3 The Neolithisation as Seen from the East

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

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

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

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

3 Endo et al. 2022.

4 Benecke 1997; Stupak et al. 2022.

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

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

3.1 The First Temperate Neolithic in the Pontic Steppe

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

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

5 Gaskevych 2011; Kotova 2009.

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

7 Larina 1994; Zvelebil, Lillie 2000.

8 Lazarovici 1993.

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

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

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

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

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

10 Krauss 2016, 212.

11 Weninger et al. 2006.

12 Biagi et al. 2005.

13 Dergachev, Dolukhanov 2007; Larina 1994.

14 Ursulescu 1984, 83.

15 Weller, Dumitroaia 2005.

16 Larina 1994.

17 Ursulescu 1984.

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

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

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

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

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

18 Markevich 1974; Yanushevich 1989.

19 Larina 1994.

20 Larina 1994.

21 Kuzminova et al. 1998.

22 Dergaciov, Larina 2015.

23 Dergaciov, Larina 2015; Turcanu 2009, 123.

24 Comşa 1987.

25 Dergaciov, Larina 2015.

26 Meadows 2019.

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

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

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

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

27 Covalenco 2017.

28 Dergaciov, Larina 2015, 340.

29 Markevich 1974; Tovkailo 2020.

30 Haskevych et al. 2019.

31 Diana et al. 2019.

32 Kiosak et al. 2023b.

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

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

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

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

33 Biagi et al. 2005.

34 Diana et al. 2019.

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

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

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

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

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

37 Biagi, Spataro 2005; Meadows 2019.

38 Meadows 2019.

39 Monah, Monah 2002; Zaliznyak 1998.

40 Zaitseva et al. 2009.

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

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

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

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

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

41 Meadows 2020.

42 Courel et al. 2021.

43 Dolbunova et al. 2020.

44 Tovkailo 2014.

3.2 Linear Pottery Culture at Its Easternmost Fringe

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

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

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

45 Pavuk 1969.

46 Kadrow 1990; Kulczycka-Leciejewiczowa 1970.

47 Dębiec, Saile 2015; Haskevych 2024.

48 Larina 1999.

49 Saile et al. 2016a.

50 Valeanu 2003, 91.

51 Kadrow, Trela-Kieferling 2013.

52 Valeanu 2003.

53 Pasternak 1948.

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

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

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

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

54 Lenartowicz 2009.

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

56 Konoplia 2008.

57 Dębiec, Saile 2015.

58 Lenartowicz 2011.

59 Okhrimenko 2009.

60 Mylian et al. 2009.

61 Dębiec, Saile 2015.

62 Pasternak 1948.

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

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

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

63 Dębiec, Saile 2015.

64 Okhrimenko 2009.

65 Stadler 2005.

66 Pavuk 2005.

67 Okhrimenko 2009.

68 Telegin 1985b.

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

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

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

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

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

70 Lenartowicz 2013; Saile et al. 2016a.

71 Pasternak 1948.

72 Sveshnikov 1954.

73 Buttler 1938.

74 Paret 1942.

75 Soudský 1966.

76 Danilenko et al. 1957.

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

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

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

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

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

77 Pasternak 1948, 7.

78 Passek, Chernysh 1963.

79 Lenartowicz 2013.

80 Saile et al. 2016a.

81 Kiosak et al. 2021a; Saile 2020.

82 Telizhenko, Silaiev 2022.

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

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

85 Kiosak 2019b.

86 Man'ko, Telizhenko 2016.

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

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

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

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

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

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

87 Kiosak 2016a.

88 Kiosak 2017.

89 Kiosak 2013; Kiosak 2017b.

90 Birkenhagen 2003.

91 Kiosak 2017.

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

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

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

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

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

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

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

93 Okhrimenko 2009.

94 Larina 1999.

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

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

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

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

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

95 Păunescu 1970.

96 Dergaciov, Larina 2015.

97 Kiosak 2017.

98 Larina 1999.

99 Kotova 2003.

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

101 Kovaliukh et al. 2007.

102 Kiosak et al. 2023c.

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

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

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

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

103 Kiosak et al. 2023c.

104 Stadler, Kotova 2013; Stadler, Kotova 2021.

105 Lenneis, Stadler 1995; Stadler, Kotova 2021.

106 Marinescu-Bîlcu 1971.

107 Sapozhnikov, Sapozhnikova 2011.

108 Motuzaite Matuzeviciute, Telizhenko 2016.

109 Oross, Banffy 2009.

110 Stadler, Kotova 2021.

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

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

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

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

111 Kovaliukh et al. 2007.

112 Kiosak, Salavert 2018.

113 Moskal-del Hoyo et al. 2023.

114 Kiosak et al. 2021b.

115 Larina 1999.

116 Moskal-del Hoyo et al. 2023.

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

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

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

117 Konoplia 2008.

118 Bardetskiy 2012.

119 Zlatohorskyi, Bardetskyi 2010.

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

121 Kovaliukh et al. 2007.

122 Lenneis, Stadler 1995.

123 Saile 2020.

124 Dębiec 2015; Okhrimenko 2009.

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

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

3.3 Chronology of the First Domesticates

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

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

125 Bardetskiy et al. 2017.

126 Kiosak et al. 2023c.

127 Kotova 2003; Kovaliukh et al. 2007.

128 Motuzaite Matuzeviciute, Telizhenko 2016.

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

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

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

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

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

129 Endo et al. 2017; 2019; 2022.

130 Martin et al. 2021; Motuzaite Matuzeviciute 2020.

131 Monah, Monah 2002.

132 Comşa 1991.

133 Yanushevich 1989.

134 Kuzminova et al. 1998.

135 Motuzaite Matuzeviciute 2020.

136 Kuzminova et al. 1998.

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

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

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

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

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

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

137 Dergaciov, Larina 2015.

138 Kotova, Pashkevich 2003.

139 Dal Corso et al. 2022.

140 Endo et al. 2022.

141 Motuzaite Matuzeviciute, Telizhenko 2016, 105.

142 Motuzaite Matuzeviciute, Telizhenko 2016, 108.

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

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

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

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

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

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

144 Moskal-del Hoyo et al. 2023.

145 Kotova, Pashkevich 2002.

146 Moskal-del Hoyo et al. 2023.

147 Kiosak 2017.

148 Saile et al. 2016a.

149 Saile 2020.

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

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

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

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

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

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

150 Moskal-del Hoyo et al. 2023.

151 Passek, Chernysh 1963.

152 Larina 1999; Yanushevich 1989.

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

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

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

153 Telizhenko, Man'ko 2021.

154 Bogaard et al. 2011.

155 Salavert et al. 2020.

3.4 Eneolithisation or Late Neolithic Crisis?

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

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

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

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

156 Kadrow 2015.

157 Chernish 1982.

158 Korobkova 1987.

159 Borić 2015.

160 Petrequin et al. 2017.

161 Petrequin et al. 2017.

162 Shnirelman 1989.

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

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

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

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

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

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

164 Dergaciov 2007; Lichardus, Lichardus-Itten 1995.

165 Govedarica 2004; Manzura 2005.

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

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

168 Slavchev 2010.

169 Reingruber, Thissen 2009.

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

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

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

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

170 Dumitrescu 1963; Passek 1949; Videiko 2004.

171 Videiko 2004.

172 Ursu 2016.

173 Boghian, Enea 2013.

174 Burdo 2011.

175 Passek 1961; Zbenovich 1989; Zbenovich 1996.

176 Kiosak 2016a.

177 Zbenovich 1996.

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

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

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

178 Allentoft et al. 2024.

179 Motuzaite Matuzeviciute 2020.

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

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

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

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

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

180 Burdo 2003.

181 Mantu 2000; Rassamakin 2012.

182 Gaskevych 2014.

183 Kotova, Videiko 2004.

184 Rassamakin 2012.

185 Burdo 2003.

186 Shatilo 2021.

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

188 Popovici, Draşovean 2020.

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

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

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

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

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

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

191 Videiko 2004; Zbenovich 1989.

192 Dumitrescu 1957; Dumitrescu 1963.

193 Popovici, Drașovean 2020; Rassamakin 2012.

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

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

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

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

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

195 Popovici, Draşovean 2020.

196 Popovici, Draşovean 2020, 371.

197 Stuiver, Polach 1977.

198 Biagi et al. 2005.

199 Oross, Siklósi 2012.

200 Müller 2004.

201 Diachenko et al. 2024.

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

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

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

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

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

202 Tovkailo 2005.

203 Haskevych 2021.

204 Forenbaher, Miracle 2005.

205 Burdo 2018.

206 Videiko 2004.

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

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

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

207 Burdo 2018.

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

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

210 Sorochin 2002.

211 Popovici, Drașovean 2020.

212 Rassamakin 2012.

213 Lazarovici 2010.

214 Bem 2007, 241.

215 Kiosak, Lobanova 2021.

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

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

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

216 Kotova 2008.

217 Rassamakin 2017.

218 Kotova 2008.

219 Kotova 2008.

220 Kotova 2008; Rassamakin 2004.

221 Govedarica, Manzura 2016.

222 Rassamakin 2009.

223 Bem 2007, 58.

224 Palaguta 1998; Popova 2003.

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

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

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

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

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

226 Reingruber, Rassamakin 2016.

227 Burdo 2015; Kiosak, Lobanova 2021.

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

229 Manolakakis 2017.

230 Sorochin 2001.

231 Frînculeasa 2016.

232 Subbotin 2013.

233 Subbotin 2013, 113.

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

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

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

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

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

234 Frînculeasa 2016.

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

236 Biagi et al. 2005.

237 Burdo 2015; Palaguta 2007; Sorochin 2002.

238 Pavuk 2005.

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

3.5 Conclusion

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

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

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

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

240 Motuzaite Matuzeviciute 2020.

Figures

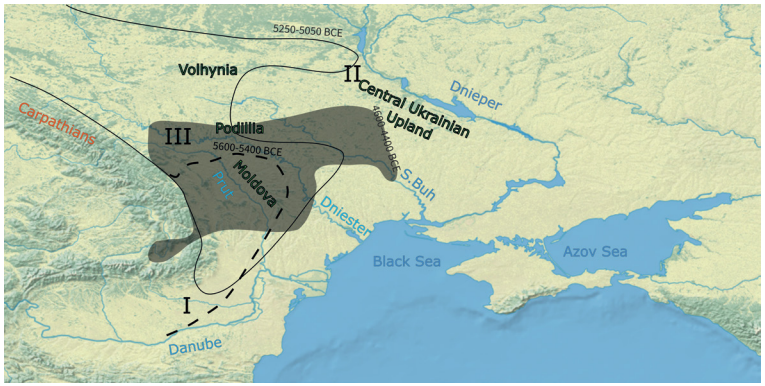

Figure 38 Multiple Neolithisations in the Carpathian-Dnieper region. I: extent of Criș spread; II: LBK expansion; III: early Trypillian dispersal. Topo: Natural Earth. Mapping by the Author

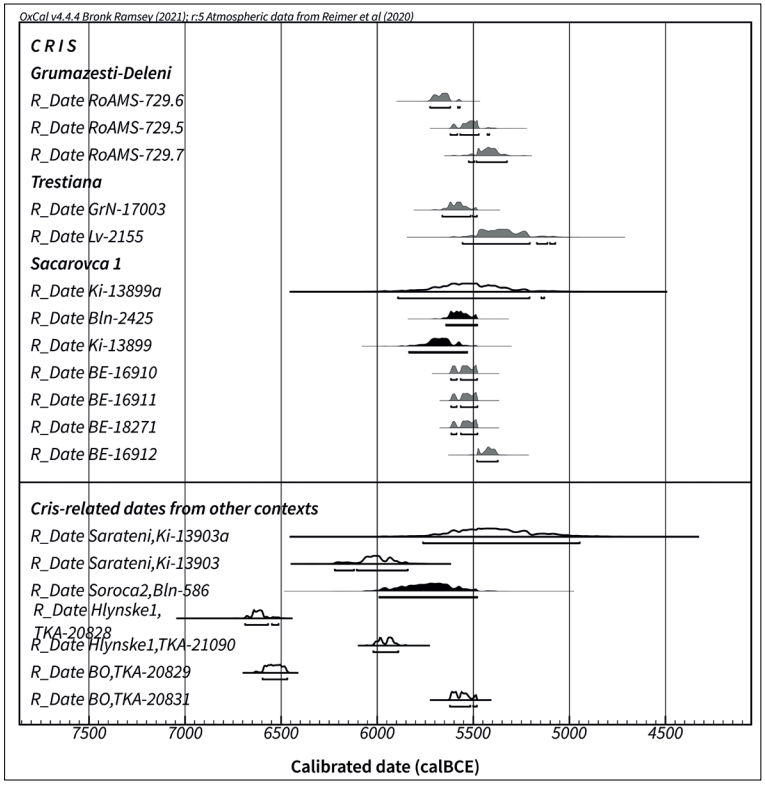

Figure 39 Radiocarbon dates for the Criș culture sites east of the Carpathians. Black: charcoal dates; grey: bone dates, empty: TOCC of potsherds dates. BO – Bazkiv Ostriv. Done in OxCal by the Author

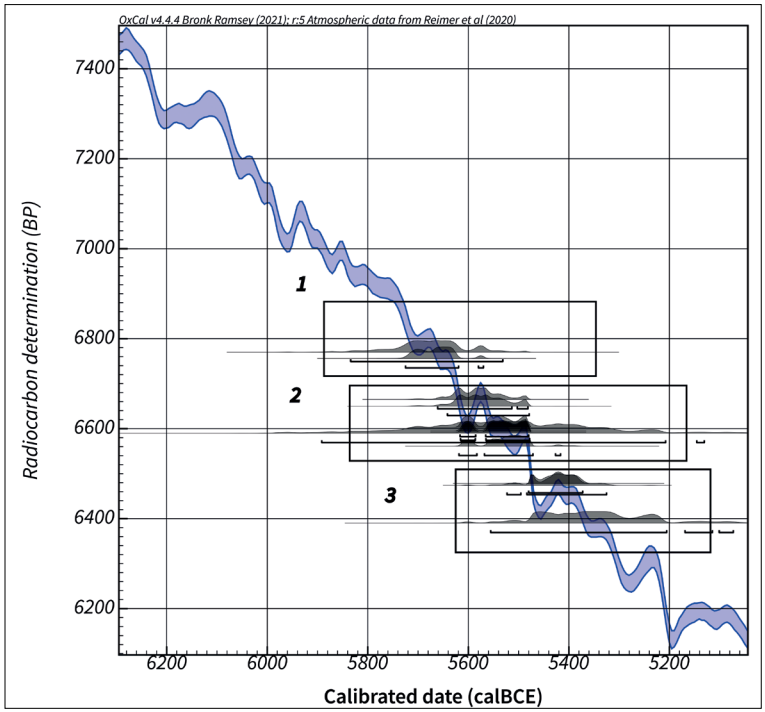

Figure 40 Radiocarbon dates for the Criș culture sites east of the Carpathians when plotted on a calibration curve. 1-3: chronological groups. Done in OxCal by the Author

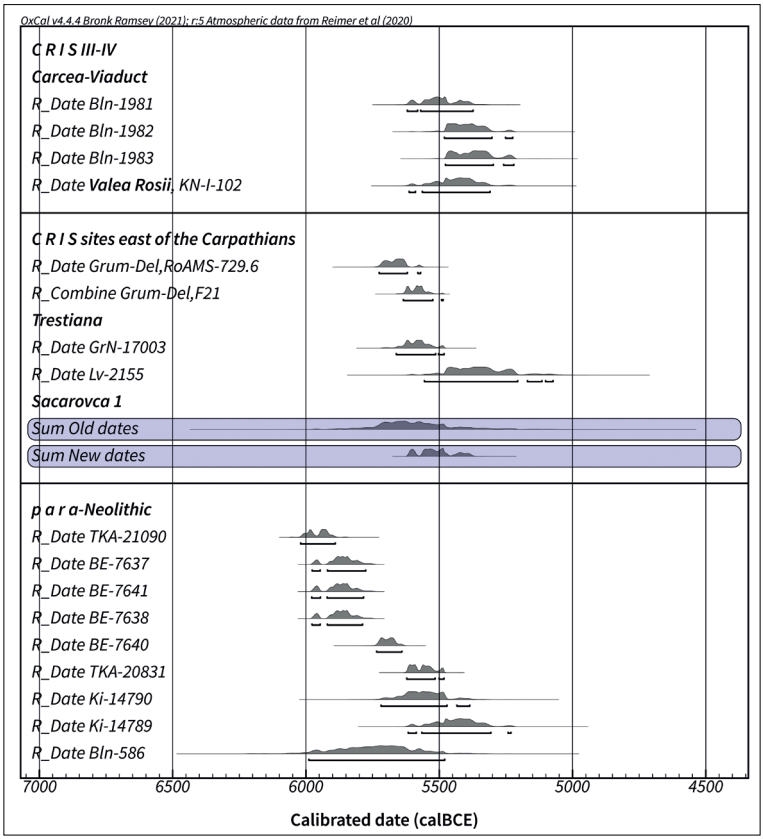

Figure 41 Comparison of radiocarbon dates for the sites of Criș east of the Carpathians (middle) with dates for the Late Criș sites elsewhere in Romania (above) and selected radiocarbon dates for Buh-Dniester para-Neolithic (below). ST 3-1. Done in OxCal by the Author

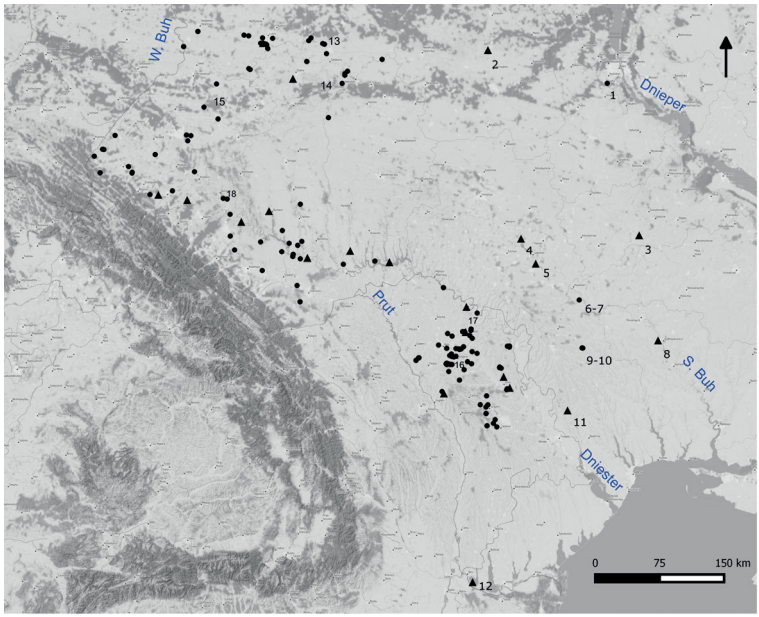

Figure 42 LBK sites east of the Carpathians. Circles: settlements; triangles: straw finds. 1: Vita Poshtova; 2: Fasova; 3: Dobrianka 3; 4: Bazkiv Ostriv; 5: Shchurivtsi-Porih; 6-7:- sites near Zavallia; 8: Gard; 9-10: sites near Ananiev; 11: Hirzheve; 12: Orlovka-Cartal; 13: Rivne, Rovantsi; 14: Mezhyrich;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

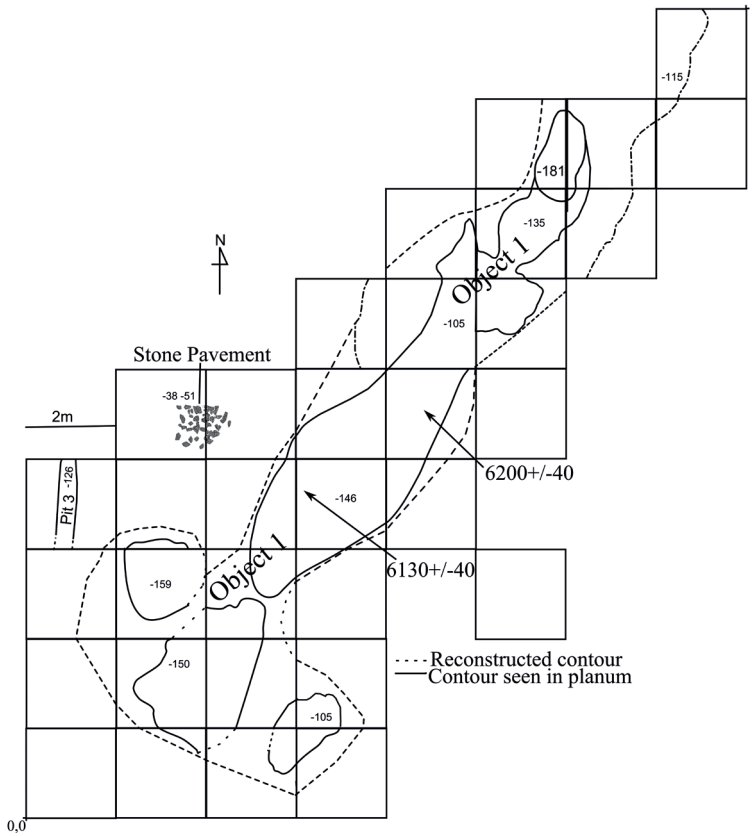

Figure 43 Plan of Trench 1. Kamyane-Zavallia. After Kiosak 2019

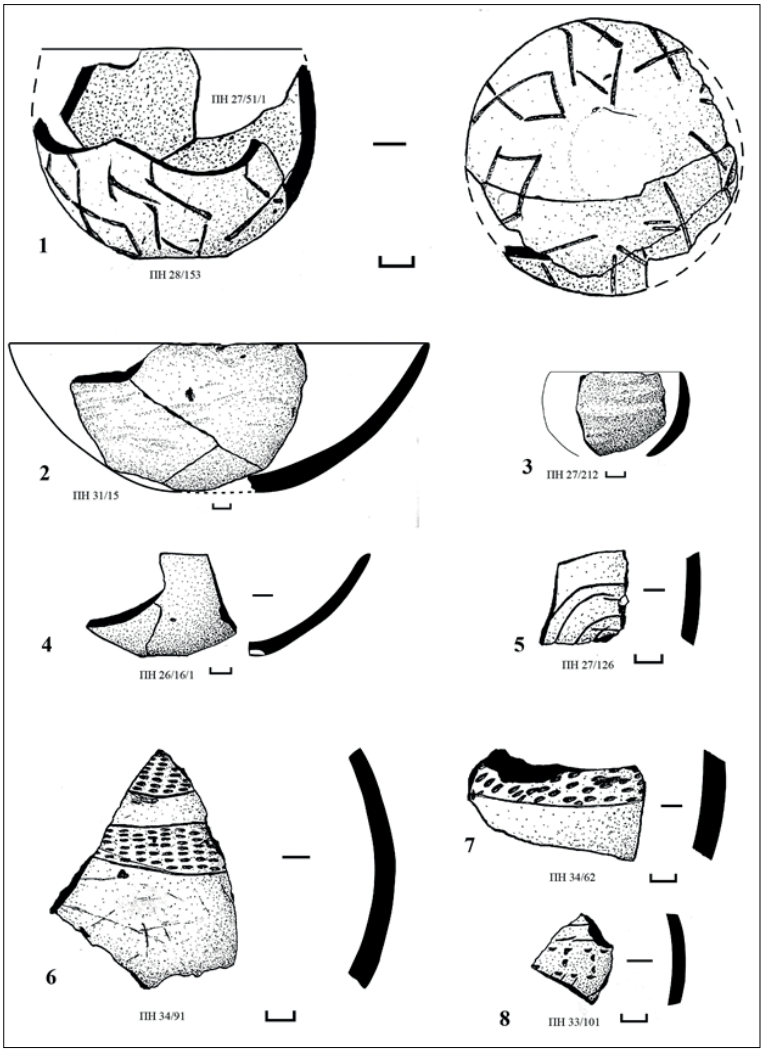

Figure 44 Kamyane-Zavallia. Samples of pottery. After Kiosak 2019

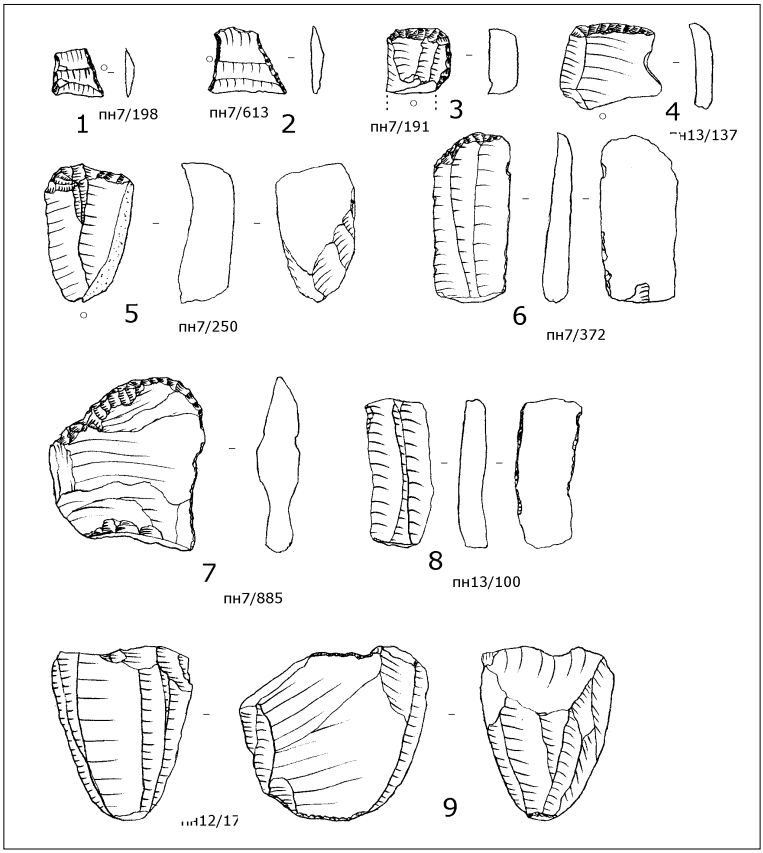

Figure 45 Kamyane-Zavallia. Samples of lithic inventory. After Kiosak 2019

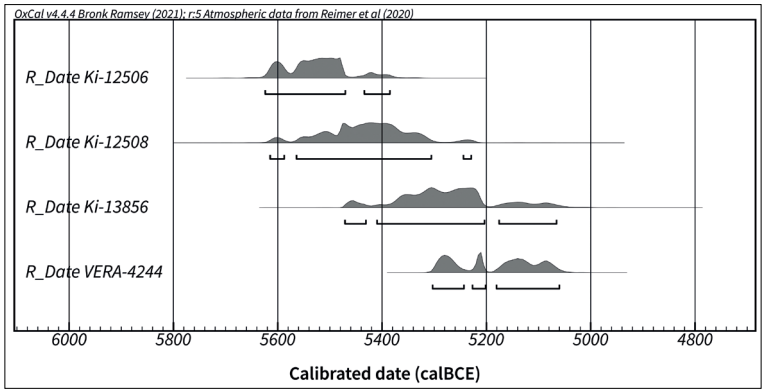

Figure 46 Radiocarbon dates. Rivne. Ki-12508 and VERA-4244 are dates of the same bone sample. **ST 3-2**. Done in OxCal by the Author

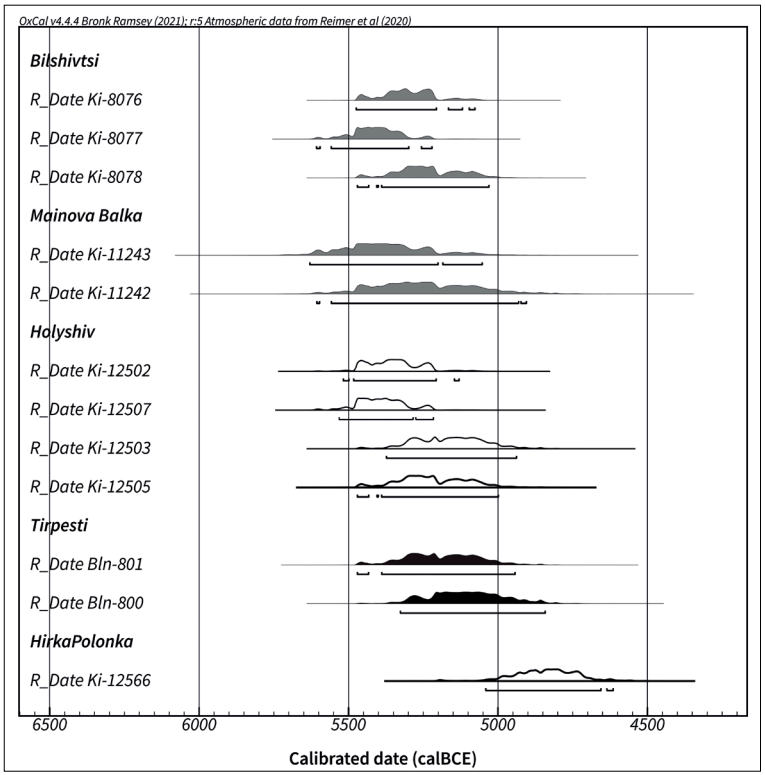

Figure 47 Conventional radiocarbon dates for LBK sites east of the Carpathians. Grey: animal bone, empty: TOCC of potherds, black: charcoal. **ST 3-2**. Done in OxCal by the Author

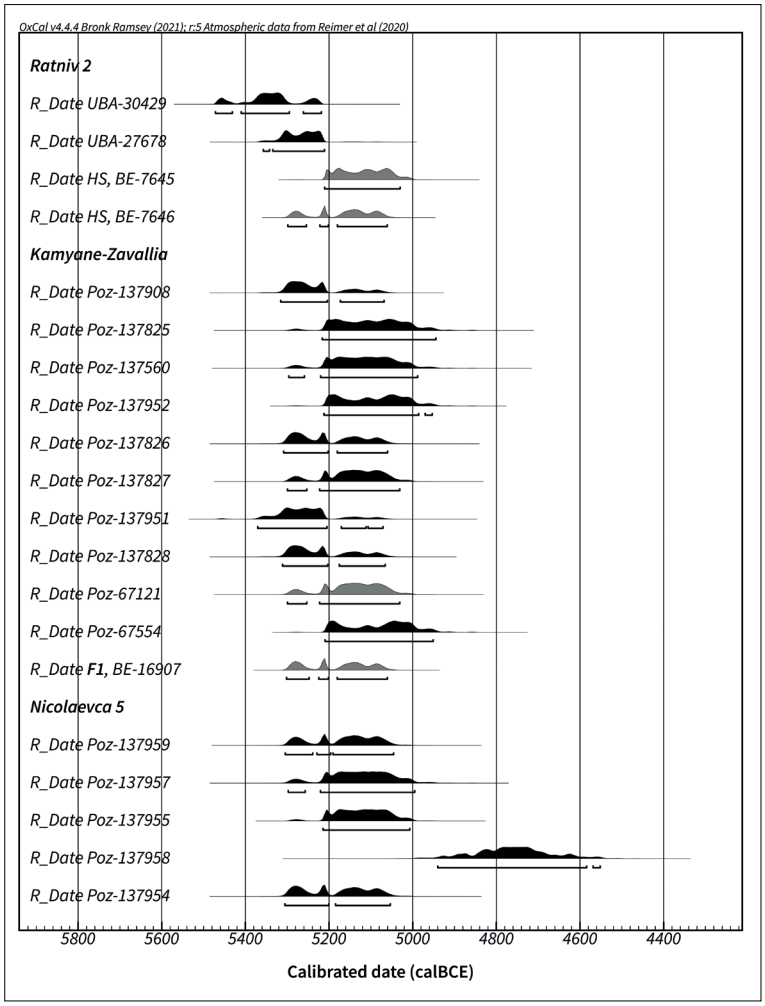

Figure 48 AMS radiocarbon dates for LBK sites east of the Carpathians. Grey: animal bone; black: charred remains of plants. HS: Hnyla Skelia; F1: Floresti 1. **ST 3-2**. Done in OxCal by the Author

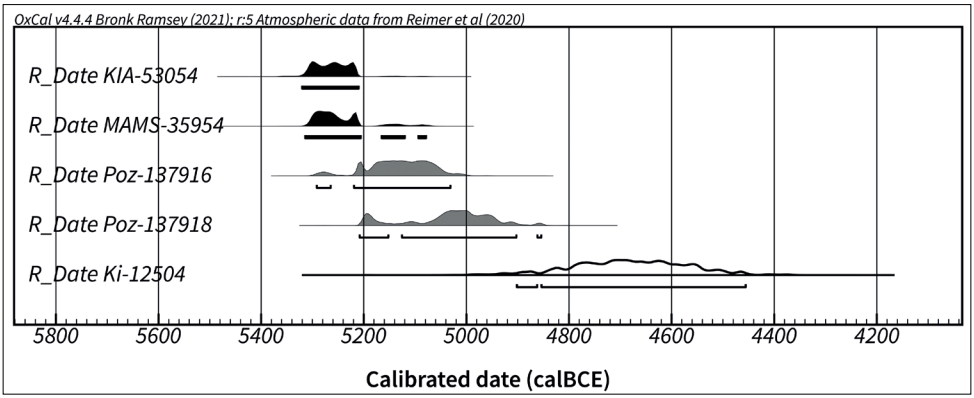

Figure 49 Rovantsi. Radiocarbon dates. Black: human bone; grey: animal bone; empty: TOCC of potsherd. **ST 3-2**. Done in OxCal by the Author

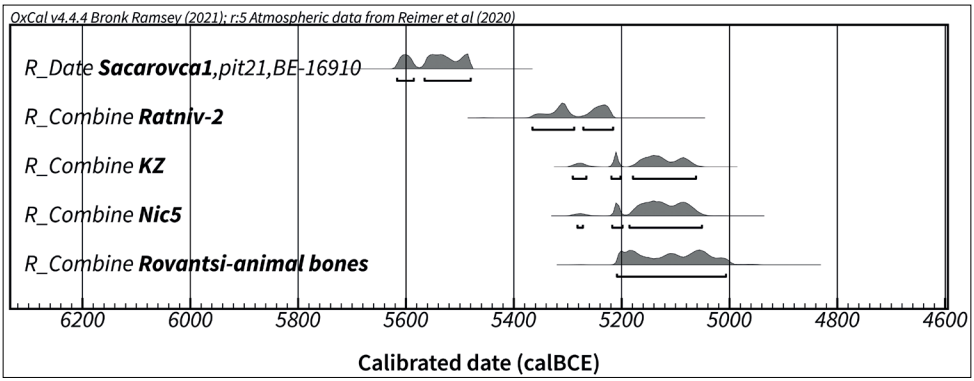

Figure 50 Radiocarbon chronology for the earliest cultivated plants of southern Eastern Europe. KZ: Kamyane-Zavallia; Nic5: Nicolaevca 5. **ST 3-1** and **3-2**. Done in OxCal by the Author

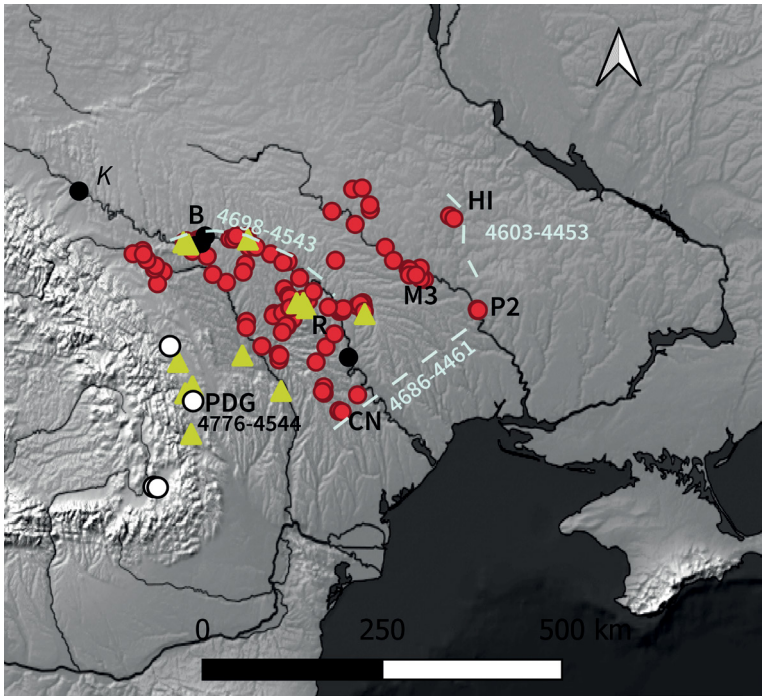

Figure 51 Map of Early Trypillia distribution indicating the calibrated relevant dates available to this moment (in years, BCE, 2σ). I, II. Distribution of Precucuteni I and II after Garvăn et al. 2009. White dots: Precucuteni I; yellow triangles: Precucuteni II – Trypillia A1-2 sites; red dots: Trypillia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

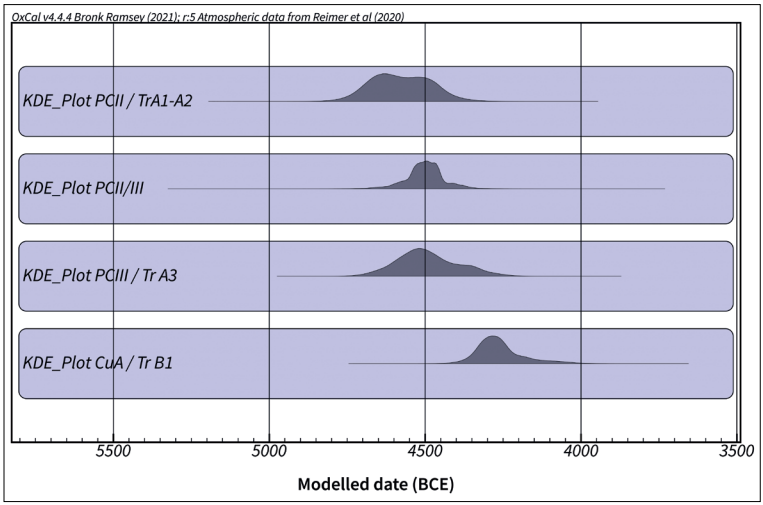

Figure 52 Modelling of the dates: KDE (Kernel Density Estimates) model plots (KDE-Model) according to OxCal. PCII/TrA1-A2 – Precucteni II, Trypillia A1-A2; PCII/III – Precucuteni II-III; PCIII/TrA3 – Precucteni III, Trypillia A3; CuA/TrB1 – Cucuteni A – Trypillia B1. Done in OxCal by the Author

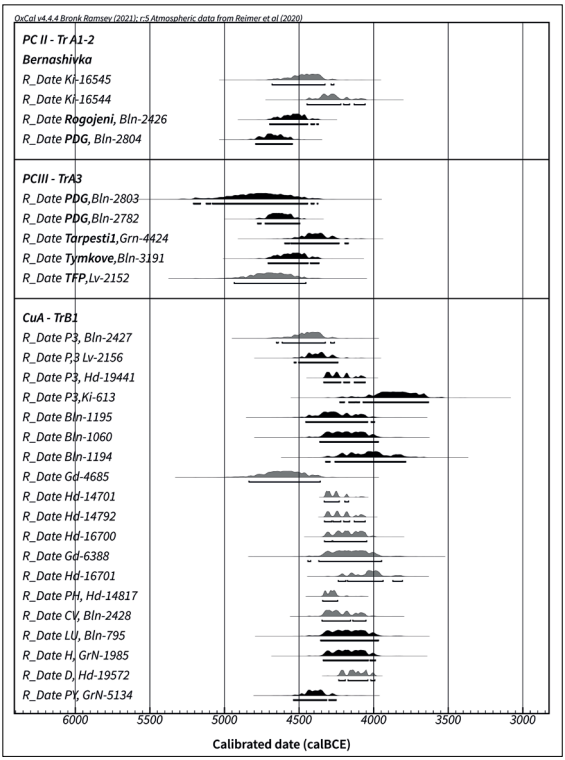

Figure 53 Legacy dates for Precucuteni –Cucuteni A/Early Trypillia and Trypillia B1. Black charcoal, grey: animal bones. PDG: Podul Dealul Ghindaru; TFP: Târgu Frumos-Pătule; P3: Putinești III; DO: Drăgușeni-Ostrov; PH: Preuteşti-Haltă; CV: CuconeștiiVechi; LU: Leca-Ungureni; H: Hăbășești; D: Dumești;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

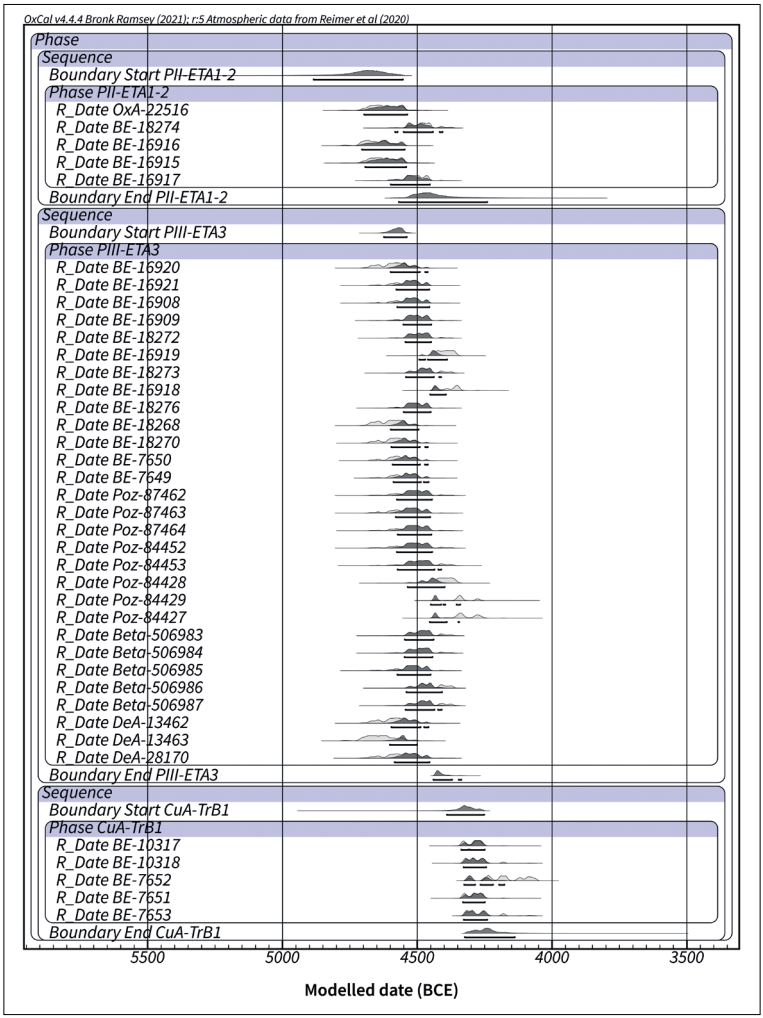

Figure 54 Modelling with overlapping phases. P – ET – Precucuteni – Early Trypillia, Cu – Cucuteni, Tr B1 – Trypillia B1. Model 3-1. Dates of Trypillia B1 are not shown in the graph for clarity sake. **ST 3-3**. Done in OxCal by the Author

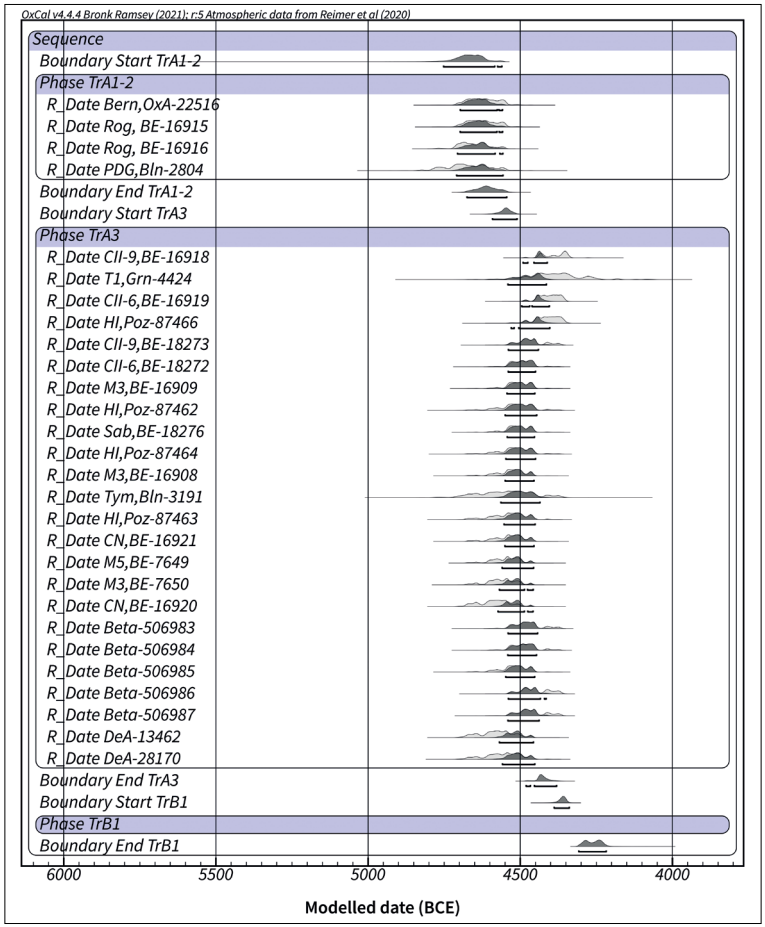

Figure 55 Precucuteni – Cucuteni A/Trypillia A – B1. Selected dates with sequential phases. **Model 3-3**. **ST 3-3**. Done in OxCal by the Author

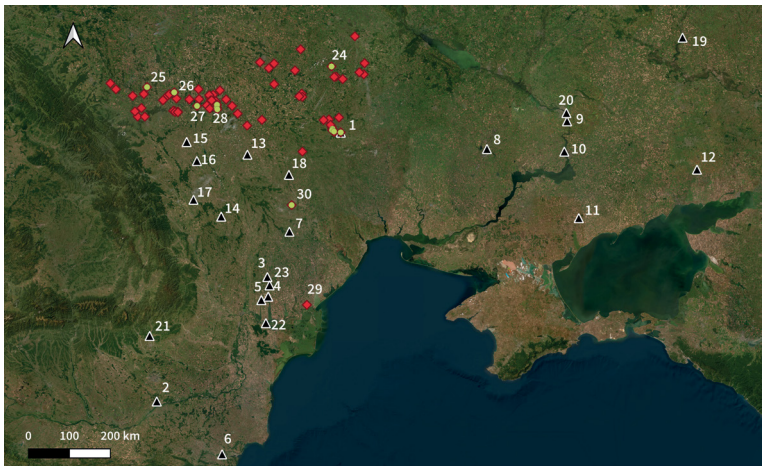

Figure 56 Trypillia B1 sites in the context. Diamonds: Trypillia B1 sites; diamonds with green circle: dated Trypillia B1 sites; triangles: relevant neighbouring sites. 1: the Sabatynivka group (Sabatynivka 1, Berezivska HES, Kamyane-Zavallia 1, Shamrai); 2: Pietrele; 3: Cealîc; 4: Bolhrad; 5: Vulcaneşti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

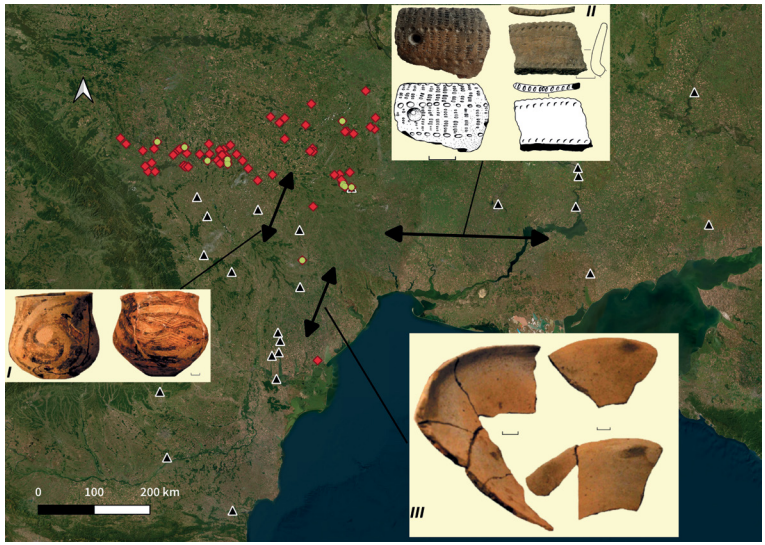

Figure 57 Contacts of Trypillia B1 sites of Central Ukraine: I: painted ware of Cucuteni A3 style (exemplified by finds from the Berezivska HES site, Kiosak, Lobanova 2021); II: shell-tempered ware from Skelia aspect (exemplified by finds from the Shamrai site, Kiosak, Lobanova 2021); III: burnished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

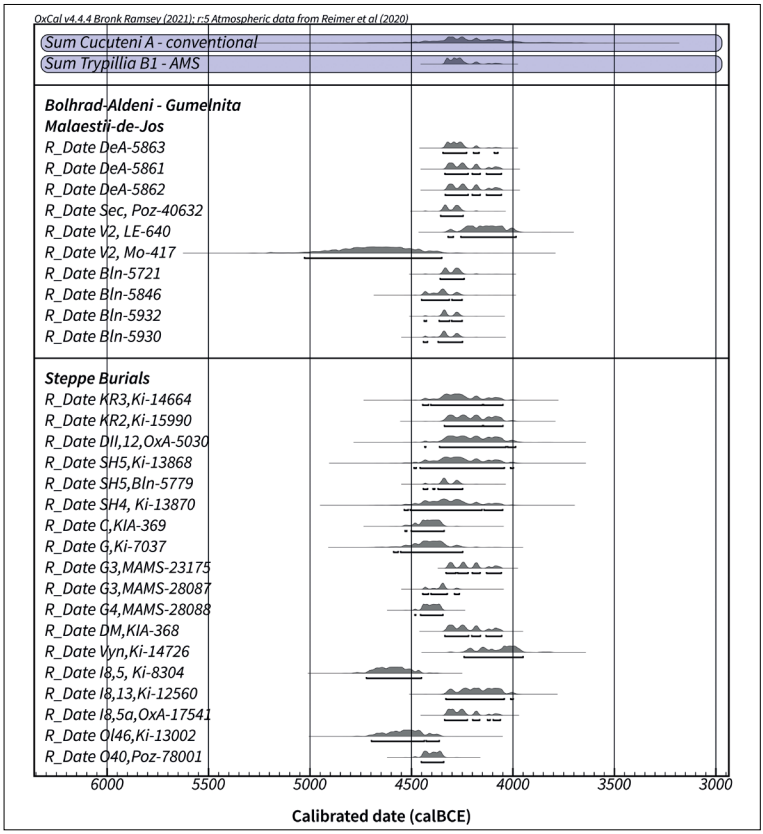

Figure 58 Chronology of Cucuteni A – Trypillia B1 in its context. KR3 – KryvyiRih, b.3, KR2 – KryvyiRih, b.2, DII, 12 –Dereivka II, b. 12, SH5 – Shakhtar 29/5, SH4 –Shakhtar 29/4, C – Cainari, G – Giurgiulesti, burials 3 and 4, DM – DeciaMuresului, b. 12, Vyn-Vynohradne 3/15, I8 – Ihren VIII, burials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

Supplementary Tables

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

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

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

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

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

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

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

ST 3-4 Comparative material for Trypillia B1 chronology

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

Models

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

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

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

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

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

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

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

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

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

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

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