

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

The issue of the ‘resurgence’ of hunter-gatherer lifestyles in the region between the middle courses of the Southern Buh and Dniester rivers during the post-LBK period

Otázka „obnovení“ lovecko-sběračského způsobu života v oblasti mezi středními toky Jižního Bugu a Dněstru v post-LBK období

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A re-dating of the end of the Linear Pottery culture (LBK) and the expansion of the Early Trypillians revealed an approximately 300-year gap between these events in the region east of the Carpathians and west of the Dnieper. Radiocarbon dates within this interval come from ceramic hunter-gatherer camps. This paper reviews sites likely inhabited during this post-LBK phase, many of which have been linked to the Savran phase of the Buh-Dniester culture. Although the very existence of the Savran phase and that of the Buh-Dniester culture is questionable, it is clear that these later sites yielded Savran-style pottery. And while Savran pottery is not exclusive to this interval (it existed prior to it), the evidence suggests that much of its development occurred during post-LBK times. Moreover, the ceramic assemblages of the sites in question brought several shapes and decorations resembling those characteristic of ceramic hunter-gatherers living to the north and east of the region of study. As such, the authors put forward a hypothesis of a hunter-gatherer revival in this region after the demise of the LBK and prior to the expansion of the Pre-Cucuteni/Early Trypillia. The cultural landscapes developed by the LBK were evidently abandoned. This revival brought to light sites with Savran-style pottery influenced by northern and eastern styles of pottery-making and decoration.

de-Neolithisation – para-Neolithic – ceramic hunter-gatherers – radiocarbon chronology – Bayesian modelling

Nové datování konce kultury s lineární keramikou (LBK) a expanze raného tripolského osídlení odhalilo v oblasti východně od Karpat a západně od Dněpru přibližně tři sta let trvající mezeru mezi těmito událostmi. Radiokarbonová data spadající do tohoto intervalu pocházejí z keramických lovecko-sběračských tábořišť. Tento článek přináší přehled lokalit pravděpodobně osídlených během této post-LBK fáze, z nichž mnohé byly spojovány se savranskou fází bugo-dněsterské kultury. Ačkoli samotná existence savranské fáze i bugo-dněsterské kultury zůstává sporná, je zřejmé, že tyto mladší lokality poskytly keramiku savranského typu. Přestože savranská keramika není omezena výlučně na toto období (vyskytovala se již dříve), dostupné doklady naznačují, že významná část jejího vývoje proběhla právě v době po zániku LBK. Keramické soubory z dotčených lokalit navíc obsahují řadu tvarů a výzdobných prvků připomínajících keramiku lovců a sběračů žijících severně a východně od studované oblasti. Autoři proto předkládají hypotézu o obnově lovecko-sběračského způsobu života v tomto regionu po zániku LBK a před expanzí pre-Cucuten-sko/raného tripolského horizontu. Kulturní krajina vytvořená nositeli LBK byla zjevně opuštěna. Tato obnova se projevila vznikem lokalit se savranskou keramikou, ovlivněnou severními a východními tradicemi výroby a výzdoby keramiky.

de-neolithizace – para-neolit – keramičtí lovci a sběrači – radiokarbonová chronologie – bayesovské modelování

Introduction

During the 6th–5th millennia BC, the region between the Carpathians and the Dnieper was home to two fundamentally different cultural spheres. One consisted of Neolithic farming groups of Central European (Linearbandkeramik/Linear Pottery culture, LBK, 5500–5050 BC) and Balkan origin (Criș 5900–5300 BC, Gumelnița 4700–4150 BC, Early Trypillia-Pre-Cucuteni in Romanian tradition, 4750–4400 BC, Cucuteni-Trypillia 4500–3100 BC). The other comprised local ceramic-producing hunter-gatherer societies (*Telegin 1985; 1987; 1992; Kiosak 2024*). There is no evidence so far that the latter practiced limited agriculture or animal herding (*Motuzaitë-Matuzevičiūtė – Telizhenko 2016; Motuzaitë Matuzevičiūtė 2020; Endo et al. 2022*).

These traditions produced contrasting archaeological signatures. Farming communities built large, permanent settlements with substantial houses, standardised pottery, often decorated or painted, and figurines. Hunter-gatherers, in contrast, left behind short-term riverside campsites with sparse structural remains, shells and animal bones, chipped stone industries, and distinctive but highly varied ceramic assemblages (*Tringham 1971*).

In this region, the ‘Buh–Dniester culture,’ representing the hunter-gatherer sphere, emerged by at least the early 6th millennium BC (*Kotova 2009; Haskevych et al. 2019; Kiosak et al. 2021*) and lasted either until 5300 BC (*Kotova 2003, 32*) or until 4750–4500 BC (*Tovkailo 2020, 136*). It comprises several ceramic traditions, whose interrelations remain unclear. The label ‘Buh–Dniester’ has effectively functioned as an umbrella term applied broadly to sites of this hunter-gatherer group, despite substantial internal diversity (*Kotova 2015*). A more nuanced classification is therefore both necessary and promising.

Recent refinements in the chronology of the LBK collapse in its eastern area of distribution (*Moskal-del Hoyo et al. 2023; Kiosak 2024*) and the spread of Early Trypillian communities (*Shatilo 2021; Kiosak et al. 2024*) have revealed an interval of roughly 300–400 years between these two events in the region situated east of the Carpathians and west of the Dnieper River. While a hiatus of this kind had been implicitly suggested in several typochronological schemes (*Danilenko 1969; Telegin 1971*), it had not previously been recognised or demonstrated on the basis of absolute dating. Several radiocarbon dates fall within this gap and originate from ceramic-bearing hunter-gatherer sites (para-Neolithic) along major rivers such as the Southern Buh and Dniester, as well as from smaller inland camps. These dates could have been attributed to Early Trypillian activity, mainly because Early Trypillian artefacts were present at the same locations (*Tovkailo 2005*). It is now clear, however, that these dates postdate the end of the LBK and precede the arrival of Early Trypillian populations.

This paper surveys archaeological sites that most plausibly belong to this post-LBK horizon. It addresses a twofold research question: first, what can be stated with confidence about these sites, and how are they distinguished, namely in terms of material culture, from earlier ceramic hunter-gatherer contexts? Second, what do these archaeological observations reveal about the nature of post-LBK (i.e. post-contact) hunter-gatherer sites? Specifically, why did they emerge and how did the availability of early farming in the region possibly transform the lifeways of these communities?

Assessing the radioisotopic data

The study area encompasses the middle reaches of the Southern Buh and Dniester river valleys, including the adjacent valleys of their numerous tributaries. Several dozen ceramic hunter-gatherer camps have been documented here, typically situated within floodplains or on islands along the main rivers (*Tovkailo 2020*).

In contrast, LBK settlements are located primarily inland, away from the major rivers. In the Southern Buh valley, the LBK presence is attested by four sites and four additional findspots within other contexts. There are three other LBK sites and a single findspot between the aforementioned rivers. While numerous LBK settlements are known west of the middle Dniester along its tributaries (*Larina – Dergaciov 2017*), only a single campsite has been identified on the banks of the Middle Dniester itself as well as several findspots (*Kiosak 2014; Haskevych 2024*).

The expansion of the LBK reached the region in the late 6th millennium BC (*Moskal-del Hoyo et al. 2023; Kiosak 2024*).

A total of 33 radiocarbon dates (*Fig. 3–4; Online Supplementary Material 1*) have been published for the Ukrainian LBK, along with 6 dates from Moldova and 2 from Romania. Because the reliability of dating organic residues from ceramic sherds (total organic carbon content, TOCC) is highly questionable (*Meadows 2020*), several of these determinations, particularly the series from Holyshiv and a single date from Hnidava, must be treated with caution. Additionally, Kyiv radiocarbon laboratory dates produced between 1998 and 2008 belong to the ‘suspicious’ series and should only be considered when supported by cross-laboratory verification (*Kiosak et al. 2023*).

Only one site from the earliest LBK phase in the region has been radiocarbon dated. Four measurements were obtained from animal bones at the settlement of Rivne, which typologically belongs to the pre-music-note phase (*Kotova 2003*). Some of these dates appear to be too early. The earliest determination (Ki-12506: 6570±60 BP) comes from a pit containing only antler fragments (but it is located within the settlement area). Two additional determinations, obtained in different laboratories from opposite ends of the same animal bone (Ki-12508: 6475±80 BP and VERA-4244: 6230±31 BP), are inconsistent and point to methodological issues in cross-laboratory comparison. Therefore, Rivne should be dated to just before 5250 BC. A further determination from Kyiv laboratory (Ki-13856: 6310±70 BP) supports this conclusion.

Legacy conventional dates contribute little to refining the chronology of the *Notenkopf* phase in the study area. At best, they encompass this phase, whose temporal range is well established from numerous Central European dates. Although AMS dates generally offer narrower standard deviations, they likewise fail to resolve the internal chronological order of sites within the duration of the *Notenkopf* phase. Nevertheless, the existing evidence clearly indicates that the LBK did not persist in this region significantly longer than in its Central European core.

Namely, the supposedly late (in terms of typochronology) site of Rovantsi – Hnidavska Hirka (Hnidava) yielded radiocarbon dates that align with the same late 6th-millennium BC period of the *Notenkopf* phase rather than extending into the 5th millennium BC. The only ‘late’ date from Hnidava was obtained from potsherd total organic content (TOCC) and should be dismissed as unreliable (*Bardetskiy et al. 2017; Mazanec et al. 2020; Saile 2020; Kiosak et al. 2023*).

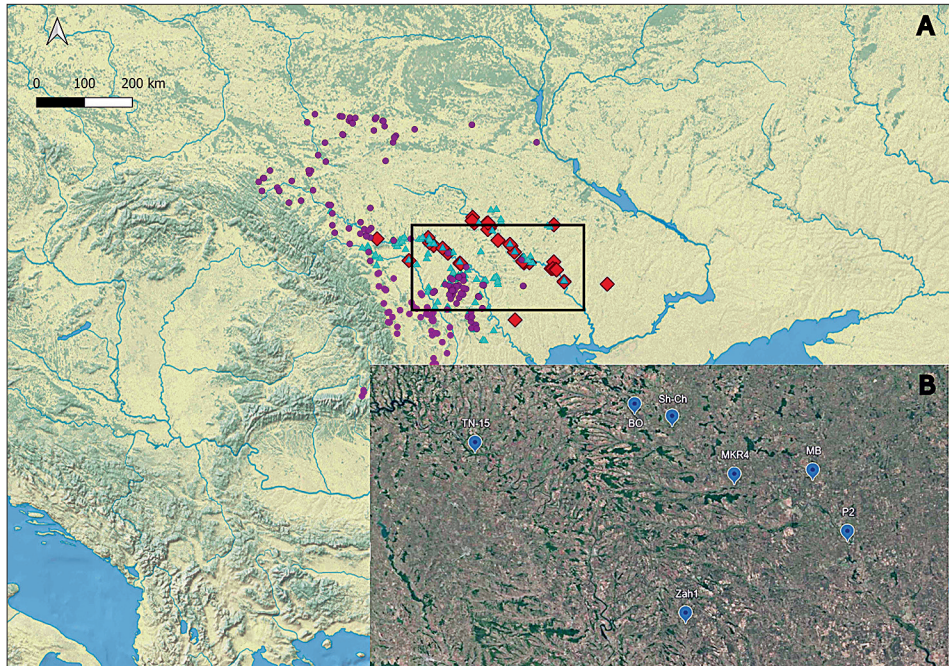


Fig. 1. A: Area of study on the map of Southeastern Europe (basemap: Natural Earth); violet dots – LBK sites; red diamonds – para-Neolithic sites; blue triangles – Early Trypillian (Pre-Cucutenian) sites of relevance. B: close-up of middle sections of Dniester and Southern Buh valleys (basemap: Google Earth), TN-15 – Tătărauca Noua 15; Zah1 – Zaharivka 1; BO – Bazkiv Ostriv; Sh-Ch – Shumylyiv-Cherniatka; MKR4 – Melnychna Krucha R4; MB – Mykolyna Broiaka; P2 – Puhach 2.

The Pre-Cucuteni/Early Trypillia culture, formed through the synthesis of earlier Neolithic farming traditions on both sides of the Carpathians (*Dumitrescu 1957; Marinescu-Bîlcu 1974*), began expanding around the 47th century BC and reached the Dnieper highlands by the 45th century BC (*Shatilo 2021; Kiosak et al. 2024*). These communities occupied permanent settlements with wattle-and-daub houses that often appear archaeologically as compacted clay platforms (*ploshchadkas*). Their material culture is marked by rich, standardised pottery, a developed lithic industry, and bone and antler tools (*Zbe-novich 1996; Bodean 2001*).

The dataset for the radiocarbon chronology of the Early Trypillia consists of 25 conventional radiocarbon dates and 35 AMS measurements collected from thirteen archaeological sites (*Fig. 3–4; Online Supplementary Material 1*). The conventional dates show high variability, are often based on charcoal samples (making them susceptible to the old wood effect) and frequently do not directly correspond to the research aims. Notably, sixteen of these measurements were produced at the Kyiv laboratory across multiple analytical series. These dates from the questionable 1998–2008 Kyiv series consistently failed cross-laboratory validation (*Kiosak et al. 2023*) and, therefore, will be excluded from subsequent modelling.

While ceramic hunter-gatherers of the region were traditionally described using the umbrella ‘Buh-Dniester culture’ term, we can probably now be more precise. A total of

69 radiocarbon dates are available for these para-Neolithic groups (*Haskevych et al. 2019; Tovkailo 2020*), though some are clearly unreliable (*Fig. 3–4; Online Supplementary Material 1*). Kernel Density Estimation (KDE) reveals a bimodal distribution (*Fig. 2: A, B*): a pre-LBK peak; a decline during LBK expansion; and a renewed peak after the LBK collapse.

The latter peak is of particular interest. While the persistence of hunter-gatherer communities after the onset of Neolithisation is well documented in many regions, it remains insufficiently understood in the southern part of Eastern Europe. To evaluate these patterns, we must examine the sites from which the dates of the latter peak (*Fig. 2: C*) originate.

Sites and radiocarbon evidence

Mykolyna Broiaka

The site of Mykolyna Broiaka (*Tab. 1; Fig. 1: B, MB; Fig. 6*) lies along the Chornyi Tashlyk, an eastern tributary of the Southern Buh. This site was first investigated in 1928–1932 by P. V. Kharlampovych, whose work was cut short by Stalinist repression. The early collections are now lost (*Polishuk – Kiosak 2018*). Later, in 1955, V. Danilenko excavated c. 50 m², providing the main basis for current interpretations. The pottery belongs to the Savran style, and the site is considered one of the latest para-Neolithic occupations in the region (*Tovkailo 2005*). Two AMS radiocarbon dates diverged notably. One, Be-18269 (6762±27 BP) places the site in the second quarter of the 6th millennium BC (5719–5620 cal BC, 95.4% probability), the other, Be-18270 (5731±26 BP), points towards the second quarter of 5th millennium BC (4678–4493 cal BC, 95.4% probability) (*Kiosak et al. 2024*).

A conventional bone date from Kyiv falls between these AMS values (*Online Supplementary Material 1*). Field documentation (*Polishuk – Kiosak 2018*) reveals two cultural layers not distinguished in Danilenko's publication. Because of its late position within the Buh–Dniester sequence, clarifying the upper layer's nature and chronology is especially important.

Puhach 2

Puhach 2 (*Tab. 1; Fig. 1: B, P2; Fig. 5*), on the left bank slope of the Southern Buh, was excavated by M. Tovkailo (1983–1985) over 655 m² (*Tovkailo 2005*). The site contains Mesolithic, para-Neolithic, Eneolithic, and Late Bronze Age materials. Para-Neolithic and Early Trypillian ceramics co-occur in a layer at a depth of 2.05–2.4 m, with para-Neolithic vessels showing Savran-style decoration.

An early radiocarbon date from the Kyiv laboratory (Ki-3030: 5920±60 BP) placed the site in the early 5th millennium BC (*Tovkailo 1996*), while six additional dates from the same laboratory rather suggested the early 6th to mid-6th millennium BC (*Telegin et al. 2000; Burdo 2003*). However, the latter dates are considered unreliable (*Tovkailo 2004; Kiosak 2024*).

A more recent AMS date (*Online Supplementary Material 1*) places the site in the time-slot of 4686–4503 cal BC (*Kiosak et al. 2024*). This value may relate either to an Early Trypillian phase or to the para-Neolithic component.

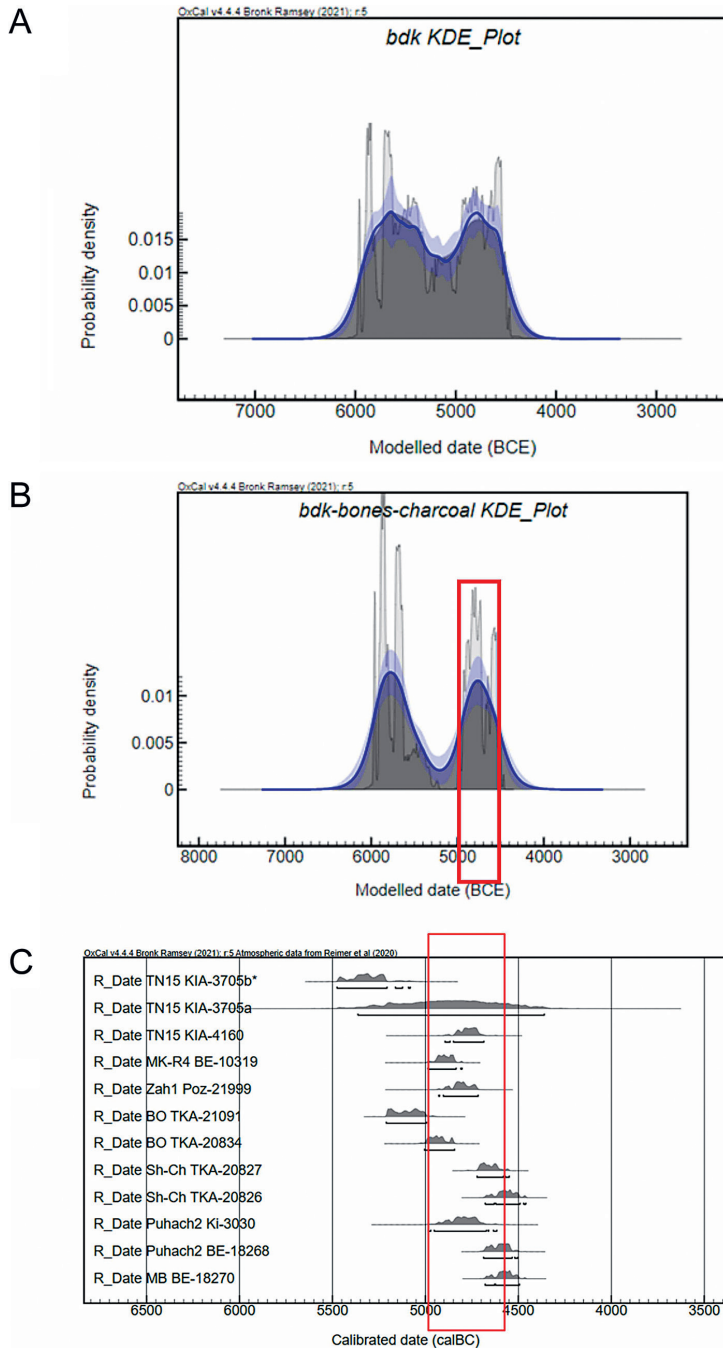


Fig. 2. Radiocarbon dates associated with ceramic hunter-gatherers. Red rectangle: the interval of interest. A: Kernel Density Plot for every relevant date (discarding evidently wrong and dates from Kyiv laboratory of suspicious series, see *Kiosak et al. 2023*); B: the same plot displaying only dates on animal bones and charcoal. C: dates of the ‘second peak’. For abbreviations see *Fig. 1*.

Site name	Coordinates	Other radiocarbon dates	Materials	Features	Excavator
Zaharivka 1	47°21'21"N, 29°47'26"E	no	microlithic assemblage and 'archaic'-looking potsherds	no	Kiosak, Kotova
Melnychna Krucha R4	48°08'50"N, 30°13'00"E	yes	lithic assemblages of Mesolithic, para-Neolithic, and Eneolithic; potsherds of para-Neolithic, Trypillia B1-B2, and Steppe Eneolithic	scatters of lithics, shells, and potsherds	Dobrovoskyi, Danilenko, Kiosak
Mykolyna Broiaka	48°09'53"N, 30°54'53"E	yes	lithic assemblage of para-Neolithic and Eneolithic; potsherds of para-Neolithic and Eneolithic	scatters of lithics, shells, and potsherds	Kharlampovich, Danilenko
Puhach 2	47°48'37"N, 31°10'51"E	yes	lithic assemblages of para-Neolithic and Early Trypillia; potsherds of para-Neolithic and Early Trypillia	scatters of lithics, shells, and potsherds	Tovkailo
Shumyliv–Cherniatka	48°29'17.69"N, 29°40'33.54"E	no	lithic assemblages of para-Neolithic and Early Trypillia; potsherds of para-Neolithic and Early Trypillia	scatters of lithics, shells, and potsherds	Danilenko
Tătărauca Nouă 15	48°19'25"N, 27°58'52"E	yes	finds of Middle Trypillia, LBK, and para-Neolithic	probably anthropogenic scatters of shells	Wechler, Larina, Dergaciov
Bazkiv Ostriv	48°33'07"N, 29°21'30"E	yes	lithic assemblages and potsherds of Mesolithic, para-Neolithic, and Eneolithic	scatters of lithics, shells, and potsherds	Danilenko

Tab. 1. The contingency table of the sites which yielded radiocarbon dates of the early 5th millennium BC from the region of study.

Shumyliv–Cherniatka

Located on the high floodplain of the Southern Buh between Shumyliv and Cherniatka (Vinnytsia region), this site (*Tab. 1; Fig. 1: B, Sh*) was excavated by V. Danilenko in 1960 (c. 300 m²). Concentrations of para-Neolithic and Early Trypillian materials were found at a depth of 0.5–0.8 m in grey-green loam. The site is assigned to the Savran phase of the Buh–Dniester culture (*Danilenko 1969*). Pottery from both traditions appears in roughly equal proportions (*Haskevych et al. 2019*).

A single vessel was dated using TOCC and adhering residues; both results are consistent, yielding 4723–4491 cal BC (*Online Supplementary Material 1*), aligning with the Early Trypillian expansion (*Haskevych et al. 2019*).

Tătărauca Nouă 15

Discovered in 1996 and excavated in 1997 by a German–Moldovan team (*Wechler et al. 1998*), Tătărauca Nouă 15 lies on the right bank of the Dniester (*Tab. 1; Fig. 1: B, TN; Fig. 7*). The 150 m² excavation revealed Neolithic, Late Trypillian, and Iron Age materials. The site is a riverside fishing camp with associated shell accumulations (*Wechler 2001*), the anthropogenic character of which is yet to be proved.

The para-Neolithic layer includes classic Buh–Dniester ceramics but also sherds affiliated with northeastern Ukrainian Neolithic cultures (Strumel–Gastiatin, Volyn) and the LBK (*Larina 2006*). The LBK component consists of 54 small sherds from roughly 14–16 vessels and combines typical LBK features with later Buh–Dniester traits.

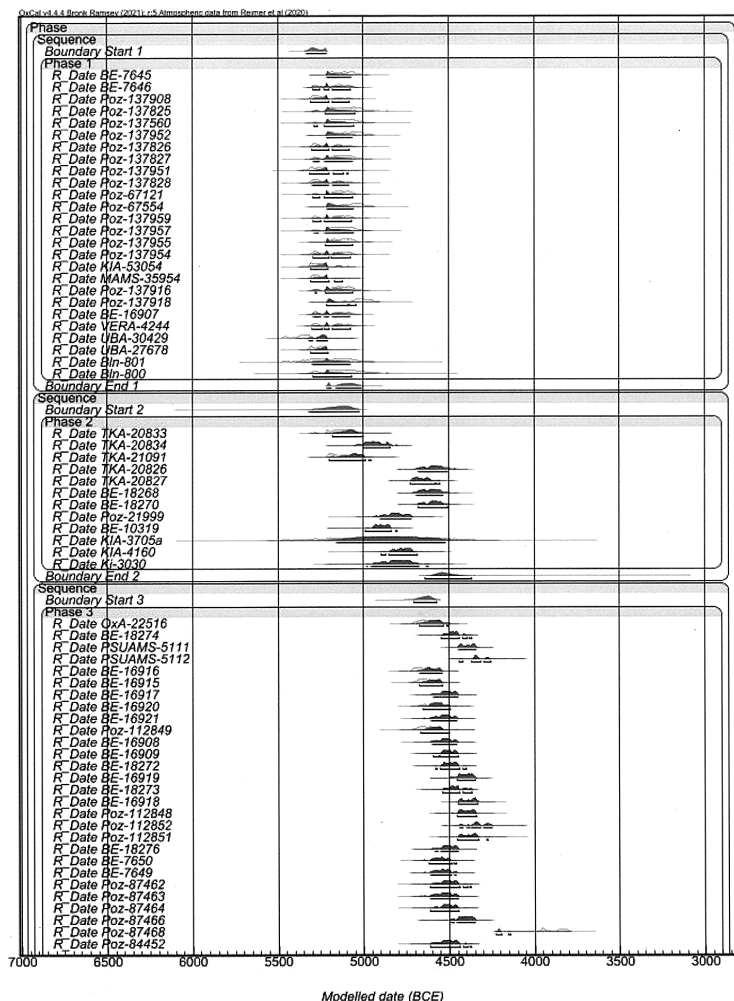


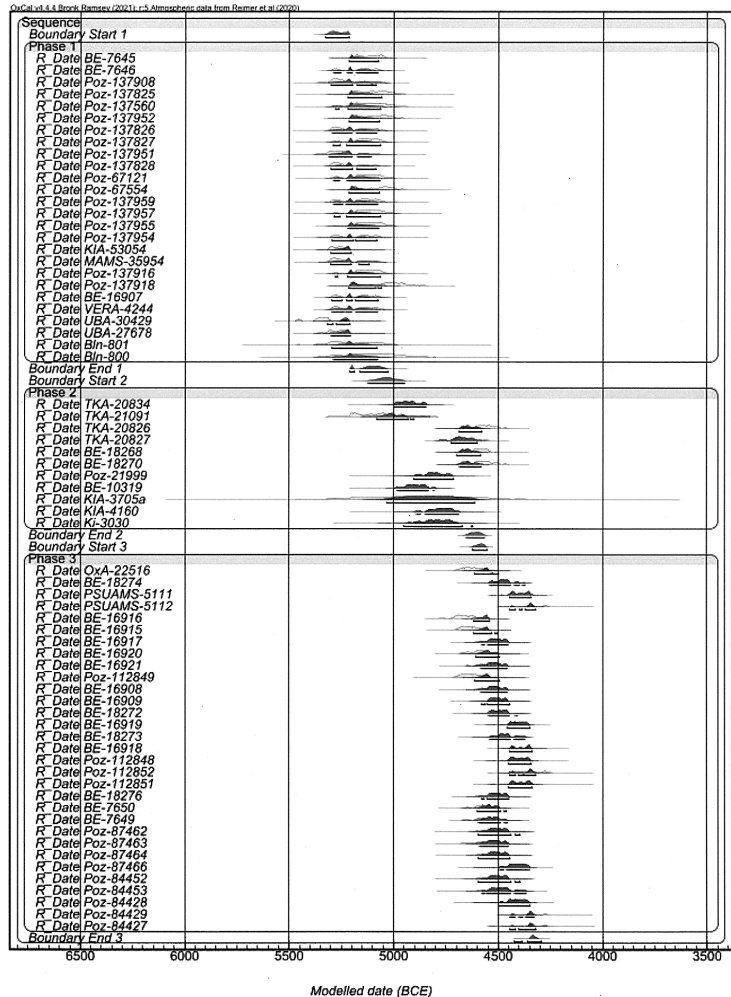
Fig. 3. Bayesian model with overlapping phases. Phase 1 – LBK, 2 – ‘second group’ of para-Neolithic, 3 – Early Trypillia.

Three relevant radiocarbon dates are somewhat contradictory, encompassing either the late 6th millennium BC or the early 5th millennium BC. There were several interpretations put forward. These dates may represent a late LBK occupation, with the Buh–Dniester ceramics undated (Wechler *et al.* 1998). The site may have been jointly occupied by LBK groups and local foragers (Larina 2006). The dates may reflect a post-LBK reuse of an earlier LBK settlement by hunter-gatherers (Kiosak 2024). At present, none of these hypotheses can be conclusively preferred.

Bazkiv Ostriv

The site was located on an island in the Southern Buh River near Skybyntsi (Vynnytsia region; *Tab. 1*; *Fig. 1*: B, BO) and was excavated by V. Danilenko in 1959 over more than 300 m². The para-Neolithic assemblage included concentrations of potsherds, lithic arte-

Fig. 4. Bayesian model with sequential phases. For captions: see Fig. 3.



facts, animal bones, and *Unio* shells (Danilenko 1969, 62–70). Danilenko interpreted the site as stratified, assigning the deposits to the Skybyntsi, Samchyntsi, and Savran phases of the Buh–Dniester culture.

Re-analysis identified two cultural layers (early and late) (Kotova 2003). A later stratigraphic reassessment by D. Haskevych, based on field documentation and a spatial analysis of finds, suggested three artefact-rich horizons: two with para-Neolithic ceramics and one aceramic, probably Mesolithic (Haskevych 2018).

Fourteen radiocarbon dates are currently available: seven on animal bones and antlers from the Kyiv laboratory (Telegin et al. 2000; Kotova 2003), six direct dates on pottery, and one on charred residues adhering to a potsherd (Haskevych et al. 2019). In this paper, we are interested in a series of three dates which fell into the LBK and post-LBK periods, acquired from two vessels. Two dates (TKA-20833, 6190 ± 35 BP and TKA-20834, 6040 ± 25) were obtained from the total organic content of a potsherd (TOCC), while a single date

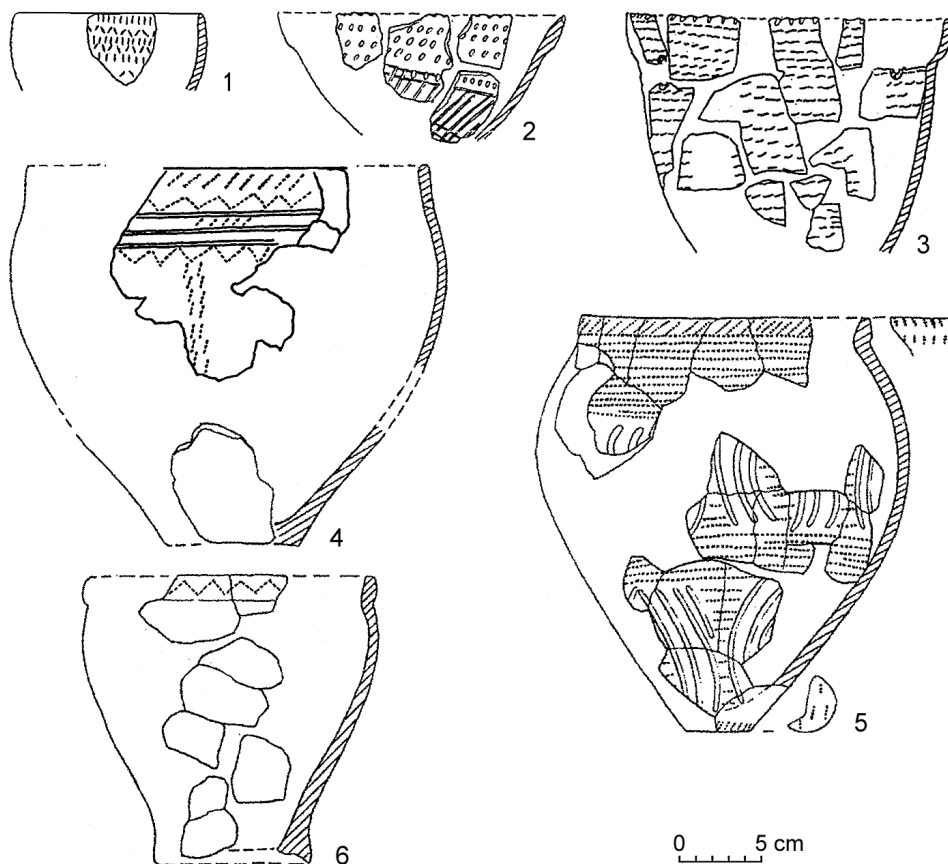


Fig. 5. Overview of pottery finds from Puhach 1 and 2 sites. After *Tovkailo 2005*.

(TKA-21091, 6145 ± 35 BP) comes from a food crust on the same vessel as TKA-20834 and is notably earlier, which questions this pair of dates. To summarise, there was certain activity at the site either in the late LBK period, but more likely afterwards, at the very beginning of the 5th millennium BC.

Zakharivka I

The prehistoric site on the southern slope of the Podillian Upland (Odesa region; *Tab. 1; Fig. 1: B, Z1*) was discovered by a team led by O. Gudkova in 1974 and investigated by Kiosak and Kotova in 2011 (*Kiosak – Kotova 2020*). The cultural layer is heavily disturbed by slope processes but contains a microlithic assemblage with pottery and animal bones. The lithic industry is microlithic—thin bladelets, prismatic cores, end-scrapers, and geometric forms such as trapezes—typical of the late Mesolithic/para-Neolithic of the North Pontic region; a rhomboid point may indicate an early Trypillian (Pre-Cucuteni) influence. Small, poorly diagnostic fragments of hand-made pottery resemble para-Neolithic ceramics from the Southern Buh and Dniester areas. A single radiocarbon date (*Online Supplemen-*

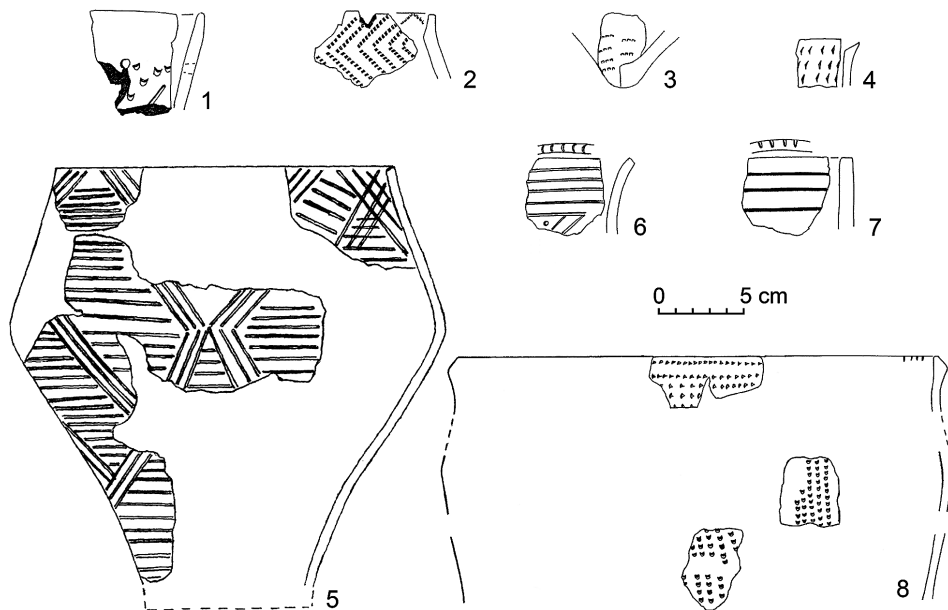


Fig. 6. Potsherds from Melnychna Krucha (1) and Mykolina Broiaka sites (2–8) (drawings by N. Kotova).

tary Material 1) places the site in the period between the decline of LBK and the early expansion of Trypillian farmers.

Melnychna Krucha (R4)

The site of Melnychna Krucha forms part of a multi-layered Early Holocene settlement complex on the Middle Southern Buh River (*Tab. 1; Fig. 1: B, MK*). The R4 artefact scatter, situated c. 150 m upstream from the main SU2 unit, includes para-Neolithic pottery of a Savran appearance, chipped stone artefacts, and animal bones, representing a later phase within the site's long occupational sequence (*Kiosak et al. 2021*). A single radiocarbon determination from R4 on animal bone (*Online Supplementary Material 1*) dates this horizon to the post-LBK period.

Results: Bayesian modelling

Radiocarbon dates were calibrated using Bayesian modelling tools implemented in OxCal (*Bronk Ramsey 2009; 2017*) and employing the IntCal20 calibration curve (*Reimer et al. 2020*). To explore potential discontinuities in human occupation, the *Interval* query was applied. It provides probabilistic estimates of temporal gaps between sequential occupation phases, each defined by radiocarbon dates corresponding to distinct cultural groups. Each phase was modelled as part of a sequential structure, allowing for the possibility of temporal hiatuses between them, with three main phases: LBK, later ceramic hunter-gatherers ('second peak') and Early Trypillia.

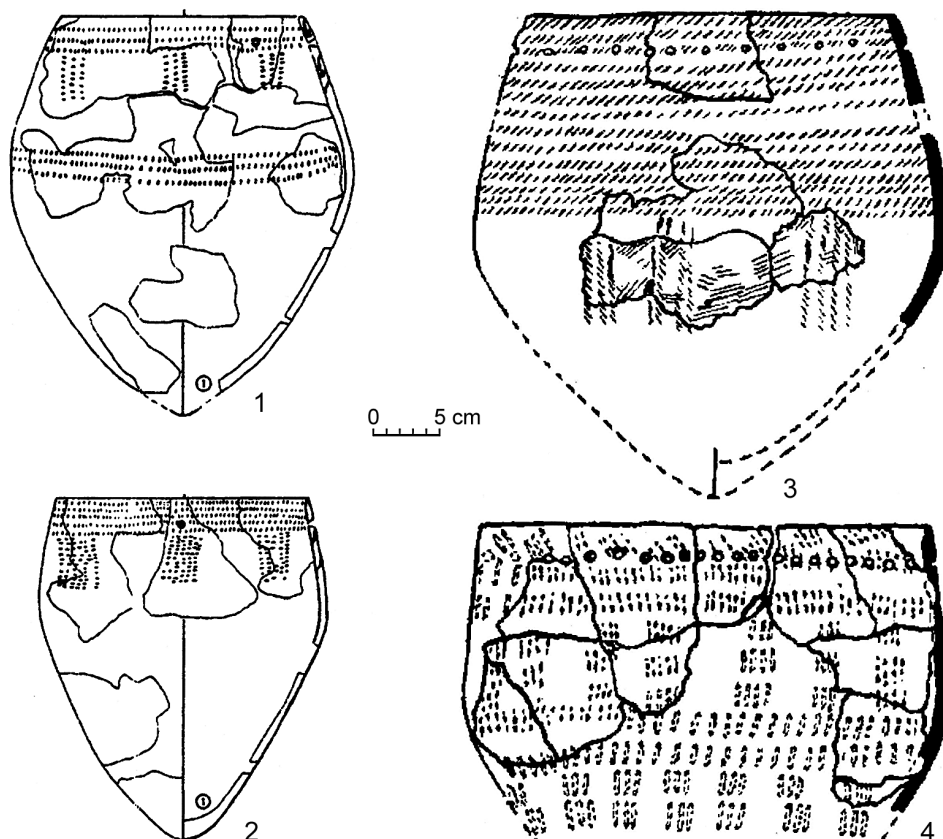


Fig. 7. Selected pottery finds from the Tătărauca Nouă 15 (1, 2, after Larina 2006) and Hryni site (3, 4, after Telegin 1968).

The interval function yielded a gap between the LBK and Early Trypillian phases, which is especially pronounced, estimated at 371–602 years (95.4% probability), and more narrowly at 418–524 years within a 68.3% confidence interval.

The dates from ceramic hunter-gatherer sites fill the previously defined chronological gap like a well-fitting cork, with partial overlap extending into both the early and late phases of early farmer presence. The question of whether ceramic hunter-gatherers and early farmers overlapped in time is far from straightforward. At a large spatial and temporal scale, the two cultural traditions clearly co-existed. However, isolating a narrower window of possibilities or a specific region where their occupations were truly contemporaneous proves much more difficult, both due to the nearly total absence of well-defined features at the sites of a para-Neolithic and blurry character of radiocarbon chronology.

When modelled in a Bayesian sequence as three overlapping phases (Fig. 3; *Online Supplementary Material 2*), the model produces the following estimated chronological ranges for the end of LBK: 5207–5048 cal BC (68.3% probability) or 5211–5010 cal BC (95.4% probability), which basically covers all of the infamous late 6th-millennium BC radiocarbon plateau (Stäuble 2013). Not surprisingly, very similar estimates (5202–5066 and

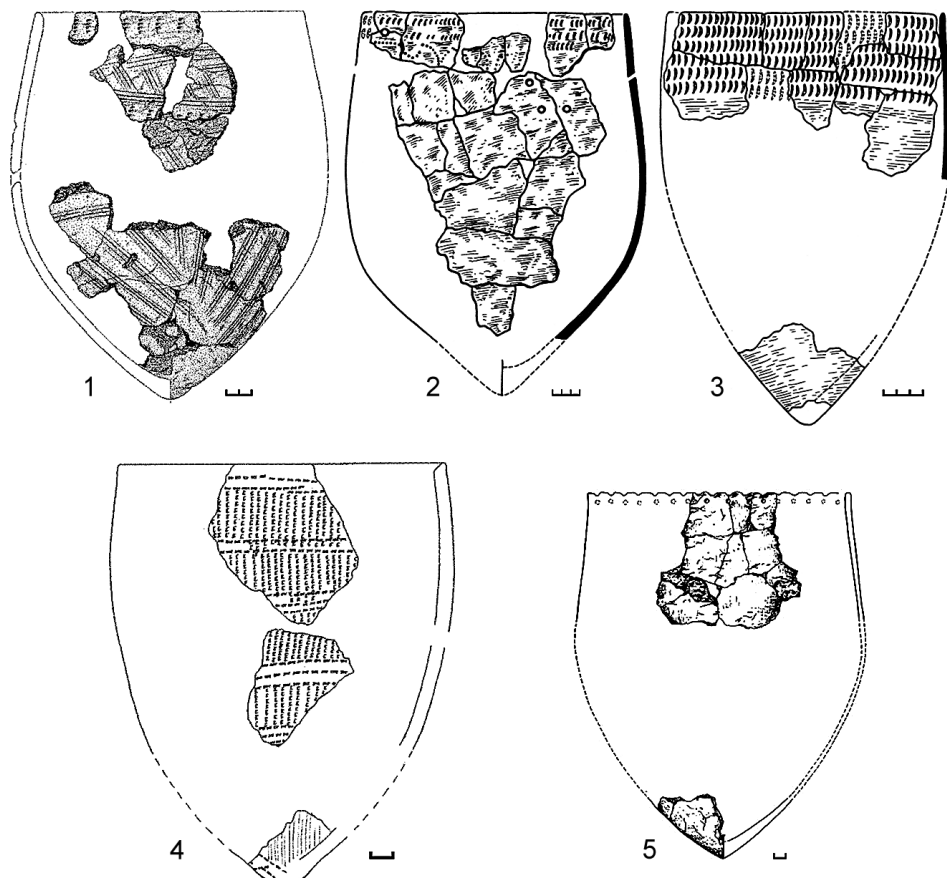


Fig. 8. Vessel from the Schurivtsi site and similar Neolithic pottery. 1 – Schurivtsi (after *Gaskevich 2011*); 2 – Gastiatyn (after *Telegin 1973*); 3 – Hryni (after *Telegin 1973*); 4 – Serebrianske (after *Sanzharov et al. 2000*); 5 – Senchitsy 1 (after *Tkachev 2017*).

5317–5048 cal BC at 68.3% and 95.4% probability respectively) are obtained for the start of the para-Neolithic phase ('second peak'). Probably due to the 'plateau effect', some dates (like TKA-20833) partially fell into it and thus, their calibration was stretched to the limits of the plateau. The end of ceramic hunter-gatherer phase is modelled at 4584–4472 cal BC or 4640–4366 cal BC at 68.3% and 95.4% probability, respectively, which overlaps with the expected start of Early Trypillian phase: 4666–4598 or 4706–4576 cal BC at 68.3% and 95.4% probability respectively.

Therefore, when the dates assigned to the second chronological group of hunter-gatherers are plotted, they appear to overlap with the chronological range of the LBK. However, closer examination reveals that direct evidence for such contemporaneity is limited. For example, the dates from Bazkiv Ostriv were obtained from TOCC residues on potsherds (*Haskevych et al. 2019*), and one of these dates is paired with a food-crust date from the same vessel. Yet, the food-crust date falls earlier, within the LBK period (*Haskevych et al. 2019*). Statistically, the likelihood of these dates being contemporaneous is low, as measured

by the *R_Combine* function of Oxcal. Moreover, TOCC-derived dates can be misleading (Meadows 2020).

A similar lack of clarity is seen at Tătărauca Nouă 15, where the two available dates come from the same sample but diverge significantly: one falls clearly within the 6th millennium BC, while the other carries such a large deviation that virtually any chronological interpretation remains possible (Wechler 2001).

When the LBK, ceramic hunter-gatherers and Early Trypillians are modelled as sequential phases (Fig. 4; *Online Supplementary Material 3*), we take the internal consistency of dates within each cultural phase suggesting that they represent single occupation episodes, rather than independent and potentially unrelated events, as granted. The duration of cultural phases becomes more constrained, and the hiatuses between them proportionally longer (Pedersen et al. 2018). According to this simplified reconstruction (Fig. 4), the LBK phase spans 5213–5050 cal BC (95.4%), ending in 5158–5008 (88.9% probability), or 5125–5046 (68.3%), while the Early Trypillian phase starts at 4676–4662 cal BC (95.4%), and ceramic hunter-gatherers fill in the remaining interval in between.

Discussion

Thus, modelling of the radiocarbon dates indicates that after the decline of the LBK in the valleys of the Southern Buh and Dniester, ceramic hunter-gatherer populations reappeared in the region. These groups may have lived alongside the LBK communities, although the evidence for such coexistence remains limited and uncertain.

Namely, synchronisation of archaeological cultures and intercultural relations are often inferred from shared features in pottery, stone tools, and other artefacts, especially when distinctive items appear in another culture’s context. These considerations led to the proposed synchronisation of the LBK with the Samchyntsi phase of the Buh-Dniester culture (Danilenko 1969; Telegin 1977), and of Trypillia A3 with the Savran phase of the latter (Tovkailo 1996; 2005; 2020). However, as demonstrated by D. Haskevych (Gaskevych 2011), potsherds in the Samchyntsi style occur in a wide range of contexts that far exceed the chronological and spatial limits of this supposed phase of a single local culture. Moreover, the ceramic styles of hunter-gatherer pottery do not appear to have purely chronological significance in general (Gaskevych 2013; 2014; Kotova 2015).

Looking from the other perspective, several sites have produced LBK fineware potsherds from layers that also contain pottery of ceramic hunter-gatherers, including Gyrzheve (Petrenko 2009), Bazkiv Ostriv (Passek – Chernysh 1963), Soroca 5 (Markevich 1974), Tătărauca Nouă 15 (Wechler et al. 1998), Dobrianka 3 (Zaliznyak et al. 2013), and Gard (Tovkailo 2014). Because LBK fineware is highly distinctive, these identifications are likely reliable. An LBK coarseware sherd was also reported from Schurivtsi-Porih (Gaskevich 2010).

However, these finds come from cultural layers rather than secure, closed contexts. Given that some of these layers contain materials from different cultural traditions and periods (Kotova 2015), their interpretive value for intercultural contact is limited. In post-Soviet scholarship, such items are conventionally labelled ‘imports’. However, many cases show that these artefacts can actually be ‘mechanical admixtures’, mixed into deposits through natural, post-depositional processes rather than cultural contact (Sorokin 2006).

Conversely, pottery attributed to hunter-gatherers has been reported from LBK contexts, notably at Mainova Balka (*Larina et al. 1999*) and Rusești Noi (*Markevich 1974*), though such cases are less certain. LBK coarseware is more variable than often assumed and may be misidentified, particularly in small assemblages from test trenches.

More complex cases involve sherds in hunter-gatherer contexts that resemble distant traditions. Some pieces previously thought to be unpainted were later found to bear pigments and incised decoration forming patterns similar to that of the Szakálhát culture and Bükk subunit of the LBK, while their paste and surface treatment remain consistent with local hunter-gatherer traditions (*Haskevych 2017*). Moreover, at the site of Tatareuca Nouă 15, O. Larina reported an assemblage of syncretic pottery combining traits of the LBK and several traditions of local ceramic hunter-gatherers, including some from geographically distant cultural aspects (*Larina 2006*).

As demonstrated in many studies, attributing isolated traits to specific cultures can be misleading (*Heyd 2017; Riede et al. 2024*). Such traits only gain meaning within a particular technological process, and similar-looking features may result from different production methods (*Palaguta 1998; Gomart 2014*). Since pottery analysis largely relies on an ‘informed’ typology here rather than on fully reconstructed operational sequences, conclusions based on supposedly ‘syncretic artefacts’ remain tentative and may be premature. These approaches can underestimate the variability, creativity, and innovation of prehistoric material culture makers.

Thus, there is no direct or indisputable evidence for the coexistence of the LBK with any particular subgroup of local ceramic hunter-gatherers. Rather, the overall pattern only suggests that such coexistence may have occurred. More detailed post-depositional analysis and broader, more precise application of radiometric methods are required to clarify this issue.

In contrast, the presence of hunter-gatherers following the collapse of the LBK until the arrival of the earliest Trypillian groups is better attested in the region of study, and the available data, while still not fully conclusive, makes at least partial contemporaneity between these hunter-gatherers and the Early Trypillians increasingly plausible. Several sites along the Southern Buh have yielded thousands of Early Trypillian sherds alongside para-Neolithic ceramics. Mykola Tovkailo has identified ‘syncretic’ vessels that incorporate technological or decorative features from both traditions (*Tovkailo 2005*). Early Trypillian sites in this zone also show unusually high proportions of wild fauna relative to domestic species, indicating continued reliance on hunting (*Zbenovich 1989*). Fishing and a well-developed antler and bone industry are also documented (*Zhuravlev – Kotova 1996*). Lithic assemblages include rhomboid projectile points produced using the microburin technique, typical of hunter-gatherer toolkits (*Kiosak 2016*). These attributes suggest Early Trypillian groups in the region could have adopted or integrated practices from indigenous foragers.

The emerging pattern may reflect partial displacement of para-Neolithic groups during the LBK expansion, pushing them toward regions where related forager traditions subsequently flourished. Later, during the so-called Middle Neolithic crisis (*Amkreutz – van de Velde 2018*), the retreat of LBK populations likely opened several areas to renewed hunter-gatherer occupation. Fifth-millennium BC hunter-gatherers are well known from more eastern and northern areas of Ukraine (*Kotova 2015*). In the north, they also expanded into territories previously settled by LBK groups, although they tended to occupy different types of locations (*Kovaliukh et al. 2007; Okhrimenko 2009*).

Other explanations remain possible:

1. Prolonged coexistence of LBK farmers and para-Neolithic foragers, with localised micro-regional interactions. One might argue that the hunter-gatherers were largely unaffected by the LBK expansion and simply continued their traditional lifeways, making any notion of ‘resurgence’ inappropriate where no actual break occurred (*Haskevych 2021*). However, the marked decrease in radiocarbon dates during the LBK period (*Kiosak et al. 2024*), together with the considerable demographic impact implied by the spread of the LBK, characterised by hundreds of permanent settlements compared to the few dozen temporary camps of ceramic hunter-gatherers (*Tovkailo 2020; Haskevych 2024*), suggests a significant transformation. Therefore, at present, the extent to which the expansion of the LBK resulted in the abandonment of river valleys by hunter-gatherer groups cannot be determined, and the currently available evidence for interaction requires critical reassessment.

2. Cultural reorientation within former LBK communities, which may have adopted hunter-gatherer lifeways after the collapse of the wider LBK network (*Larina – Dergaciov 2017*). This line of interpretation was inspired in part by the materials from the Tătărauca Nouă 15 site, where purported elements of several hunter-gatherer complexes were observed interwoven with late, ‘decadent-style’ LBK pottery (*Larina 2006*). However, this site remains unique, and its implications should be treated with caution. Moreover, while we still lack genetic data for the ceramic hunter-gatherers of the Dniester and Southern Buh regions (*Nikitin et al. 2025*), their lifeways were entirely those of foraging communities (*Motuzaitė Matuzevičiūtė 2020; Endo et al. 2022*), showing no trace of the early farming traditions that would be expected if they had played the kind of role proposed in this scenario.

3. Continuous local development, whereby para-Neolithic traditions evolved directly into Early Trypillian communities, possibly including early integration of forager populations into the emerging Trypillian cultural sphere (*Danilenko 1974*). This long-standing notion was thoroughly and productively challenged, and it was convincingly demonstrated that many supposedly ‘ceramic hunter-gatherer’ elements in Early Trypillian material culture can be explained as internal variability within early farming communities rather than as evidence of external influence (*Zbenovich 1996*). Ancient DNA studies indicate an influx of forager ancestry into Trypillian populations, which may have occurred during the formation of the Early Trypillian culture (*Nikitin et al. 2025*). However, the identity of these foragers remains unknown. Because the Pre-Cucuteni–Early Trypillia cultural complex emerged around the Carpathian region (*Bodean 2001; 2017; Garvăn et al. 2009; Boghian – Enea 2013*), the forager groups involved may have been quite different from those inhabiting the valleys of the Southern Buh and Dniester.

At present, none of the proposed models can be either fully accepted or rejected given the current state of the archaeological record. What can be stated with a notable degree of certainty is that in the region between the middle courses of the Dniester and Southern Buh river valleys there are ceramic hunter-gatherer sites that postdate the LBK and predate Early Trypillia, while earlier LBK sites are also present in the area.

Therefore, the fifth-millennium BC hunter-gatherers of the Southern Buh and Dniester valleys represent an important cultural and demographic phenomenon that merits further detailed study.

Unfortunately, relatively little can be said about their material culture, owing to significant post-depositional disturbances at their sites and the inadequate documentation of early

excavations (*Gaskevych 2012; 2013; 2014*). One feature, however, consistently unites them: the presence of Savran-style pottery, characterised by the use of tempering materials such as vegetable fibres, sand, and graphite, which together produce a distinctive texture and firing quality. The vessels typically bear linear-polished decorations, a hallmark of the tradition, though additional decorative techniques are also attested. These include the use of small-toothed comb impressions and occasional single stick impressions, which introduce subtle variation within an otherwise coherent stylistic repertoire (*Danilenko 1969; Kotova 2015; Tovkailo 2020*). Can we constrain the chronology of the Savran style to the early 5th millennium BC? Most likely not. There are several earlier dates, from the mid-6th millennium BC onwards (*Tovkailo 2014*). However, a notable share of its time span occurred after the direct presence of early farmers (Cris and LBK) in the region.

Thus, to isolate traits characteristic of the 5th millennium BC, we need to identify features that represent a later stage of the Savran style. As has long been proposed and recently confirmed, another cultural component of the ceramic hunter-gatherer tradition persisted well into the 5th millennium BC: the Azov – Dnieper culture (5500–4500 BC), occupying terrain to the east of the discussed region (*Kotova – Tuboltsev 1996; Kiosak et al. 2023*), while in the north the similar chronology (5550–4350 BC) could be suggested for the Kyiv-Cherkassy cultural aspect (*Kotova 2015*). It is therefore plausible that elements of their distinctive pottery could serve as chronological markers. Indeed, such features are present at some of the sites discussed above.

Later Savran-style pottery is characterised by being heavily tempered with plant fibres, which had earlier produced a characteristically soft surface. The latter was replaced by vessels made from a denser clay body containing sand and only small amounts of vegetal material. Although traces of these fibres remain visible on the surface, they no longer imparted softness to the sherds. Pottery tempered with graphite, talc, and mica also appeared during this period. Additives known from earlier phases, such as sand, sand mixed with plant fibres, and crushed shell, continued to be used as well. These subtle nuances resemble changes visible in the east, in the Azov-Dnieper cultural area (*Kotova 2015*).

Returning to Savran-style pottery, vessels commonly had pointed or flat bases. However, a few pots with rounded bases now emerged, and the proportions of vessel types shifted: the numbers of jars and pots increased, while bowls were produced less frequently. The ornamentation employed drawn or incised lines, punctures, and impressions made with short-toothed comb stamps (*Kotova 2015*).

At the settlement of Puhach (*Tovkailo 2005*), pottery of this type has been identified. These include flat-based vessels represented by closed bowls (*Fig. 5: 1*), bowls with a profiled upper section (*Fig. 5: 3, 4*), jars with pronounced necks (*Fig. 5: 5, 6*), and more rarely, simple bowls (*Fig. 5: 2*). Characteristic features include a collar-like thickening on the rim, comb-impressed zigzags, impressions made with long-toothed comb stamps, and ornamentation applied to the inner edge of the rim. They are attested and described numerous times for the collections of Azov-Dnieper pottery (*Kotova 2015*).

At the Mykolyna Broiaka site, the pottery contains sand temper with small additions of plant fibres (*Fig. 6*). In some cases, white particles are visible in the clay, possibly representing small shell fragments similar to those observed at the site of Gard (*Gaskevych 2011; Tovkailo 2014*). One vessel, decorated with widely spaced punctate impressions, features a collar-like rim (*Fig. 6: 8*). Another vessel, with a rim cut at a slant, is ornamented with long-toothed comb impressions arranged in a ‘fir-tree’ (herringbone) pattern; the inner edge

of its rim is also decorated (*Fig. 6: 2*). Both features are well-known in Azov-Dnieper contexts (*Kotova 2015*).

From the rich, and probably heterogeneous, assemblage of Tătăreuca Nouă 15, our focus is on the group of pointed-based vessels (*Fig. 7: 1, 2*). They are made from clay tempered with plant fibres and sand, and are decorated with comb-stamp impressions and punctate impressions (*Larina 2006*). Unfortunately, we possess only a few reconstructed forms of Neolithic vessels from the Polissia region and the forest-steppe of the Middle Dnieper. Among these comparanda, the vessels from Moldova show the closest parallels, particularly to the closed biconical jars (*Fig. 7: 3, 4*) of the Kyiv-Cherkassy culture from the Hryni settlement (*Kotova 2012*).

This observation can be enhanced by the materials from the Southern Buh valley. Namely, at the Shurivtsi site, two pointed-based closed jars (*Fig. 8: 1*) were found (*Kotova 2015*), closely resembling the vessel forms of the Kyiv-Cherkassy culture from the forest-steppe of the Middle Dnieper (*Fig. 8: 3*). Similar shapes are also attested in the Polissia region of Northern Ukraine and Southern Belarus, the ‘Sokołuwiek’ type (*Fig. 8: 2, 5*), which is dated from the end of the 6th millennium to the beginning of the 5th millennium BC (*Telegin 1968; Tkachev 2017*).

Thus, the Savran-style pottery of these late hunter-gatherers incorporates components likely linked to cultural traditions of hunter-gatherer groups to the north and east of the region. These observations suggest that the resurgence of forager groups in this area may have been, at least partially, reinforced by non-local demographic inputs originating outside the region.

The phenomenon of Neolithisation reversal is well documented in several regions of Europe, particularly in areas peripheral to the main Neolithisation expansion routes associated with the LBK and Impressed Ware cultures (*Amkreutz – van de Velde 2018; Nielsen et al. 2019*). Neolithisation can no longer be viewed as an inevitable and irreversible achievement of humankind. Under specific historical and environmental conditions, its advances could be abandoned, at least temporarily. Early farming populations declined, while hunter-gatherer groups reoccupied previously cultivated landscapes, exploiting abandoned fields and pastures through hunting and gathering.

The region surrounding the middle course of the Dniester River and up to the very valley of the Southern Buh, characterised today by highly fertile soils (*Chesworth et al. 2008*), was likely abandoned by the early LBK farming communities and effectively resettled by foragers in the early 5th millennium BC. The adaptation of these latter groups was sufficiently successful that some incoming early farming populations (Early Trypillians) likely adopted, at least in part, elements of the lifeways of their hunting-and-gathering predecessors, particularly practices related to riverside fishing (*Tovkailo 2005*).

Conclusion

Bayesian analysis of the currently available radiocarbon dates indicates a gap of approximately 300–400 years between the decline of the LBK horizon and the arrival of a new wave of early farming groups associated with the Pre-Cucuteni or Early Trypillia cultural complex in the middle reaches of the Southern Buh and Dniester rivers and the region in-between. Several radiocarbon dates from the early 5th millennium BC fall within this gap.

But these derive from riverside camps attributed to ceramic hunter-gatherer communities. This study examines the sites in question with particular attention to the ambiguities in their chronological attribution. In terms of material culture, given that each site represents a palimpsest, making the secure assignment of specific elements to discrete phases of occupation difficult, the analysis instead seeks recurring patterns across these assemblages attributed to late ceramic hunter-gatherers. One such recurring feature is Savran-style pottery, which exhibits clear eastern and northern influences.

Thus, we can state that in the areas formerly inhabited by the LBK communities around the middle courses of the Dniester and Southern Buh valleys, a ceramic-producing hunter-gatherer population persisted after the decline of the LBK. These groups likely continued to thrive until the next wave of early farming expansion, represented by Early Trypillia. Their pottery was predominantly of the Savran type and displayed certain features characteristic of ceramic hunter-gatherer traditions known from regions to the north and east of the study area.

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