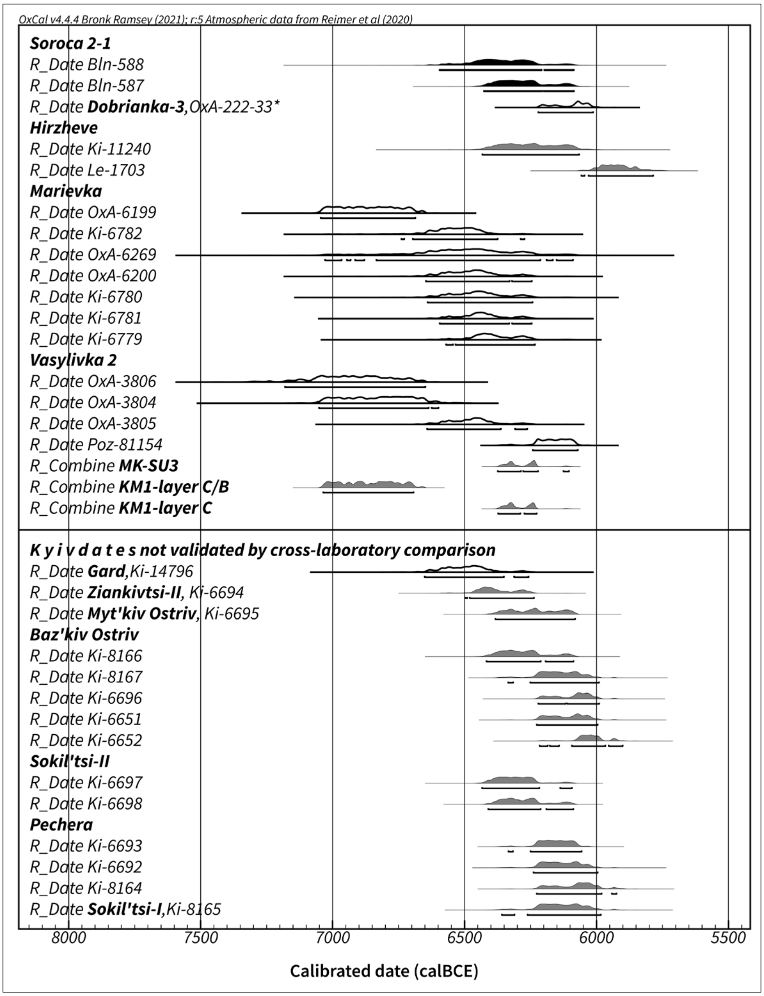

Figure 16 Radiocarbon dates for the sites of the seventh millennium BCE in the North Pontic region. Black: charcoal; grey: animal bones; empty: human bones. MK – Melnychna Krucha, KM1 – Kamyana Mohyla 1. **ST 1-7**. Done in OxCal by the Author

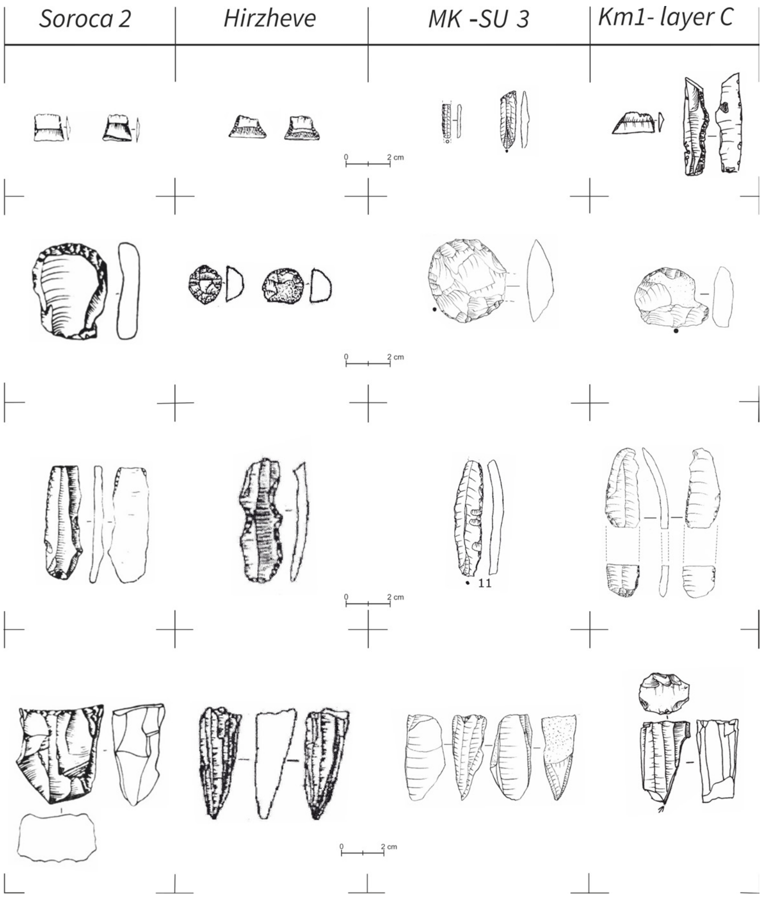

Figure 17 The comparison of lithic complexes of the second half of the seventh millennium BCE from the Northern Pontic region. Soroca 2: after Marchevich 1974; Hirzheve: after Stanko, Kiosak 2010; MK-SU3, Melnychna Krucha SU3: after Kiosak 2019; KM1, Kamyana Mohyla 1 – layer C: after Kotova et al. 2017.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

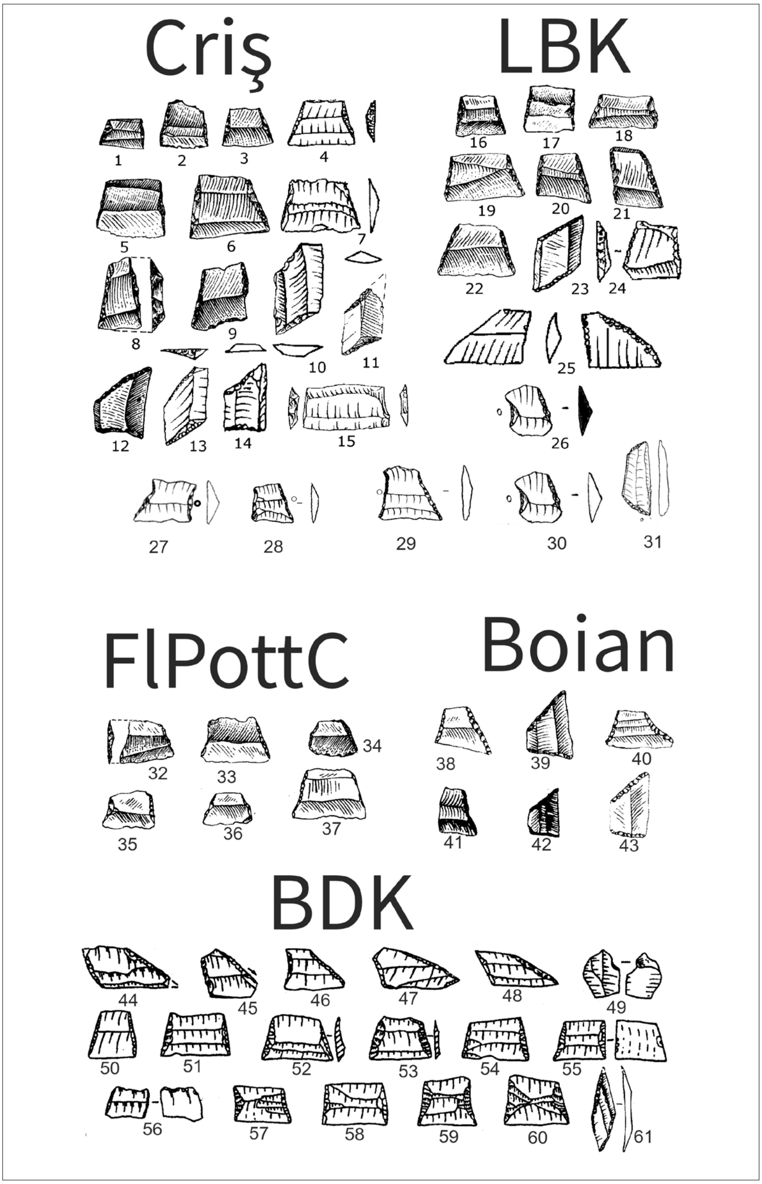

Figure 18 Geometrical microliths of Neolithic from Carpathian-Danubian region and trapezes from Kamyane-Zavallia (after Kiosak 2016 with modifications). Cris: Criş culture (1-15), including Sacarovca group (4, 7, 11, 13-15); LBK: LinearBandkeramik Culture (16-31); FlPotC: Fluted Pottery Cultures (Dudeşti [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; Glăveneşti Vechi: 24; Chişchereni 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");
    };
  };
```