Longhouse times: dating the Alsónyék LBK settlement

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Introduction

From a central European point of view, Transdanubia belongs to the south-eastern periphery of the Linearbandkeramik culture or LBK, but there is a very broad consensus that this region was its specific area of origin. When Neolithic sites attributed to the LBK are evaluated, their subsequent analysis normally follows well known rules and methods, as settlements of the first farmers of central Europe have been the object of countless archaeological investigations since the late nineteenth century. Almost canonised approaches, however, can make it difficult to draw appropriate conclusions when assessing individual sites and assemblages.

Significant discoveries over the past 20 years have enriched the dataset available for LBK sites in western Hungary. These achievements have substantially altered our knowledge of their architecture, settlement layout and material culture. Much more extensive radiocarbon dating is required to help with the understanding of settlement development and to

establish a robust absolute chronological framework for the LBK in the region. Other tasks are to validate or modify the generally accepted typo-chronological sequence of the LBK at a regional level and thereby to enable reliable comparisons with the culture's development across wider areas.

The region around and south of Lake Balaton has a particular character in contrast to all other parts of central Europe, since the sites of the LBK here did not belong to the first food-producing communities. They are located in an area that was the north-west fringe of the Starčevo-Körös-Criş cultural complex in the earlier sixth millennium cal BC (Kalicz 1990; 2011; Bánffy 2013a; Oross et al. this volume [a]). The large-scale excavation of LBK sites began in this region even later than in northern Transdanubia. Balatonszárszó-Kis-erdei-dűlő and other sites were uncovered along the southern shore of the lake between 2000–2006 (Oross 2004; 2013a, 171–173, 210–345). The most recently investigated region is south-east Transdanubia, where, among other sites, excavations have been carried out at Tolna-Mözs (Marton / Oross 2012), Szemely-Hegyes (Oross 2013a, 177) and at the Alsónyék complex (Gallina et al. 2010; Osztás et al. 2012).

The LBK settlement at Alsónyék

At Alsónyék, the LBK features could be identified in different parts of the area investigated, but they are definitely concentrated in its central and east-central portions. Most of them were uncovered in subsite 11, and others could be identified in subsite 5603. In subsite 10B, LBK features and houses were discovered in an area close to subsite 11, and some scattered features more to the north were identified without any traces of houses *(fig. 1)*. A considerable number of the LBK features were not identified as belonging to the culture during the course of excavation, and were either attributed to other periods or simply documented generally as Neolithic pits and postholes.

A large number of long pits of the kind that flank the typical timber-framed, above-ground longhouses of the LBK are very visible on the site plan, but it was challenging to attempt to reconstruct the houses, their size and the overall structure of the LBK site. While the long pits relate to houses, the postholes marking the post-frames of the buildings could only be documented in a few cases. The reconstructed settlement layout currently incorporates a total of 50 houses. Small clusters of houses could be distinguished all over the settlement, seemingly constituting house rows. There are usually two to five houses in each of these clusters *(figs 2; 6)*.

In subsites 11 and 5603, a total of 46 houses were reconstructed, forming a densely settled area. At its centre, 30 houses form a compact focus of habitation *(fig. 2)*. There are also extended features between houses H24 and H25, as well as north of houses H28 and H29, that were not completely excavated and were most probably not large pits belonging to the settlement but the lowermost levels of the soil covering the Neolithic settlement. This fact makes the reconstruction of the settlement layout imperfect in those areas. Three houses are located about 30 m to the north of all the others. Thirteen houses were located 30–120 m to the south. A large area in the southern part of the settlement could not be excavated, however, so the relationship of this southern house group to the other parts of the site remains unknown. Four houses were found in subsite 10B, on the western part of the presumed ancient stream-bed.

There are a limited number of instances with observable overlap between houses, which obviously indicates chronological difference. In most cases, the houses in question belong to different house clusters and it is the short sides (that is, the façades of the houses) which

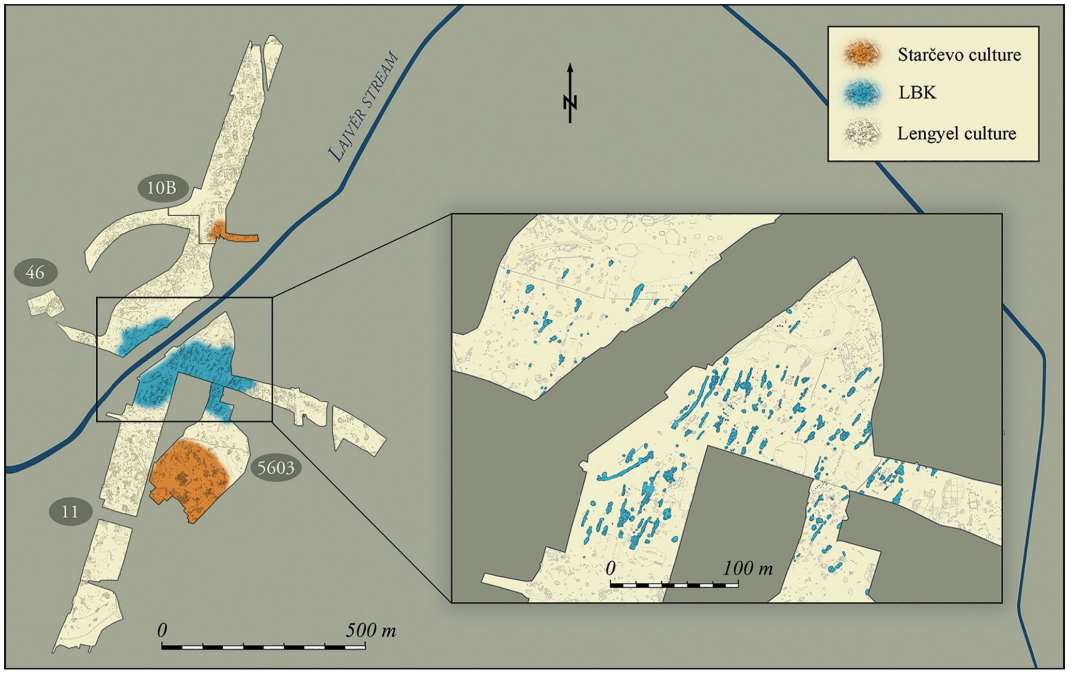

Fig. 1. Location of the LBK settlement in the Alsónyék complex.

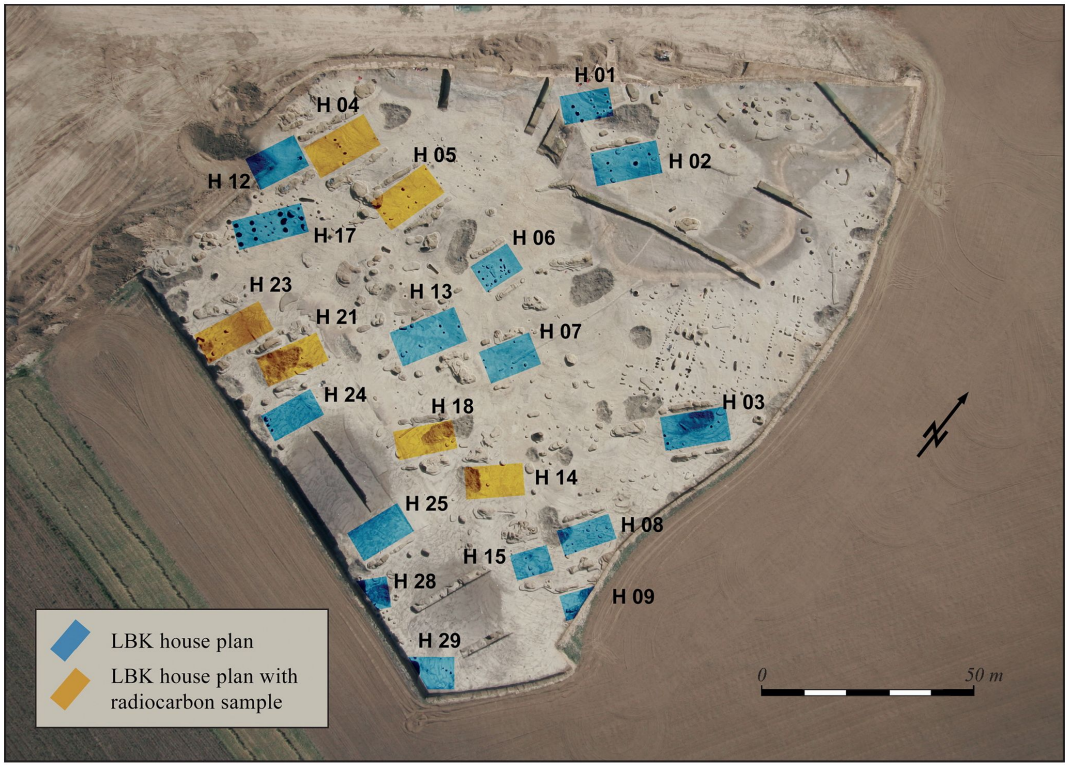

Fig. 2. Aerial photo of the northern part of the LBK settlement.

Fig. 3. The radiocarbon-dated western long pit (3259) of House H04 with Grave 2888 in the long pit.

overlap. In one house cluster, however, consisting of houses H22, H20, H23, H21 and H24, houses H20 and H21 are shifted to the north, which means that their northern façades are approximately in line with one another, but not in line with the other houses. In addition to this, the adjacent houses H22 and H20 overlap one another *(fig. 6)*.

Five LBK settlement graves were dug into house long pits *(fig. 3)*. The mortuary practice was rather uniform, as all of the deceased were deposited into western long pits, closely associated with houses. The four carefully excavated bodies were left-crouched and oriented east–west, while the fifth was extremely disturbed. The details of this mortuary practice are different to those of the settlement burials scattered between features of the LBK site at Balatonszárszó-Kis-erdei-dűlő. There, no connection could be detected between the graves and the houses, and the deceased were most probably buried in a part of the settlement no longer in use for residence (Oross / Marton 2012).

Many regional traits can be observed in the material culture of the LBK sites in the Tolna Sárköz region, such as at Alsónyék and Tolna-Mözs. This is particularly true for the pottery assemblages, which show very strong Early Neolithic roots with characteristics of the Starčevo culture seen in the technology of their production, as well as in their shapes and decoration. Channelled barbotine *(fig. 4,4.10–12)* and short incisions *(fig. 4,8–9)* are very common decoration, but Early Neolithic painted patterns are unknown. Red slip was occasionally observed on the surface as on a pedestal *(fig. 5,11)* that echoes early Vinča

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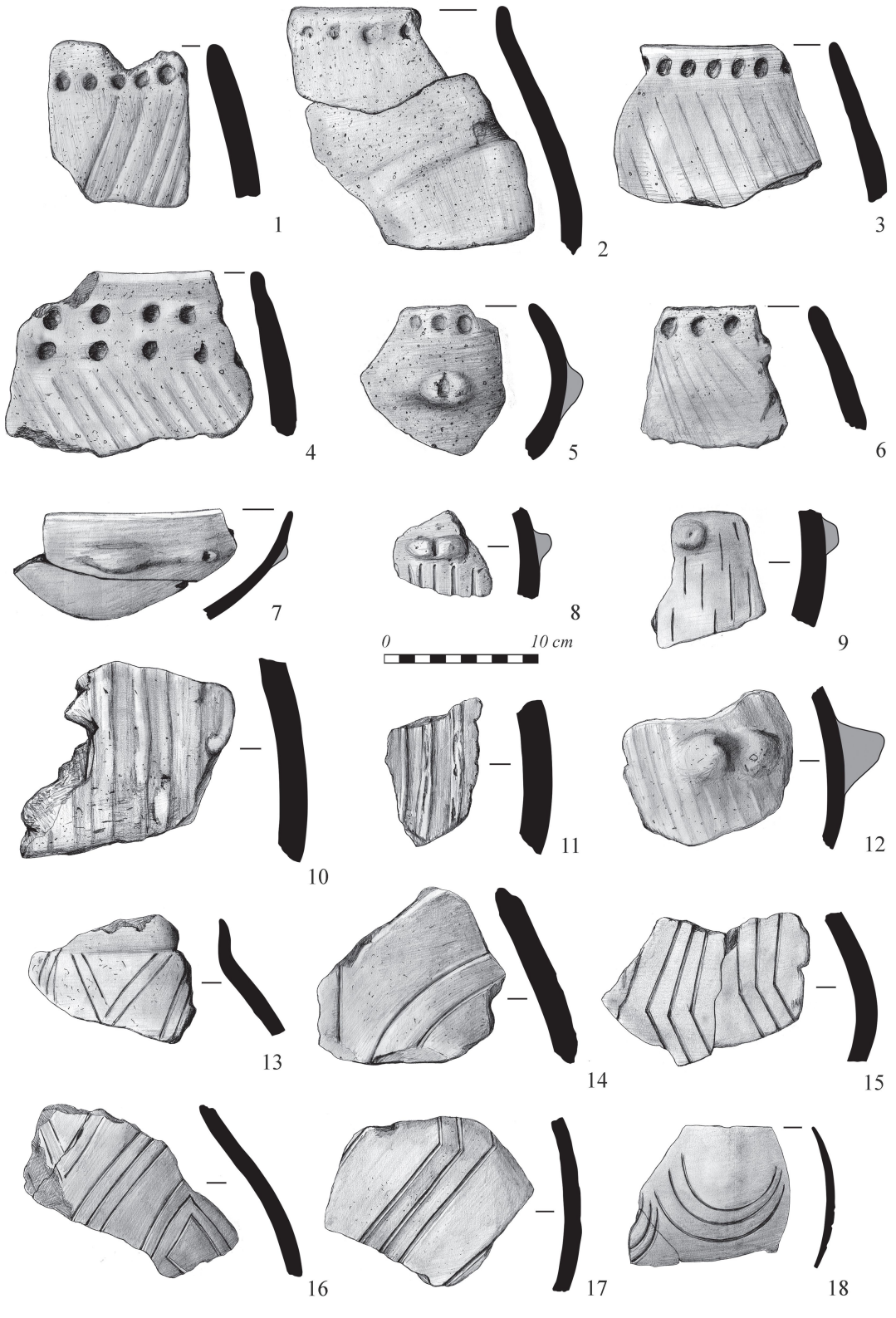
Fig. 4. Pottery from radiocarbon-dated LBK features. 1–2 H21: 2568, 3 H20: 2564, 4 2360, 5–6 H23: 2526, 7–9 2360, 10 H23: 2526, 11–12 H04: 3259, 13 H05: 3010, 14 H21: 2568, 15 H05: 3010, 16 H18: 2674, 17 H21: 2568, 18 2360.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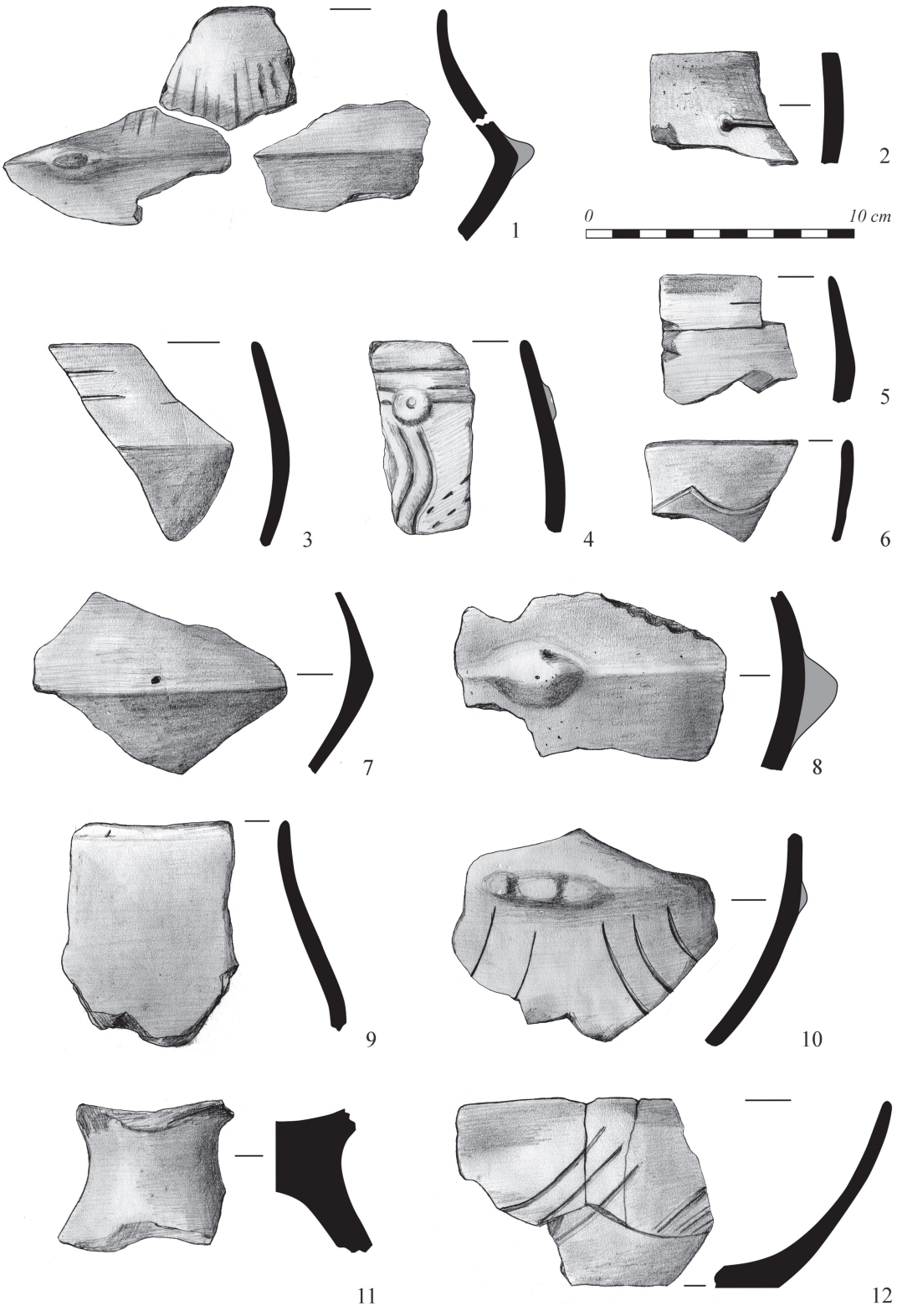
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characteristics. The open biconical bowls decorated with knobs *(fig. 4,7)* and their variants with a tight rim and fine channelled surface *(fig. 5,1)* also resemble the material culture of early Vinča assemblages. In the coarse ware, globular vessels with a row of inserted dots below the rim can be regarded as general *(fig. 4,1–6)*. Earlier research deemed the latter type as a typical decoration of early LBK and earlier Vinča culture (Pavúk 1997, 171; Dimitrijević 1969b, 48–50). In south-east Transdanubia, as at Tolna-Mözs, however, it seems to be general at least until the beginning of the later and late LBK phases (Marton / Oross 2012, 227–228 Abb 5,10; 230 Abb. 7,14). In contrast, it has been recorded very rarely in central Transdanubia, for example at Balatonszárszó-Kis-erdei-dűlő (Marton 2013, 165). Vessels with a cylindrical neck and with incised decoration are typical in the early LBK (Pavúk 1980, 33–34); spirals and meanders and their combinations were characteristic among the incised motifs *(fig. 4,13–17)*.

Given the relatively small assemblage, finding any groupings in the Alsónyék LBK pottery is particularly problematic. This could be attempted with the incised pottery, but this is only partly comparable to the more intensively analysed finds of northern and central Transdanubia. The open biconical forms of the Vinča culture already noted seem to appear in the Alsónyék LBK assemblage, combined with curved and sometimes straight incised lines *(fig. 5,3.5.10)*, and were decorated in a few cases with rows of inserted dots. Along with the typical biconical shapes of the early LBK period, incised wavy lines running around the entire surface are common. The latter are typical for the Milanovce phase, regarded as the final stage of early LBK development according to the traditional typo-chronological approach (Pavúk 1980, 45–47; 1997, 172). A possibly younger style group is represented by a few sherds with a Notenkopf decoration *(fig. 5,2)*, but there is no sign of the Zseliz / Želiezovce style in the assemblage. The traits of the later and late LBK Keszthely style typical for central Transdanubia, with globular shapes and incised interlocking semi-circular lines, S-motifs and spiraloid decoration running around vessels, are also virtually unknown in the Alsónyék LBK assemblage. It is the multiple curved motifs on conical and semi-spherical vessels alone which resemble the decoration of regions to the north *(figs 4,18; 5,12)*. One sherd that is decorated with a combination of a bundle of incised lines below its rim, a cylindrical knob, vertical wavy lines connected to the latter, and two further parallel rows of short incised lines, can be regarded as a unique piece *(fig. 5,4)*. The motifs and their composition can be linked to the assemblages of the classical Alföld LBK. Similarly designed pots are known from the mixed assemblages that consist of Alföld LBK and Vinča pottery in the region at the confluence of the Tisza and Maros rivers (Horváth 1994, 97 fig. 4,1.3). The coarse ware represents a style that obviously existed in an unchanged form for a longer period. Further evaluation of local typo-chronological development may be possible in conjunction with more detailed analysis of fine pottery in the future.

The pottery assemblage uncovered in Pit 2360 is particularly diagnostic. Among the 230 sherds, it was possible to identify traits characteristic of the LBK assemblage as a whole, such as chaff and small pebble tempering, and inserted dots below the rims on globular coarse-ware vessels *(fig. 4,4)*. Incised cuts *(fig. 4,8–9)* and divided knobs are also characteristic of the coarse pottery. There is one storage vessel with a grooved neck. That form has

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Fig. 5. Pottery from radiocarbon-dated LBK features. 1 H46: 2519, 2 2360, 3 H10: 2396, 4 H20: 2222, 5 H10: 2396, 6 H27: 2368, 7 H16: 2351, 8 H04: 3259, 9 H23: 2526, 10 H21: 2568, 11 H46: 2519, 12 H27: 2368.

been found in some of the local assemblages, for example at Tolna-Mözs. The most common fine-ware forms are spherical vessels *(fig. 4,18)* and bowls with a biconical body and a wide open rim *(fig. 4,7)*. The biconical shapes resemble those of the Vinča culture. A sherd with a Notenkopf motif *(fig. 5,2)* could provide an anchor to connect the material with other typo-chronological sequences from the western Carpathian basin. On this basis, the assemblage could be associated with the evolution of the later LBK, with the implication that many early LBK elements were still in use.

Linearbandkeramik sites in the western Carpathian basin

The state of research on the LBK in western Hungary has differed considerably compared to other regions, even in the early twentieth century. At that time, a few small-scale excavations were carried out in the region of Budapest such as at Békásmegyer (Tompa 1937) and Budapest-Tabán (Tompa 1942), and in southern Transdanubia at Balatonendréd, Medina and Bonyhád (Banner 1943). Only deep features were recorded, with no note of any traces of post-framed constructions similar to those at Köln-Lindenthal (Buttler/Haberey 1936) and other sites in Germany. Even though the above-ground constructions were at first regarded as granaries, the function of the timber-framed buildings as dwellings became obvious across central and western Europe soon afterwards (Paret 1942; Childe 1949, 77–78; Stieren 1951). Later on, LBK sites were investigated in various research projects from the Paris basin (Hachem 2011; Ilett et al. 1982; Ilett 2012) and Dutch Limburg (Modderman 1970; 1972) across Germany (Lüning 1982a; 1982b; Boelicke et al. 1988; 1994) to Poland (Milisauskas 1986) and to their easternmost periphery in Romania, Moldavia and Ukraine (Marinescu-Bilcu 1981; Larina 2009).

In Hungary only a few post-framed buildings were uncovered even in those decades of intensive central European research, for example at Győr-Pápai vám (Mithay 1966) and Almásfüzitő-Foktorok (Vadász 1971). Despite sporadic but available evidence on above-ground constructions, the idea of sunken pit-houses was not completely refuted, and the 'pit-house' of Bicske-Galagonyás was an often cited LBK phenomenon from the region (Makkay 1978). Even though 637 LBK sites were catalogued in Hungary in the early 1990s (Gläser 1993), we still had very poor knowledge about architecture, settlements and the development of the settlement system. Since then, salvage excavations in advance of motorway construction and other building activities have provided a unique opportunity for large-scale investigation of LBK sites. Mosonszentmiklós-Egyéni földek (Egry 1996; 1997; 2003a) with 20 houses, and Törökbálint-Dulácska (Endrődi 1993; 1994; Horváth 2004) near Budapest, were the first discoveries of the new era.

After two decades of intensive research, about 50 sites in western Hungary with the remains of timber-framed LBK houses have been documented, and the number of house plans had exceeded 300 by 2010 (Oross 2013a). Many of these excavations have not been published, even in short reports, and the actual number of investigated LBK settlements and houses must in fact be considerably larger. The most thoroughly investigated regions coincide with the routes of new motorways, resulting in unevenness in the density of research activity as well as in our knowledge of the LBK settlement system. House remains are preserved in various conditions, and there are a number of sites where only the pairs of long pits indicate the former presence of houses. In contrast, structures definable by post-holes provide a good basis for detailed architectural analysis such as at Balatonszárszó-Kiserdei-dűlő (Oross 2009; 2010; 2013a) or Torony-Nagyrét-dűlő (Ilon 2013).

Fewer overlaps can be observed between the house plans on many Transdanubian sites than in the more westerly regions of the LBK distribution. For example, at Balatonszárszó-Kis-erdei-dűlő not a single overlap was recorded (Oross 2013a, 320–345). In Tolna-Mözs, there is sometimes limited overlap, but almost exclusively on one of the short, façade ends of the houses (Marton / Oross 2012, 225–227 Abb. 3). The houses form clusters, usually consisting of three to six houses, built up along a linear axis, and showing a row-like layout. Two main patterns can be reconstructed on Transdanubian sites. Either the different house clusters are very close to each other, without any large gaps, as at Tolna-Mözs, or there are larger areas free of houses between the different clusters, as at Balatonszárszó-Kis-erdei-dűlő.

Until recently, chronological studies have been almost solely based on typological analyses of pottery. In the 1970s, the so-called 'Medina type' was introduced as a first attempt to demonstrate the earliest stage of LBK development (Kalicz / Makkay 1972a). It turned out later, however, that the published material is mixed and consists of both Starčevo and early LBK sherds. No material remained that could serve as a connecting link in the typo-chronological sequence between the Starčevo culture and the already evolved early LBK (Kalicz 1990, 92–94). The formative phase of the LBK was distinguished much later, together with the establishment of an overall model for the Neolithisation of the region. According to that, the earliest LBK communities developed with roots both in the late Starčevo and the local Mesolithic population in the Balaton area (Bánffy 2000; 2004). Pottery assemblages of the early LBK period were published in a very detailed chronological framework in Slovakia with four distinctive phases (Pavúk 1980), the Notenkopf ceramic style was identified as a later LBK constituent, and the pottery development of the late LBK period was discussed in terms of the independent Zseliz / Želiezovce group (Pavúk 1969a; 1994). In Hungary, the early LBK period was regarded as more uniform (Makkay 1978; Kalicz 1980b; 1994). For the later phases, the Slovakian chronology was broadly accepted in northern Transdanubia and the Keszthely style was introduced as the later and late LBK ceramic style for southern Transdanubia (Kalicz 1991).

Within the western Carpathian basin, the settlements of northern Transdanubia form a common region together with those of south-west Slovakia and the westernmost fringes of the Carpathian basin in Austria, in terms of both their architecture and their material culture (Oross 2013b). In contrast, the southern Transdanubian sites and assemblages differ considerably (Bánffy / Oross 2009, 220; 224 Abb. 1; 3; Oross / Bánffy 2009, 177; 182), while there is a zone of transition between them (Kalicz 1991 Abb. 1; Oross / Bánffy 2009, 182 fig. 7).

As already demonstrated, the sites of south-east Transdanubia differ from even those of the southern shore of Lake Balaton. Based on a study of the ceramic material from Tolna-Mözs, shapes and forms resembling the Vinča culture appear to be a significant component of the material culture in the Tolna Sárköz microregion (Marton / Oross 2012). In the southernmost part of Transdanubia, at Szederkény-Kukorica-dűlő, the pottery material is literally identical with those of early Vinča assemblages, although the hill land of southern Baranya must be further investigated both at a site and a microregional scale to gain more information on the nature of this phenomenon (Jakucs / Voicsek 2015).

General models for the development of LBK settlements

The first complex model for the development of LBK sites that claimed to present the site dynamics at the scale of house generations was created based on the excavations of the

Merzbachtal microregion in the Rhineland. The engine of the independent homestead model *(Hofplatzmodell)* was constituted by the statistical analysis (correspondence analysis) of pottery assemblages, the correlation of house plans with contemporaneous pits around the buildings, and the analysis of overlaps between the houses. Different spatial units, homesteads or yards, were postulated where the houses were built sequentially, with only one house standing at any one time (Lüning 1982a; 1982b; Boelicke et al. 1988; 1994; Zimmermann 2012). However, the idea of homesteads with a constant space over generations, or even for the entire lifespan of a settlement, based on the rule of impartible heritage *(Anerbfolge)*, was much more a premise of the model than a result given by analysis (Lüning 1982a, 146; Zimmermann 2012, 15). One house generation was declared to be equivalent to one human generation, some 30 years (Lüning 1982a, 144). Later on, the 25-year life-span of a building was regarded as the most reliable estimate (Stehli 1989b, 75). The results were also supplemented with 33 radiocarbon dates, but these came from different sites across the Rhineland and Dutch Limburg (Stehli 1989b, 75–76).

Jens Lüning has also recognised that some LBK sites must have had a substantially different structure to those from the area where the model was developed. Compared to Langweiler 8, the reference settlement for the independent homestead model, far fewer overlaps between house plans could be observed elsewhere and these were often arranged into rows. Schwanfeld in Germany was the site where Lüning created a model that kept the homestead model virtually intact, but at the same time provided an explanation for the row-like layouts. Two settlement rows, each with five houses, were regarded as equivalent to a homestead, in which only one building stood at any one time. In one row the subsequent buildings were built up on both sides of a central building, while in the other the successive building was always erected on the western side of the former one, resulting in a westward shift of the actively used area (Lüning 2005).

With very few exceptions, the interpretation of LBK sites followed the homestead model for some four decades. That approach was challenged precisely on the point of rows by Oliver Rück, who systematically emphasised its weaknesses. He pointed out the problems of pottery statistics and of dating features based on them. The substantial methodological contradictions incurred by the creation of yards that represent units of houses and other related features around them were also discussed. Rück proposed that houses could exist much longer than previously assumed, even for a century. As a consequence, he proposed the radically different model of row settlement *(Zeilensiedlungsmodell)* for LBK sites (Rück 2007; 2012).

There were attempts to reconcile the two models with each other, like that of Thomas Link who regards them not as two mutually exclusive approaches. In his view, the model of row settlement could serve as a good supplement to the independent homestead model. Considerable changes to the original model are proposed, however, for example that more than one house could stand in a homestead at the same time (Link 2012).

The validity of the independent homestead model in the eastern-central European distribution of the LBK has been tested on Austrian sites by Eva Lenneis and her colleagues. The models for the settlement structure of the sites of Strögen and Neckenmarkt were developed 15 years ago following the homestead model (Lenneis / Lüning 2001). Later evaluations, however, for example of the sites of Ratzersdorf and Saladorf, could not provide solid evidence for chronological differences between neighbouring houses of the same house clusters. Two main phases of the settlement were distinguished at Rosenburg, but homesteads could not be recognised at all. At Mold, some buildings of the same house cluster were investigated with the aim of establishing the internal chronology of a possible homestead. In contrast, both ceramic analysis and radiocarbon dates suggest that the

houses could have stood at the same time. Based on all this, Lenneis has proposed an alternative approach for eastern-central European sites in which house clusters can also consist of contemporaneous buildings. Different house clusters were used in different periods and as a consequence there are considerable shifts of the actively inhabited area within a settlement (Lenneis 2012).

Aims of the dating programme

Only a few radiocarbon results for the LBK of Transdanubia have been published. Four are available from Becsehely Bükkaljai-dűlő (Kalicz et al. 2007b, 44), eight from Becsehely Homokos (Barna 2012, 190 tab. 9), one from Budapest-Aranyhegyi út but without any standard deviation given (Kalicz 1995, 53), three from Kustánszeg-Lisztessarok, one from Pári (Kalicz 1991, 27; Kalicz et al. 2007b, 44), four from Petrivente-Újkúti-dűlő (Kalicz et al. 2007b, 44), and one from Zalavár (Kohl / Quitta 1963, 301; 1964, 316). There is a series of ten dates on charcoal samples from Szentgyörgyvölgy-Pityerdomb for the formative phase of the culture (Bánffy 2004, 299–309). In the case of the two dates from Győr-Szabadrét-domb attributed to the LBK, the samples originated most probably from a Lengyel culture context (Figler et al. 1997, 212). To ensure the chronological position of the aDNA samples of the project led by Kurt W. Alt and Eszter Bánffy, four samples were dated from Budakeszi-Tangazdaság, one from Balatonszárszó-Kis-erdei-dűlő, one from Kóny-Proletár-dűlő II, two from Szemely-Hegyes, and two from Tolna-Mözs (Szécsényi-Nagy et al. 2014, Supplementum 2; 2015, Supplementum 2). A series of 45 dates from Balatonszárszó-Kis-erdei-dűlő remains unpublished. The overall number of published dates is 44 from 14 Transdanubian sites, of which 42 from 13 sites can be regarded as radiocarbon results for the LBK.

One of the main goals at Alsónyék was therefore to date the LBK settlement activity as a whole. Beyond this, the target was to gain information about site development at the level of individual houses and house clusters. Furthermore, we hoped to gain information about the chronological relations between the settlement graves and the long pits into which they were cut. On a regional scale, we were interested in how far a series of radiocarbon dates from a south-eastern Transdanubian site would agree with or contradict former assumptions about typo-chronology and the chronological aspects of cultural connections inside and beyond the western Carpathian basin.

Sampling strategy

As an initial strategy, the team selected samples from the western and the eastern long pits flanking timber-framed houses in house clusters that appeared to have row-like layouts. However, insufficient articulated and articulating bones were available from the houses and clusters investigated. In the second round of selection, a larger part of the site was involved in the sampling such that samples were collected from adjacent houses, with the assumption that they were probably related to each other. In addition to this, in four cases human remains uncovered in western long pits of houses were dated along with the faunal samples from the related underlying feature. In three examples (houses H04, H22 and H46), it is well documented that graves (2888, 1972 and 2559) were dug into the long pits; the fourth case (house H21) is probably similar, but, as observed above, the grave (2910) was severely disturbed during the excavations.

Samples and the structure of the model

Twenty-three radiocarbon results are available from 21 samples that were submitted to three radiocarbon laboratories (SUERC, Oxford and Poznań). The pretreatment and measurement methods are given in Bayliss et al. (this volume). The C:N value for Poz-68720 (3.7) is outside the generally accepted values for good collagen preservation (2.9–3.6: DeNiro 1985), but the sample passed all other quality assurance indicators and was deemed acceptable for radiocarbon dating. Overall the samples suffered from poor collagen preservation, and this posed a serious challenge in the dating process: four samples each failed in Oxford and Poznań, and one at SUERC. Two Oxford results (OxA-30355, OxA-30357) were successfully replicated at SUERC (SUERC-58484, SUERC-58485). One further result (Poz-68348) dates a sample to a substantially younger period than the LBK, and this has been excluded from all the modelling.

A total of 17 settlement pits and four human burials were dated *(fig. 6)*. The settlement pits served with one single exception (2360) as long pits flanking post-framed houses of the LBK, forming closed features. In three, or most probably in four, cases (houses H20, H23, H10 and probably H21), both the western and the eastern long pits of the houses could be dated. That means that the 16 results from long pits can be associated with a total of 12 houses.

Five pairs of houses could be dated that were either built next to each other or overlapped. All five pairs (H04–H05, H18–H14, H16–H10, H22–H20 and H23–H21) follow a similar pattern with one house slightly more north and east than the other. Two house pairs, H22–H20 and H23–H21, belong to the same house cluster. All five house pairs are located on the densely built central area of the settlement.

The chronological model was constructed as described by Bayliss et al. (this volume), using OxCal v.4.2 and IntCal13 *(fig. 7)*.

Pit 3259, the western long pit of H04 was dated (SUERC-51468) by a sample from an articulating *Ovis aries* radius and ulna. The long pit was cut by Grave 2888, a left-crouched 12–13-year-old child from which a tibia was dated (Poz-67495). North-east of H04, a *Bos taurus* thoracic vertebra with a refitting caudal epiphysis that was present in the ground, but lost on excavation, produced a result (SUERC-51464) from Pit 3010, the eastern long pit of H05.

Pit 2674, the western long pit of H18 was dated (OxA-30357) by a sample from a *Bos taurus* metacarpal which showed marks on its surface that suggested the articulating phalanges had been present in the ground, but were separated on excavation. A replicate of the sample was dated successfully (SUERC-58485). The two results are statistically consistent ($T' = 0.1$; $T'(5\%) = 3.8$; $\nu = 1$; Ward / Wilson 1978), so that a weighted mean was taken before they were incorporated in the model (6311±24 BP). North-east of H18, Pit 2787, the southern part of the eastern long pit of H14, was dated (SUERC-57544) with a sample from an articulating *Bos taurus* radius and ulna.

From Pit 2351, the eastern long pit of H16, an articulating *Bos taurus* ulna and radius was dated (SUERC-51460). H10 is located to the north-east of H16. Pit 2377 is the western long pit of H10 and was dated (Poz-67767) by a sample from an *Ovies aries / Capra hircus* tibia with refitting unfused epiphysis. Pit 2396, the eastern long pit of H10 was dated (SUERC-51461) by a sample of a *Bos taurus* femur with refitting unfused epiphysis.

Pit 2368 is the eastern long pit of H27 that was dated (SUERC-57548) by a *Bos taurus* calcaneus, which, on the basis of the colour of the bone surface, had a refitting unfused tuber calcanei in the ground (although this was lost on excavation).

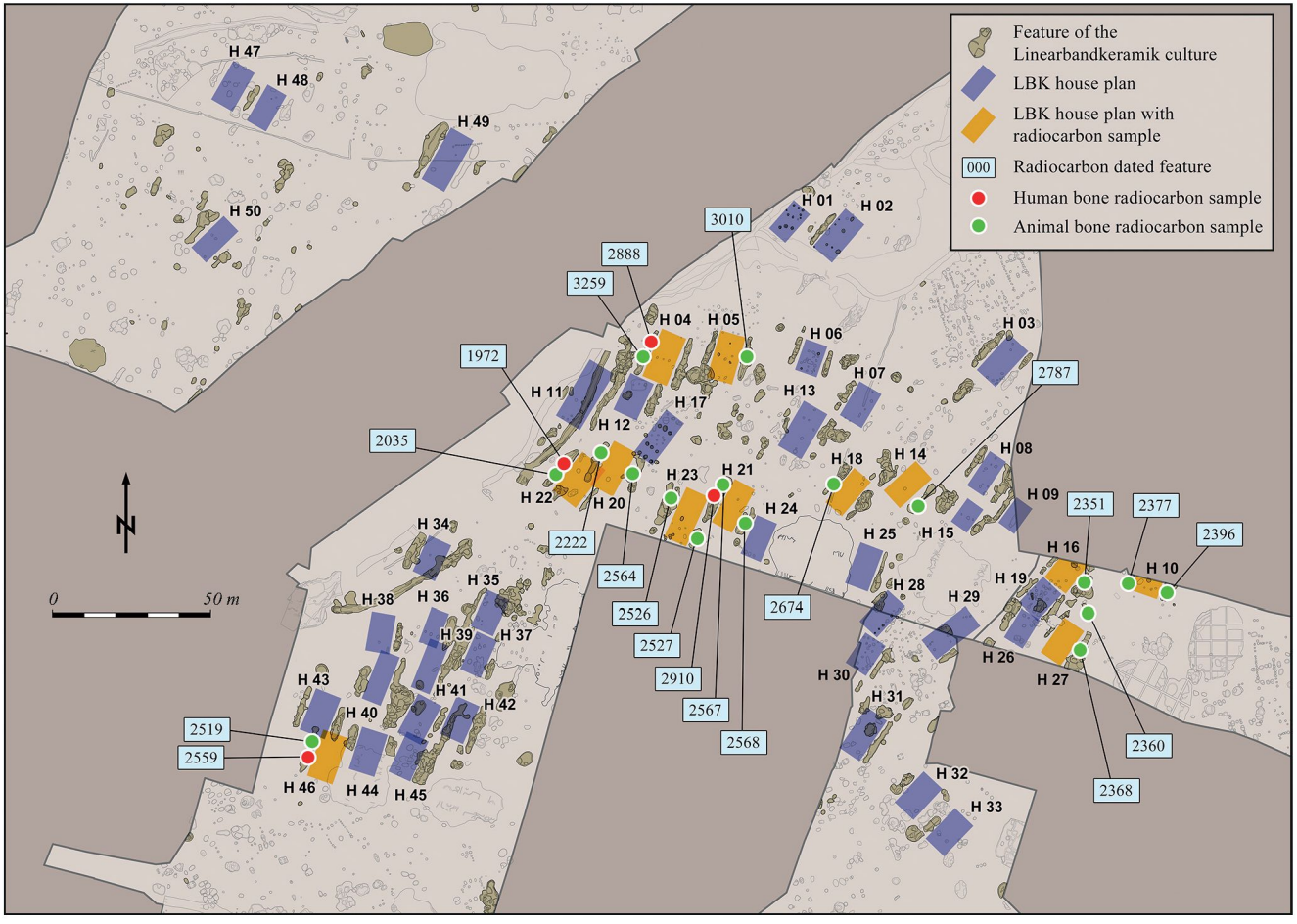
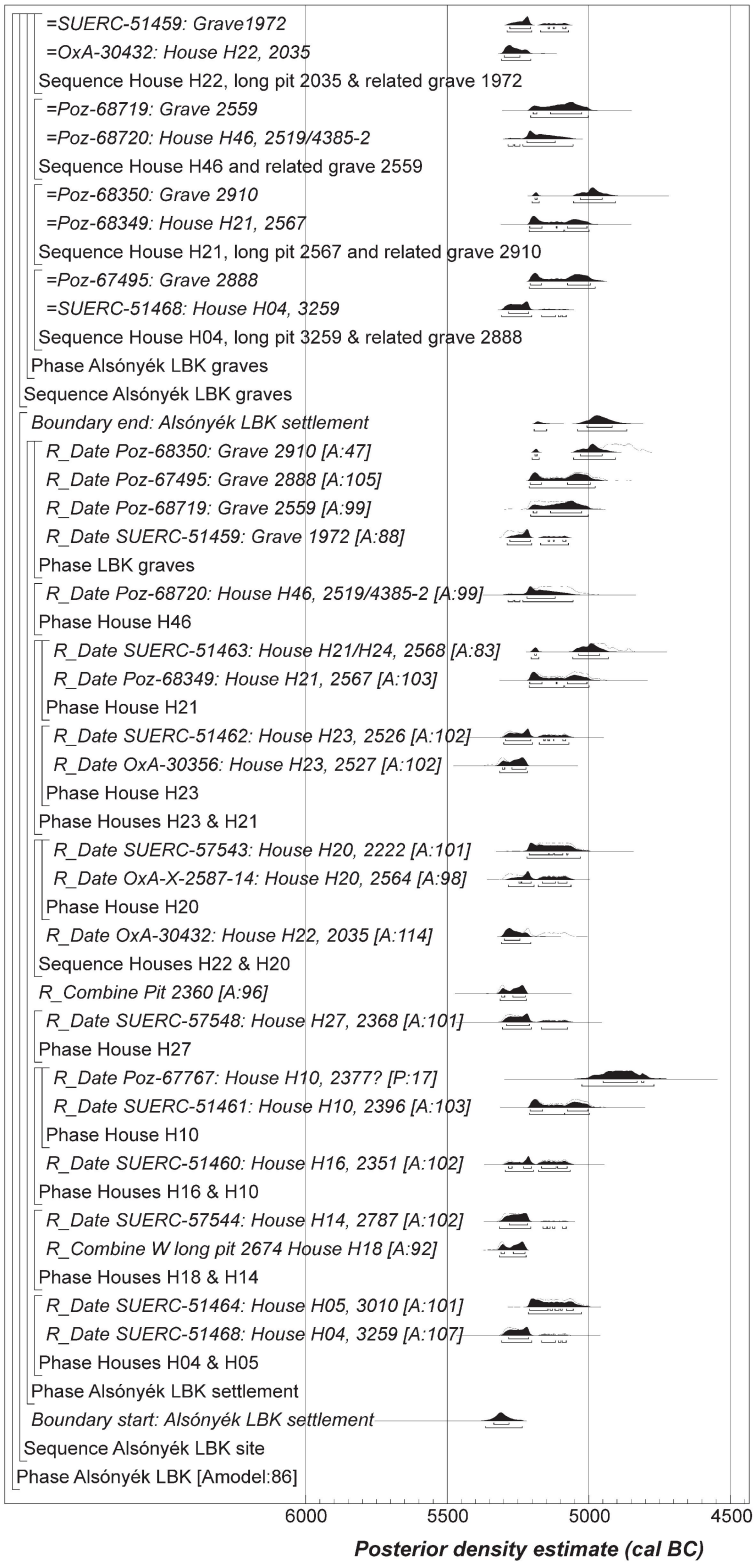


Fig. 6. Overall plan of the LBK settlement with radiocarbon samples and dated features.


=SUERC-51459: Grave1972
=OxA-30432: House H22, 2035
Sequence House H22, long pit 2035 & related grave 1972
=Poz-68719: Grave 2559
=Poz-68720: House H46, 2519/4385-2
Sequence House H46 and related grave 2559
=Poz-68350: Grave 2910
=Poz-68349: House H21, 2567
Sequence House H21, long pit 2567 and related grave 2910
=Poz-67495: Grave 2888
=SUERC-51468: House H04, 3259
Sequence House H04, long pit 3259 & related grave 2888
Phase Alsónyék LBK graves
Sequence Alsónyék LBK graves
Boundary end: Alsónyék LBK settlement
R_Date Poz-68350: Grave 2910 [A:47]
R_Date Poz-67495: Grave 2888 [A:105]
R_Date Poz-68719: Grave 2559 [A:99]
R_Date SUERC-51459: Grave 1972 [A:88]
Phase LBK graves
R_Date Poz-68720: House H46, 2519/4385-2 [A:99]
Phase House H46
R_Date SUERC-51463: House H21/H24, 2568 [A:83]
R_Date Poz-68349: House H21, 2567 [A:103]
Phase House H21
R_Date SUERC-51462: House H23, 2526 [A:102]
R_Date OxA-30356: House H23, 2527 [A:102]
Phase House H23
Phase Houses H23 & H21
R_Date SUERC-57543: House H20, 2222 [A:101]
R_Date OxA-X-2587-14: House H20, 2564 [A:98]
Phase House H20
R_Date OxA-30432: House H22, 2035 [A:114]
Sequence Houses H22 & H20
R_Combine Pit 2360 [A:96]
R_Date SUERC-57548: House H27, 2368 [A:101]
Phase House H27
R_Date Poz-67767: House H10, 2377? [P:17]
R_Date SUERC-51461: House H10, 2396 [A:103]
Phase House H10
R_Date SUERC-51460: House H16, 2351 [A:102]
Phase Houses H16 & H10
R_Date SUERC-57544: House H14, 2787 [A:102]
R_Combine W long pit 2674 House H18 [A:92]
Phase Houses H18 & H14
R_Date SUERC-51464: House H05, 3010 [A:101]
R_Date SUERC-51468: House H04, 3259 [A:107]
Phase Houses H04 & H05
Phase Alsónyék LBK settlement
Boundary start: Alsónyék LBK settlement
Sequence Alsónyék LBK site
Phase Alsónyék LBK [Amodel:86]
6000
5500
5000
4500
Posterior density estimate (cal BC)

Pit 2360 is located between H16 and H27 in the easternmost part of the LBK settlement from which there is a result (OxA-30355) on a sample of a lumbar vertebra, probably *Sus scrofa*, which, on the basis of the preservation of the epiphyseal surface, had a refitting unfused epiphysis. A replicate of the sample was dated successfully (SUERC-58484). The two results are statistically consistent ($T' = 0.0$; $T'(5\%) = 3.8$; $\nu = 1$)), and so a weighted mean was taken before they were incorporated in the model (6306±24 BP).

Pit 2035, the western long pit of H22, was dated (OxA-30432) by a *Bos taurus* femur with a refitting unfused epiphysis that was present in the ground but lost on excavation. Pit 2035 is cut by Grave 1972, a left-crouched 40–45-year-old man from which there is a result (SUERC-51459) on a femur. H22 and H20 partially overlap each other, with H20 a little more to the north-east. Unfortunately, the chronological relationship of the houses is unclear, although H20 was more likely the younger one, and it is this relationship that has been included in the model. Pit 2222, the western long pit of H20, was dated (SUERC-57543) by a *Bos taurus* radius with refitting unfused epiphysis, while Pit 2564, the eastern long pit of H20, was dated (OxA-X-2587-14) by an articulating *Bos taurus* radius and ulna.

A *Bos taurus* metacarpal, whose surface bore the marks of articulating phalanges that were lost on excavation, was dated (SUERC-51462) from Pit 2526, which is the western long pit of H23. Pit 2527 is the eastern long pit of H23 that was dated (OxA-30356) by another *Bos taurus* metacarpal, which again bore the marks of articulating phalanges that were present in the ground but lost on excavation. H21 is located to the north-east of H23. The northern part of the western long pit of H21 was documented as Pit 2567, while the southern one as Pit 2911, although they are obviously two parts of the same long pit divided by a narrower section. Pit 2567 was dated (Poz-68349) by a *Bos taurus* femur with refitting unfused epiphysis. Grave 2910, seriously disturbed by the excavation activity, was most probably dug into the western long pit (2911, 2567) of H21, exactly at the join of the two parts, spatially more associated with the southern part (2911). Grave 2910, containing a 5–6-year-old child, was dated (Poz-68350) using a sample from a femur.

Pit 2568 is a feature between H21 and H24. The eastern long pit of H21 and the western long pit of H24 cut each other and were documented with a single feature number. According to the photographic record, 2568 marks the much deeper eastern long pit of H21. The material of Feature 2568 was most probably uncovered in the eastern long pit of H21. The result (SUERC-51463) for Pit 2568 was produced from an *Ovis aries*/*Capra hircus* tibia with refitting unfused epiphysis.

Pit 2519 is the western long pit of H46 in the southern part of the LBK settlement. Pit 2519 was dated (Poz-68720) by a *Bos taurus* ulna which bore the marks of the articulating radius that had been present in the ground. Another result (Poz-68348) for the same pit was produced from a *Bos taurus* left metatarsal that similarly bore the marks of articulating

◄

Fig. 7. Probability distributions of radiocarbon dates from the LBK settlement at Alsónyék. Each distribution represents the relative probability that an event occurs at a particular time. For each of the dates two distributions have been plotted: one in outline, which is the result of simple radiocarbon calibration, and a solid one, based on the chronological model used. Distributions other than those relating to particular samples correspond to aspects of the model. For example, the distribution '*start: Alsónyék LBK settlement*' is the estimated date when LBK occupation on the site began. The large square brackets down the left-hand side along with the OxCal keywords define the overall model exactly.

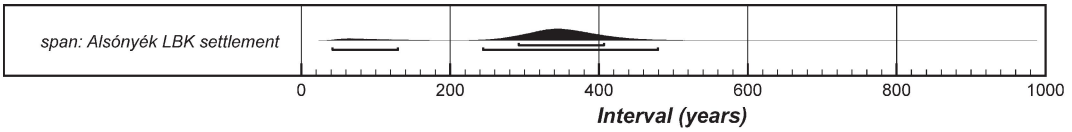


Fig. 8. Probability distributions for the number of years during which the LBK settlement at Alsónyék was occupied, derived from the model defined in *fig. 7*.

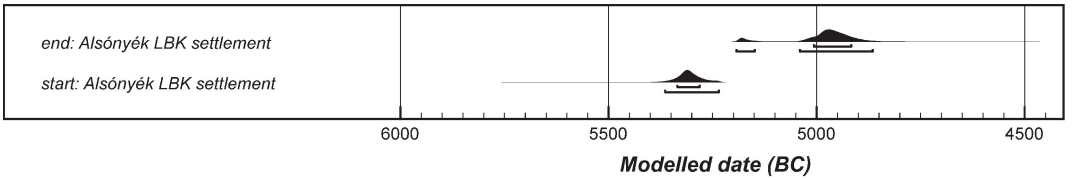


Fig. 9. Key parameters for the start and end of the LBK settlement at Alsónyék, derived from the model defined in *fig. 7*.

tarsals that had been present in the ground but were lost on excavation. The latter has given a Copper Age date, almost 1000 years younger than the LBK settlement, and is most probably a consequence of a post-excavation error. The result has been excluded from all modelling. Pit 2519 was cut by the left-crouched Grave 2559, containing a 40–45-year-old woman, who was dated (Poz-68719) by a sample from a femur.

Results

The overall model *(fig. 7)* shows good agreement between the stratigraphic and other archaeological information included and the radiocarbon dates (Amodel = 86).

The model estimates that the dated LBK activity began in *5365–5230 cal BC (95% probability; fig. 9; start: Alsónyék LBK settlement)*, probably in *5335–5280 cal BC (68% probability)*. The dated LBK occupation lasted for *40–130 years (8% probability; fig. 8; span: Alsónyék LBK settlement)* or *240–480 years (87% probability)*, probably for *290–410 years (68% probability)*. The LBK activity ended in *5195–5145 cal BC (8% probability; fig. 9; end: Alsónyék LBK settlement)* or *5040–4860 cal BC (87% probability)*, probably in *5010–4915 cal BC (68% probability)*.

Sensitivity analysis

As already discussed, house clusters with buildings arranged into rows have been recognised on many LBK settlements, sometimes with the suggestion that subsequent buildings were erected according to iterative customs that could vary but were valid for at least one house cluster or one part of the settlement. In Alsónyék, the five house pairs sketched in the description of the model above represent a recurrent spatial pattern observed on the site.

An alternative model was constructed in which the ordering associated with south-west to north-east movement for the five radiocarbon-dated house pairs (H04–H05, H18–H14, H16–H10, H22–H20 and H23–H21) was included as prior information. According to this interpretation, houses within the same house cluster (H22, H20, H23, H21 and H24) can belong to different chronological horizons when their northern façades were built in a

different position. A second model was also constructed that explored whether the data could support a recurrent shift in the opposite direction between the house pairs.

Only the first alternative model, namely that based on the interpretation that the five dated house pairs of adjacent buildings were erected in a pattern to rebuild the houses north-east of the earlier one, shows good agreement between the prior information and the radiocarbon dates (Amodel = 90). The second model showed poor agreement between the hypothesis of a north-east to south-west shift and the radiocarbon dates (Amodel = 3). This result suggests that movement in that direction is not likely.

Discussion

Many scholars regard Transdanubia as the region from which the LBK spread out across over wide areas of central Europe. There were some estimates of between 5700–5600 cal BC for the start of the culture (Lüning 1988, 37–38; 64 Abb. 33; Gronenborn 1994, 135; 146; 1997, 10; 1998, 193; 1999, 156), while other results have suggested a beginning by 5500 cal BC or even later (Whittle 1990, 301; Gläser 1991, 54–56; Stäuble 1995, 235; 2005, 245 fig. 171; Lenneis et al. 1996, 104–105). For the absolute chronology of the early LBK period in the western Carpathian basin, Peter Stadler proposed, though without publishing individual radiocarbon results or a formal model, that settlements with Bíňa-Bicske type pottery assemblages can be dated between 5400–5300 cal BC while those with Milanovce pottery material fall between 5300–5200 cal BC (Stadler / Kotova 2010, 338). For subsequent development, 5300 cal BC or a little later has been advocated for the transition to later LBK phases (Lenneis / Stadler 1995, 10 Abb. 8; Lenneis et al. 1996, 105; Stäuble 1995, 233), while the early fifth millennium cal BC has been proposed for the end of the culture (Lenneis / Stadler 1995, 10–11 Abb. 8; Lenneis et al. 1996, 105).

The modelled estimates presented here suggest a long lifespan for the LBK settlement at Alsónyék, probably over *290–410 years (68% probability; fig. 8; span: Alsónyék LBK settlement)*, equivalent to 12–16 human generations, probably between *5335–5280 cal BC (68% probability; fig. 9; start: Alsónyék LBK settlement)* and *5010–4915 cal BC (68% probability; fig. 9; end: Alsónyék LBK settlement)*. That means that Alsónyék covers practically the whole duration of the LBK in Transdanubia from the early LBK to the end of its regional development.

When the results are contrasted with the traditional typo-chronology of pottery, it must be emphasised that the sequence valid for south-west Transdanubia and for the region around Lake Balaton cannot be adopted for south-east Transdanubia. The assemblages in the latter region are more complex in the sense that the influence of Starčevo and Vinča pottery styles is more detectable than in other regions of western Hungary. As a consequence of the Alsónyék LBK dating project, the currency of pottery shapes and decorations attributed to the early LBK period must be reconsidered on a regional scale. Some of them could have remained here in use for a longer time than usually estimated, perhaps even later than the 53th century cal BC. Given the long lifespan of the settlement, it is not possible to exclude characteristic early LBK pottery being associated with younger radiocarbon dates as a consequence of significant reworking of early deposits. On the other hand, however, the assemblage is too homogeneous to accept this possibility as a general explanation. Later on, the decorated Keszthely style is regarded as the characteristic pottery of southern Transdanubia in the later and late LBK phases. At the same time, however, it has also been noted that its typical assemblages have been found mainly on south-west

Transdanubian sites (Kalicz 1991). Based on the pottery and the absolute chronology of the Alsónyék LBK occupation, the significance of the Keszthely pottery style as a well distinguished unit with a chronological relevance must be seriously challenged both on a local and a micro-regional scale.

Although it is impossible to reconstruct the whole settlement development and dynamics of the LBK site on the basis of 23 results, the five pairs of houses described above have yielded valuable results. The radiocarbon dates from the long pits suggest that the south-western house of a pair was erected first, and that the north-eastern house was probably the younger one in all five cases. The complexity of building processes was detected by the house cluster that consists of houses H22, H20, H23, H21 and H24. The radiocarbon dates cannot support a gradual shift in one direction across the whole cluster. The pattern already described could be observed, however, among the four dated houses. That scheme also makes it possible that more than one house could be inhabited in one cluster at the same time. One possible reason for rebuilding the houses on the eastern side of their presumed predecessors could be that the area of household activities was much more on the western side of the houses, with a concentration of deposited finds as already demonstrated at Balatonszárszó-Kis-erdei-dűlő (Marton 2013; 2015, 67–74).

Ongoing evaluation of other Transdanubian sites like Balatonszárszó-Kis-erdei-dűlő and Tolna-Mözs also indicates that more flexible models should be elaborated for regional practices and principles of LBK site development than either the independent homestead model or the model of settlement rows. The system of house clusters as interpreted for the Austrian sites of Rosenburg and Mold could further be developed as an appropriate model for Transdanubian sites, taking into account that the houses are arranged into rows within the clusters. Investigation can be conceptualised on three levels: across all the inhabited parts of a settlement, then house clusters and their mutual relationships, and finally possible chronological differences or the contemporaneity of houses within the same cluster. The Alsónyék results add potentially very important support to the assumption that, even if material culture is usually the same or very similar within a house cluster, not all the houses were necessarily erected at the same time or were totally contemporaneous. On the other hand, the at least partially contemporaneous existence of more than one house is a very good possibility in the house clusters. An important reflection from the dating project presented here is actually how difficult it is to produce reliable and consistent models for the development of larger units or even for whole settlements.

Acknowledgments

Grateful thanks are due to: OTKA for funding *Alsónyék: az élelemtermelés kezdeteitől az újkőkor végéig* (*Alsónyék: from the beginnings of food production to the end of the Neolithic*; grant code: K 81230), led by Eszter Bánffy; the European Research Council for funding *The Times of Their Lives* (Advanced Investigator Grant: 295412), led by Alasdair Whittle and Alex Bayliss; Alex Bayliss and Alasdair Whittle for advice and support; and Balázs Gusztáv Mende for taking samples.

Summary · Zusammenfassung · Résumé

SUMMARY In the central part of the main area of the Alsónyék complex investigated an LBK settlement was discovered. The features belonging to the LBK occupation were uncovered in subsites 10B, 11 and 5603. The location of houses could be determined by the long pits flanking presumed timber-framed constructions; postholes are very poorly preserved. Fifty house plans could be identified, most of them based on the long pits.

Most Neolithic archaeologists agree that the western part of the Carpathian basin served as the cradle of the LBK. The Balaton area and the region south of the lake had an important role in the development of the culture and in the spread of the Neolithic to central Europe. Southern Transdanubia, however, has previously been a veritable *terra incognita* for settlement research of the culture, despite the evidence for LBK sites from the region.

Dating of the LBK occupation was funded by the OTKA project, *Alsónyék from the beginning of food production to the end of the Neolithic* and has been undertaken in a cooperation with the ERC-funded project, *The Times of Their Lives*. The aim has been to provide formally modelled date estimates of the timing and duration of the LBK occupation at Alsónyék, to gain insight into intra-site development and dynamics, and further the absolute chronology of the LBK on a regional scale.

This paper presents 23 radiocarbon dates from 21 samples, interpreted within a formal chronological framework, for the LBK settlement at Alsónyék. The Bayesian model presented estimates that LBK activity probably began in *5335–5280 cal BC (68% probability)*, probably lasted for *290–410 years (68% probability)*, and probably ended in *5010–4915 cal BC (68% probability)*.

ZUSAMMENFASSUNG Im zentralen Bereich der Hauptgrabungsfläche in Alsónyék wurde eine LBK-Siedlung entdeckt. Die LBK-Befunde erstrecken sich über die Flächen 10B, 11 und 5603. Die überwiegende Mehrheit der 50 identifizierten Hausgrundrisse gibt sich durch Längsgruben zu erkennen, die die mutmaßlichen Pfostenkonstruktionen begleiteten. Pfostengruben sind nur sehr schlecht erhalten.

Die meisten Archäologen, die sich mit dem Neolithikum beschäftigen, sind sich einig, dass das westliche Karpatenbecken die Wiege der LBK ist. Die Region um den Balaton und südlich davon spielten eine wichtige Rolle in der Entwicklung der Kultur und in der Verbreitung des Neolithikums nach Mitteleuropa. Südtransdanubien galt bisher als wahres *terra incognita* für Siedlungsanalysen der LBK, trotz des Nachweises von Fundstellen dieser Kultur in der Region.

Die Datierung der linearbandkeramischen Ansiedlung in Alsónyék wurde durch das OTKA-Projekt *Alsónyék from the beginning of food production to the end of the Neolithic* finanziert und in Kooperation mit dem ERC-Projekt *The Times of Their Lives* durchgeführt. Sie zielte darauf ab, Kalkulationen zur Chronologie und Dauer der LBK-Besiedlung in Alsónyék bereitzustellen, um Einblicke in die Siedlungsentwicklung und -dynamik von Alsónyék zu gewinnen und um eine absolute Chronologie der LBK auf regionaler Ebene zu erhalten.

Es werden 23 Radiocarbondaten von 21 Proben der LBK-Siedlung ausgewertet und im Rahmen einer formalen chronologischen Analyse interpretiert. Die Berechnungen, die über das Bayes'sche Modell gewonnen wurden, belegen einen vermutlichen Beginn der LBK um *5335–5280 cal BC (68% Wahrscheinlichkeit)*, eine Dauer von *290–410 Jahren (68% Wahrscheinlichkeit)* und ein Ende um *5010–4915 cal BC (68% Wahrscheinlichkeit)*.

(M. E.)

RÉSUMÉ Un habitat du Rubané fut découvert au centre de la zone principale fouillée du complexe d'Alsónyék. Les structures attribuables à l'occupation rubanée furent plus précisément mises au jour dans les sous-sites 10B, 11 et 5603. Malgré la mauvaise conservation des trous de poteaux, 50 maisons au total purent être localisées, dont la majorité grâce aux fosses latérales longeant les constructions présumées à pans de bois.

La plupart des néolithiciens admettent que la partie occidentale du bassin des Carpates représente le berceau de la culture du Rubané linéaire. Toute la zone du Balaton et la région au sud du lac jouèrent un rôle important dans le développement de cette culture et dans la diffusion du Néolithique vers l'Europe centrale. Cependant, le Sud de la Transdanubie fut jusqu'à présent considéré comme une véritable terre inconnue dans la recherche des habitats appartenant à cette culture, malgré les traces connues de sites du Rubané dans la région.

La datation de l'occupation rubanée fut financée par le projet OTKA « Alsónyék du début de la production alimentaire à la fin du Néolithique » en coopération avec le projet financé par l'ERC « The Times of Their Lives ». Le but était de fournir des estimations modélisées de la chronologie et de la durée de l'occupation rubanée d'Alsónyék, afin de mieux saisir le développement et les dynamiques internes du site, ainsi que la chronologie absolue du Rubané à une échelle régionale.

Dans cet article, 23 datations au radiocarbone prélevées sur 21 échantillons de l'habitat rubané d'Alsónyék sont présentées et interprétées dans un cadre chronologique bien défini. Selon le modèle bayésien proposé, l'activité de la culture du Rubané aurait probablement commencé vers *5335–5280 cal BC (68 % de probabilité)* et se serait probablement achevée vers *5010–4915 cal BC (68 % de probabilité)*, comprenant une durée d'environ *290–410 ans (68 % de probabilité)*. (Y.G. / E.P.)

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Lab ID	Context no.	Context description [Sample ID]	Material	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ (‰)	C:N	Radiocarbon age (BP)	*Modelled date (95% probability)*
SUERC-51459	11-1972	Grave of left-crouched, 40–45-year-old male. It was dug into the western long pit (2035) of house H22 [11-1972]	Human bone: femur	−19.9 ± 0.2	9.2 ± 0.3	3.3	6244 ± 31	*5290–5200 cal BC* (*64%*) or *5175–5070 cal BC* (*31%*)
OxA-30432	11-2035/3964	Settlement pit, western long pit of house H22 [11-2035/3964]	Animal bone: subadult cattle; left femur; refitting unfused epiphysis (lost on excavation)	−20.4 ± 0.2	6.6 ± 0.3	3.2	6230 ± 35	
SUERC-57543	11-2222/3969	Settlement pit, western long pit of house H20 [11-2222/3969]	Animal bone: subadult cattle; right radius; with refitting unfused distal epiphysis	−19.4 ± 0.2	4.8 ± 0.3	3.2	6173 ± 34	
SUERC-51460	5603-2351/8787-9179	Settlement pit, eastern long pit of house H16 [5603-2351/8787-9179]	Animal bone: juvenile cattle; right ulna; articulating with radius	−18.7 ± 0.2	7.0 ± 0.3	3.2	6220 ± 30	
OxA-30355	5603-2360/8759	Settlement pit, east of house H16 and north of house H27 [5603-2360/8759]	Animal bone: juvenile wild boar (?); unfused lumbar vertebra; refitting unfused epiphyses (lost on excavation)	−18.7 ± 0.2	11.0 ± 0.3	3.3	6305 ± 33	

Lab ID	Context no.	Context description [Sample ID]	Material	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ (‰)	C:N	Radiocarbon age (BP)	*Modelled date (95% probability)*
SUERC-58484	5603-2360/8759	Replicate of OxA-30355 [5603-2360/8759]	Animal bone: juvenile wild boar (?); unfused lumbar vertebra; refitting unfused epiphysis (lost on excavation)	−19.7 ± 0.2	10.7 ± 0.3	3.3	6307 ± 33	
Pit 2360: ^{14}C: T′ = 0.0, T′(5%) = 3.8, ν = 1, 6306 ± 24 BP; $\delta^{13}C$: T′ = 12.5, T′(5%) = 3.8, ν = 1, −19.2 ± 0.15‰; $\delta^{15}N$: T′ = 0.5, T′(5%) = 3.8, ν = 1, 10.9 ± 0.22‰								
SUERC-57548	5603-2368/8748	Settlement pit, eastern long pit of house H27 [5603-2368/8748]	Animal bone: juvenile cattle; right calcaneus; refitting unfused tuber calcanei (lost on excavation)	−20.2 ± 0.2	8.4 ± 0.3	3.3	6245 ± 34	
Poz-67767	5603-2377/8887	Settlement pit, western long pit of house H10 [5603-2377/8887]	Animal bone: juvenile sheep / goat; right tibia; with refitting unfused distal epiphysis				6000 ± 50	

Tab. 1. Radiocarbon and stable isotopic results from LBK features at Alsónyék. The results are presented in ascending order by context number. Results are from subsites 11 and 5603.

Lab ID	Context no.	Context description [Sample ID]	Material	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ (‰)	C:N	Radio-carbon age (BP)	*Modelled date (95% probability)*
SUERC-51461	5603-2396/8908	Settlement pit, eastern long pit of house H10 [5603-2396/8908]	Animal bone: juvenile / subadult cattle; left femur; with refitting unfused proximal epiphysis	−20.5 ± 0.2	5.8 ± 0.3	3.3	6132 ± 33	
Poz-68348	11-2519/4385-1	Settlement pit, western long pit of house H46 [11-2519/4385-1]	Animal bone: subadult cattle; left metatarsal; articulating marks of tarsal bones on its surface				5355 ± 35	
Poz-68720	11-2519/4385-2	Settlement pit, western long pit of house H46 [11-2519/4385-2]	Animal bone: subadult cattle; left ulna; articulating marks of radius on its surface	−21.1 ± 0.33	5.8 ± 0.43	3.7	6180 ± 40	
SUERC-51462	11-2526/4525	Settlement pit, western long pit of house H23 [11-2526/4525]	Animal bone: adult cattle; right metacarpal; articulating marks of phalanges on its surface (articulating)	−19.6 ± 0.2	6.9 ± 0.3	3.2	6232 ± 32	

Lab ID	Context no.	Context description [Sample ID]	Material	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ (‰)	C:N	Radiocarbon age (BP)	*Modelled date (95% probability)*
OxA-30356	11-2527/4391	Settlement pit, eastern long pit of house H23 [11-2527/4391]	Animal bone: subadult / adult cattle metacarpal; articulating marks of phalanges on its surface	–20.8 ± 0.2	5.9 ± 0.3	3.3	6306 ± 32	
Poz-68719	11-2559	Grave of left-crouched, 40–45-year-old female. It was dug into the western long pit (2519) of house H46 [11-2559]	Human bone: femur	–20.3 ± 0.33	9.9 ± 0.43	3.6	6160 ± 40	*5210–5000 cal BC*
OxA-X-2587-14	11-2564/4891	Settlement pit, eastern long pit of house H20 [11-2564/4891]	Animal bone: juvenile cattle; right radius; articulating with ulna	–20.7 ± 0.2	5.1 ± 0.3	3.3	6230 ± 35	
Poz-68349	11-2567/4532	Settlement pit, northern part of the western long pit of house H21 [11-2567/4532]	Animal bone: subadult cattle; right femur; with refitting unfused proximal epiphysis	–21.3 ± 0.33	5.7 ± 0.43	3.3	6130 ± 35	
SUERC-51463	11-2568/4536	Settlement pit, most probably eastern long pit of house H21 /	Animal bone: juvenile sheep / goat; left tibia;	–21.0 ± 0.2	6.9 ± 0.3	3.2	6056 ± 31	

Tab. 1. (continued)

Lab ID	Context no.	Context description [Sample ID]	Material	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ (‰)	C:N	Radiocarbon age (BP)	*Modelled date (95% probability)*
		western long pit of house H24 [11-2568/4536]	with refitting unfused distal epiphysis					
OxA-30357	11-2674/4559	Settlement pit, western long pit of house H18 [11-2674/4559]	Animal bone: subadult cattle; right metacarpal; articulating marks of phalanges on its surface	−19.4 ± 0.2	6.7 ± 0.3	3.3	6317 ± 32	
SUERC-58485	11-2674/4559	Replicate of OxA-30357 [11-2674/4559]	Animal bone: subadult cattle; right metacarpal; articulating marks of phalanges on its surface	−19.9 ± 0.2	6.9 ± 0.3	3.2	6305 ± 34	
W long pit 2674 House H18: ^{14}C: T′ = 0.1, T′(5%) = 3.8, ν = 1, 6311 ± 24 BP; $\delta^{13}C$: T′ = 3.1, T′(5%) = 3.8, ν = 1, −19.7 ± 0.15‰; $\delta^{15}N$: T′ = 0.2, T′(5%) = 3.8, ν = 1, 6.8 ± 0.22‰								
SUERC-57544	11-2787/4570	Settlement pit, southern part of the eastern long pit of house H14 [11-2787/4570]	Animal bone: adult cattle; left radius; articulating with ulna	−20.9 ± 0.2	8.4 ± 0.3	3.3	6267 ± 35	
Poz-67495	11-2888	Grave of left-crouched, 12–13-year-old child. It was dug into the western long pit (3259) of house H04 [11-2888]	Human bone: tibia	−20.0 ± 0.33	10.7 ± 0.43	3.4	6120 ± 40	*5215–4975 cal BC*

Lab ID	Context no.	Context description [Sample ID]	Material	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N$ (‰)	C:N	Radiocarbon age (BP)	*Modelled date (95% probability)*
Poz-68350	11-2910	Grave of 5–6-year-old child. It was most probably dug into the western long pit (2567, 2911) of house H21, more associated with its southern part (2911) [11-2910]	Human bone: femur	–19.7 ± 0.33	10.0 ± 0.43	3.5	6010 ± 40	*5200–5175 cal BC* (*9%*) or *5055–4905 cal BC* (*86%*)
SUERC-51464	11-3010/4880	Settlement pit, eastern long pit of house H05 [11-3010/4880]	Animal bone: subadult cattle; unfused thoracic vertebra; refitting unfused caudal epiphysis (lost on excavation)	–21.3 ± 0.2	6.2 ± 0.3	3.2	6160 ± 30	
SUERC-51468	11-3259/4905	Settlement pit, western long pit of house H04 [11-3259/4905]	Animal bone: subadult sheep; left radius; articulating with ulna	–21.1 ± 0.2	5.8 ± 0.3	3.2	6247 ± 33	

Tab. 1. (continued)