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Rows with the neighbours: the short lives of longhouses at the Neolithic site of Versend-Gilencsa, Hungary

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Rows with the neighbours: the short lives of longhouses at the Neolithic site of Versend-Gilencsa, Hungary

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Introduction

Great timber longhouses are one of the defining features of the first Neolithic communities in central and western Europe, belonging to the *Linearbandkeramik* or LBK culture of the second half of the sixth millennium cal BC (Coudart 1988). Even in the first recorded phase of longhouse construction, belonging to what has been identified as the formative phase of the LBK, many elements of this architecture, such as longpits, side ditches and internal rows of posts, were already present (Bánffy 2013). During the succeeding *älteste* or earliest LBK, buildings could be substantial, up to 20 m long or more by 5 or 6 m wide (Stäuble 2005). From the later LBK onwards, in the Flomborn, Ačkovy, Notenkopf and Keszthely phases, which, according to conventional wisdom, begin *c.* 5300 cal BC, some longhouses became even longer, reaching over 30 m and more, and internally more elaborate, the typical internal cross-rows of three posts being amenable to any number of combinations and layouts (Modderman 1970; Coudart 1998). Settlement after settlement has been found, characterised by larger and smaller groupings of long houses.

Despite their high archaeological visibility, their very wide distribution and the thousands of examples already excavated, many questions remain about these iconic structures. Where did this architecture first emerge? In the virtual absence of preserved floors, what can be said about the use of the interiors? How long did these buildings last, given the hefty oak posts with which the great majority of them appear to have been framed? How did houses relate to their neighbours? What did the variation in house size mean in terms of household composition? Should each house be thought of as an independent unit, or was membership of households distributed across more than one building?

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For a long time, thinking about these and related questions was framed by the *Hofplatzmodell* or independent homestead model, which came in the first place out of the pioneering, large-scale rescue excavations on the Aldenhovener Platte in north-west Germany (Boelicke *et al.* 1988). According to this, and based on a complex set of arguments resting on a combination of site layouts, horizontal stratigraphy, ceramic sequence constructed through correspondence analysis of decorative motifs on fineware pottery, and an inferred house duration of some 25–30 years (summarised in Zimmermann 2012), each longhouse existed in its own space — or yard in Dutch terminology (van de Velde 1979) — and separated from irregularly spaced neighbours by a wider area that includes an activity zone that spans about 25 m in the case of Langweiler 8 (Boelicke *et al.* 1988). With each succeeding generation, these straggling, loose clusters shifted slightly. Community was thus constituted by a combination of independent households, or, as suggested by more recent research, by groupings of such households, as at Vaihingen, south-west Germany, or Cuiry-lès-Chaudardes, northern France (Bogaard *et al.* 2011; Hachem 2011); wards are a useful term in this context (van de Velde 1979).

More recently, the *Hofplatzmodell* has been strongly criticised (Rück 2009; 2012). In its place, principally on the basis of visual inspection of settlement plans, settlement layout based on rows of longhouses has been proposed, with buildings aligned long side to long side and quite closely spaced. At the same time, differing hypothetical house durations have been mooted, of up to 75 years or more (Schmidt *et al.* 2005: 162; Rück 2009). A wide range of candidates for row layout was suggested, more or less right across the area of the LBK in central and western Europe. Other studies, particularly in the more eastern part of this distribution, support the revision of the independent homestead model, without accepting all elements of the row model or necessarily following the proposed alternative estimate of house duration (Lenneis 2012; Marton & Oross 2012). Other variations, in terms of linked pairs of houses and other close-set clusters, have also been proposed (Czerniak 2016).

The chronology of these alternatives to the *Hofplatzmodell* has not, however, been formally modelled (though note Lenneis 2012). The site of Versend-Gilencsa in south-west Hungary, the focus of this paper, provides an opportunity to examine issues of layout and chronology together, as it shows clear row layout and produced large assemblages of faunal remains suitable for radiocarbon dating.

Longhouse architecture and settlement layout in western Hungary

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Archaeological research on LBK sites in the western part of Hungary has intensified substantially over the past two decades. By 2010 more than 300 houses from 50 sites were known (Oross 2013: 151–77, table 5.1, fig. 5.10, 401–2), but the real number of excavated house plans is much higher as numerous discoveries remain unpublished. Their architecture generally consists of the same elements as in other regions of east-central Europe.

The excavated house plans from later sixth millennium cal BC settlements in western Hungary form clusters arranged into rows that are usually more or less parallel to each other. Each row consists of two to six houses with their long axes perpendicular to the row. Very similar settlement layout can be observed on extended LBK sites of the region, with some rows located close to each other, as at Tolna-Mözs (Marton & Oross 2012: 225–33, fig. 3). In other cases, as at Balatonszárszó-Kis-erdei-dűlő (Oross 2013: 320–45), there were some spaces free of houses between the rows. The nearby Szederkény-Kukorica-dűlő settlement shares the same layout although the house units were associated principally with early Vinča and Ražište style pottery (Jakucs *et al.* 2016).

Versend-Gilencsa

The large-scale archaeological rescue excavation at Versend-Gilencsa (Fig. 1), preceding the construction of the M6 motorway in southern Transdanubia, was carried out by archaeologists of the Janus Pannonius Museum, Pécs, in 2006–2007. The site lies in the area of the southern Baranya hills, south of the village of Versend, and less than 3 km to the east of Szederkény-Kukorica-dűlő (Jakucs *et al.* 2016). The area excavated along a 1.2 km-long section of the motorway totalled over 6.5 ha. The Neolithic settlement extends over gently sloping, low ridges, on both sides of the Versend stream (Fig. 2).

In the eastern part of the Neolithic settlement, close to the line of the stream, there were numerous traces of longhouses, oriented north–south. Although the postholes of these structures were poorly preserved, house plans could be identified from the characteristic longpits flanking the buildings. In this part of the site, at least 21 Neolithic house plans were identified, clearly arranged in at least four rows nearly perpendicular to the streamline (Fig. 2). Only one Neolithic burial was found here.

The western part of the site is more densely packed with features of different archaeological periods. Some Neolithic structures can be identified as potential longpits on the basis of their

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form, but because of disturbance from later periods the locations of the suspected Neolithic house plans have not yet been detected. However, 24 burials came to light in this part of the settlement, mainly cut into larger pit complexes; within the area excavated, these appear to form small clusters. Most were in a crouched position, but none of the burials had any grave goods.

Material culture

A significant range of pottery styles was found at Versend, including Vinča, Ražište, early LBK and Starčevo (Fig. 3). Starčevo was the first Neolithic cultural grouping in Transdanubia, in the first half of the sixth millennium cal BC. As new evidence from Versend and other sites in south-east Transdanubia has shown, inherited elements of the Starčevo pottery style could have been preserved in the region to a greater extent than previously presumed (Marton & Oross 2012). Vinča is the major post-Starčevo cultural grouping to the south of the LBK, the earliest manifestations of which are now dateable to the last generations of the 54th century cal BC (Whittle *et al.* 2016: fig. 25). The Ražište style, an early variant of the Sopot culture on the fringes of the early Vinča culture in north-east Croatia, has been thought of as the outcome of interaction between the Vinča and LBK spheres (Marković 2012; Jakucs and Voicsek 2015). In addition to these, decorative elements of the Malo Korenovo type, which is a regional variant of the LBK in northern Croatia and south-west Hungary (Težak-Gregl 1993), also occur.

Early Vinča-style ceramics, figurines and bone tools are the most significant style found in the buildings of the northern house row of the eastern settlement area, especially in houses H15 and H17 (Fig. 4). However, in most houses, early Vinča-style vessel forms and technological markers occur together with early LBK-style ceramics (and in the cases of H3, H5, H7 and H15, with figurines as well), and also in some cases with material that appears to hark back to the Starčevo tradition (H10, H11 and H12). On the basis of analysis so far, the eastern area of Versend appears to have relatively strong Vinča influences in the material of some houses, but others show stronger affiliations to the rest of Transdanubia (Figs 3–4). A different picture has emerged so far (from ongoing post-excavation analysis) on the western side of the settlement. Distinctive early Vinča elements such as black burnishing, black-topped vessels and red slipping are numerous, but there were significant differences in vessel forms and decorative techniques. The analogies to the vessel forms and the applied decorative patterns are best matched by the ceramics of the Sopot-Ražište style of eastern Slavonia. In addition to these, decorative elements of the Malo Korenovo pottery style are more frequent in this part of the site.

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Radiocarbon dating

A radiocarbon dating programme for Versend was conceived within the framework of Bayesian chronological modelling (Buck *et al.* 1996). At the start of the project, four radiocarbon dates on human skeletons were available from the site (MAMS-; Table 1). The sampling strategy was designed to date the occurrence of longhouses and Vinča ceramics on the same site, to explore the layout of the eastern part of the settlement, and to determine whether occupation at Versend was contemporary with that at nearby Szederkény-Kukorica-dűlő.

Sampling was concentrated in the eastern part of the settlement where the layout of the buildings could be reconstructed. Only a small set of samples was dated from the western area to check that the two areas were occupied at the same time. The entire faunal assemblage from the eastern part of the site was assessed for groups of articulating bones and bones with re-fitting unfused epiphyses (cf. Bayliss *et al.* 2016: fig. 7). This material must have been deposited in its context rapidly after death or the parts would not have remained together. Strictly such samples provide *termini ante quos* for the construction of longhouses. It is likely, however, that the difference between the deposition of the dated animal bones and the date of house construction is relatively small, given that none of the material can have come from the upper parts of features as the top 0.4 m is thought to have been machined off.

A total of 68 radiocarbon measurements are available from Versend, all on samples of articulating animal or human bone (Table 1). Technical details of these results and the methods used to produce them are provided in Supplementary Information.

Modelling the chronology of the Neolithic settlement at Versend-Gilencsa

Chronological modelling was undertaken using the program OxCal v4.2 (Bronk Ramsey 2009a; Bronk Ramsey & Lee 2013) and the calibration dataset of Reimer *et al.* (2013). The algorithms used in the models are defined exactly by OxCal code provided as supplementary information. The structure of the preferred model (Model 4) is illustrated by the brackets and OxCal keywords on the left-hand side of Figs 5 and 6 (http://c14.arch.ox.ac.uk/). The outputs from the models, the posterior density estimates are shown in black, and the unconstrained calibrated radiocarbon dates are shown in outline. The other distributions correspond to aspects of the model. For example, the distribution *start Versend settlement* (Fig. 5) is the posterior density estimate for the time when the settlement at Versend was established. In the text and tables, the Highest Posterior Density intervals of the posterior density estimates are given *in italics*.

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A number of alternative models for understanding the chronology of Versend have been constructed. All these models include the limited number of stratigraphic relationships between dated features at Versend. Grave 415 is earlier than Pit 414 of H18, Pit 1123 is earlier than Graves 1121 and 1124, and Pit 1387 is earlier than Grave 1394. Replicate radiocarbon measurements are combined by taking a weighted mean before calibration (Ward & Wilson 1978) before inclusion in the models, and the three measurements on intrusive samples of post-Neolithic date are also excluded.[1]

Model 1 (Versend_Model_1.oxcal) included all the settlement features and burials in a single, continuous uniform phase of activity (Buck *et al.* 1992). This model has poor overall agreement (Amodel: 46), with burials 1049 (*SUERC-67305*) and 1078 (*SUERC-67306*) clearly continuing later than the dated settlement. Model 2 (Versend_Model_2.oxcal), therefore, places the settlement features and the burials in separate, potentially overlapping, continuous uniform phases of activity (cf. the model structures illustrated in Figs 5 and 6). This model also has poor overall agreement (Amodel: 56) and also poor overall convergence (C: 85), with three samples having poor individual agreement (*UBA-22596*, A: 42; *UBA-22602*, A: 46, and *SUERC-58578*, A: 1).[2] SUERC-58578, from a cattle tibia with refitting unfused epiphysis, is statistically significantly earlier than the other measurements on similar samples from the longpits of H15 (T'=20.4; T'(5%)=11.1; ν=1; Ward & Wilson 1978), and indeed clearly earlier than all the other dated samples from the site (Fig. S1). Given its articulation, it appears unlikely to be residual from an earlier feature and so is likely to be a laboratory outlier.

Model 4 (Versend_Model_4.oxcal), therefore, implements outlier analysis to identify and proportionally weight any statistical outliers arising from unquantified laboratory error in the data ((Outlier_Model("SSimple",N(0,2),0,"s"); Christen 1994; Bronk Ramsey 2009b). This model is identical in form to Model 2, but implements s-type outlier analysis in OxCal with each radiocarbon measurement being given a prior outlier probability of 5%. Only *SUERC-58578* (83%) and *UBA-22602* (11%) have posterior outlier probabilities of more than 10%, and it is again clear that *SUERC-58578* is a significant outlier from the main body of data from the settlement (the outlier analysis downweights this date proportionately). Model 4 is defined by the CQL2 code provided as supplementary information (Versend_Model_4.oxcal), although its overall form is illustrated in Figs 5 and 6. The first and last dated events have been calculated for each longhouse that has more than two radiocarbon dates,[3] the difference between them

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providing an estimate for the duration of use of each building, bearing always in mind that the upper longpit fills are probably missing. These key parameters are illustrated in Figs 7 and 8, and their Highest Posterior Density intervals are given in Table 2.

Obtaining a statistically plausible and stable model for the chronology of Versend has been challenging, because of the shape of the radiocarbon calibration curve between *c.* 5300 and *c.* 5000 BC (Fig. S1). This consists of two small plateaux separated by a pronounced wiggle, which leads to strongly bi-modal posterior distributions. Consequently, the models are extremely slow to converge or are unable to achieve adequate convergence at all (Bronk Ramsey 1995: 429). The highest peaks of probability, however, in all our variant models suggest a short-lived settlement occupied for a few decades around 5200 cal BC. This coincides with a steep part of the calibration curve separating two small plateaux and we were concerned that our results could be an artefact of the shape of the curve. For this reason, we ran 14 simulation models identical in form to Model 1, each spanning 30 years and starting from 5270 BC to 5130 BC. The posterior distributions produced by these simulations included the actual dates in accordance with statistical expectation (Table S1), and so we feel that the model outputs presented should be accurate to within the quoted uncertainty.

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The model shown in Fig. 5 suggests that the settlement at Versend was established in *5305–5280 cal BC* (*2% probability*; *start Versend settlement*; Fig. 5) or *5255–5210 cal BC* (*93% probability*), probably in *5235–5215 cal BC* (*68% probability*), and was abandoned in *5220–5180 cal BC* (*93% probability*; *end Versend settlement*; Fig. 5) or *5150–5115 cal BC* (*2% probability*), probably in *5210–5195 cal BC* (*68% probability*). It was in use for *1–70 years* (*93% probability*; *use Versend settlement*; Fig. 8) or *135–185 years* (*2% probability*), probably for *10–35 years* (*68% probability*). Given the short overall duration of the settlement[4], most houses were probably in use for no more than a decade or two (Fig. 8). Burial occurred for longer on the site, beginning in *5395–5225 cal BC* (*95% probability*; *start Versend burials*; Fig. 6), probably in *5330–5240 cal BC* (*68% probability*) and ending in *5040–4815 cal BC* (*95% probability*; *end Versend burials;* Fig. 6), probably in *4995–4905 cal BC* (*68% probability*). It continued for a period of *215–540 years* (*95% probability*; *use Versend burials*; distribution not shown), probably for a period for *275–415 years* (*68% probability*). This persistence is a stark contrast to the brevity of settlement on the site.

Discussion

Model 4 suggests not only short durations for individual longhouses in Versend-Gilencsa, median values not exceeding 20 years (Fig. 8), but also, in complementary fashion, a short life for the settlement as a whole, in the late 53rd century cal BC; dates from the western part, though fewer, indicate a similar period of use to the eastern part. We note a longer duration for burial on the site, which though unusual in this kind of context does not conflict with the modelled brevity of settlement. In assessing the implications of these formally modelled estimates, we have to restate what has been dated. Our short-life samples have principally come from the pits flanking the longhouses of the eastern part of the settlement, and it is believed that those features are truncated. Nor is it entirely clear how the filling of flanking longpits relates to the whole biography of individual buildings. Did these features fill up quickly? Were the finds in them foundation deposits? Were they recut periodically? These are questions which apply across the whole LBK distribution (cf. Stäuble 1997), and are therefore open to testing in other cases. Our proxy, however, is the best available for Versend-Gilencsa, and is likely to be the kind of proxy to be found in many other LBK situations.

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On this basis, the estimated short house durations have not only local significance, to which we return below, but also potential wider importance with reference to the debate about the forms and timings of LBK settlements sketched in the introduction. The eastern part of Versend-Gilencsa is unequivocally arranged in rows, and probably the western part as well. This example, and plenty of others in Transdanubia and other parts of east-central Europe, therefore confirms the spatial dimension of the row model (Rück 2009; 2012). Our date estimates for house lives, however, conform well with the estimates produced by the *Hofplatzmodell* (Zimmermann 2012), and are considerably shorter, in this instance, than those proposed as a corollary of the row model. It remains to be seen, of course, whether similar results can be produced by formal modelling of other LBK longhouse settlements. The few other formally modelled estimates for house duration in other Neolithic contexts currently available also on the whole support shorter rather than longer house lives. In the tell settlements of Vinča-Belo Brdo, Serbia, and Uivar, Romania, for example, median house durations range from 4–55 years (Tasić *et al.* 2016, fig. 10; n=10) and from 11–82 years (Draşovean *et al.* in press, fig. 7; n=8) respectively; many houses appear to have lasted from one to two human generations, and not more. All such estimates have to be contextualised. We have suggested that some houses in the early stages of tell development could have been deliberately abandoned in order to create memory and renown (Draşovean *et al.* in press), and the lives of houses in the late stages of the history of the Vinča-Belo Brdo tell could have been foreshortened by the circumstances of very unsettled times (Tasić *et al.* 2015). Short house lives, of fewer than 20 years, also appear to be the norm in the Alpine foreland, on the basis of precise dendrochronology (Hofmann *et al.* 2016). So it appears likely, though there is much scope for variation, that the Neolithic house was frequently not a long-lived phenomenon, even when it was solidly constructed. If such estimates are robust, we need to consider why this would have been so. That involves thinking about not only the individual house and household but also the nature of communities and the specific circumstances in which they found themselves.

There seems no reason why, with adequate maintenance, especially of the roof, constructions such as LBK longhouses could not have been long-lasting. Their shorter lives, if that is what they normally had, must therefore be due to the social context in which they were built and used. People may have chosen to relocate buildings (and indeed whole settlements) for other kinds of practical reasons, including to escape infestation and unsanitary conditions (Whittle 1997). There are also well documented ethnographic cases where the death of household heads, and the associated pollution, are sufficient motive to abandon particular buildings. A well-known counter-example is the Zafamaniry house in Madagascar, which can endure in parallel with long-lasting marriage (Bloch 1995).

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There is no specific evidence from individual houses at Versend-Gilencsa, and rarely elsewhere, which enables us to get closer to these kind of factors, but it seems that we have to take into account flexibility and fluidity in household composition and durability. We can also consider both the wider context of groups of houses, and the circumstances in which they were built and used. The closely set rows at Versend-Gilencsa surely project a strong sense of community. From the available evidence, it appears that the rows were more or less fully populated at the same time; only a few relationships (for example, H19 and 20; H14 and 16; Fig. 2) suggest successive building. Setting out rows of houses in the manner seen at Versend-Gilencsa, facing each other across narrow lanes and with their long sides very close to neighbours on both sides, was surely a very deliberate act of community construction. This claim gains extra force from considering earlier settlement history in the region, when many occupations of both the Starčevo and Körös cultures might have had a less concentrated character (Bánffy *et al.* 2010). By analogy, whatever the situation may be with individual houses and households, it is likely that community was often fragile and riven with difference; in settling in the same place, people probably had to work hard to stay together (Amit 2002; Birch 2013: 8; Canuto & Yaeger 2000; Cohen 1985). In the American Southwest, early Mesa Verde villages have been called 'social tinderboxes', which rarely lasted beyond 30–70 years or one–three generations (established with precision through dendrochronology) (Wilshusen & Potter 2010, 178).

Now in the case of tell settlements, while individual house lives may have often been relatively short, occupation of place was in fact maintained, on a scale of centuries (Tasić *et al.* 2015; 2016; Draşovean *et al.* in press). There is also good reason to think that many 'flat' settlements, including plenty of LBK examples, lasted for considerable periods of time. Close by, for example, formal modelling suggests that the occupation of Szederkény-Kukorica-dűlő lasted from the late 54th to the early 52nd centuries cal BC (Jakucs *et al.* 2016); Tolna-Mözs, about 50 km further to the north along the Danube (Marton & Oross 2012), is another useful point of comparison. Szederkény, which combines the presence of longhouses otherwise characteristic of the LBK orbit and pottery in early Vinča style, was probably founded soon after the initial LBK 'diaspora' spread across central Europe and beyond (Jakucs *et al.* 2016: fig. 24), in circumstances of considerable social, cultural and demographic flux. That kind of circumstance looks to have continued into the 53rd century cal BC, if the range of ceramic styles seen also at Versend-Gilencsa is anything to go by. We need to allow for the possibility that some villages came to an end much more quickly than others. In some cases, this may have been due to internal tensions; in others, shifting alliances or aggression from outside could have been the cause. There is so far no specific evidence from Versend-Gilencsa which might allow us to choose between these kinds of possibilities, though the ceramic variability at the site could evoke the co-presence of social groups with diverse cultural backgrounds and allegiances; from this mix might have stemmed difficulties in maintaining community. In assessing the relevance of the modelled estimates presented here for both longhouse and site duration, the possibilities of premature ending or some kind of social failure, in contingent circumstances, have to be kept in mind. It remains to be seen whether similar results will be found for row settlements elsewhere and in other situations. But if rows at one level were all about communal solidarity, it could be that they were also more prone to tensions and fission, and therefore shorter lives, than the more independent and autonomous social units implied in the *Hofplatzmodell*.

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[1] Two of the articulating bone groups from pit 481 (S2 and S3; UBA-22614 and SUERC-67297; Table 1) are clearly of the Avar period and must be from a feature cut into the eastern longpit of H5 that was not recognised during excavation. The single articulating bone group from the western longpit of H11 (pit 167, S1; UBA-22604; Table 1) is of late Copper Age and must similarly be from an unrecognised later feature cut into the longpit.

[2] A variant Model 3 (Versend_Model_3.oxcal), which splits the settlement into its eastern and western parts, has good overall agreement (Amodel: 63), with the same three measurements having poor individual agreement (*UBA-22596, A: 44; UBA-22602, A: 47, and SUERC-58578, A: 4*). It has poor convergence (C: 83), however, even when calculated with a minimum of 20M passes.

[3] The two measurements from longpit 532 must relate to the use of H1 or H2, although as this feature lay between these structures, it is not possible to tell to which house this duration relates.

[4] Although the dated samples derive from the infilling of the longpits and so strictly only provide *termini ante quos* for the construction of any individual house, the samples all derive from the period of use of the settlement and the modelling approach adopted takes account of the fact that it is extremely unlikely that the first material deposited in the settlement is one of the 53 samples we have chosen to date (Buck *et al.* 1992). Similarly, although machining may have removed the upper parts of features, it is extremely unlikely that none of the latest features on the site were cut to the depth at which recording began. The latest features would thus also have been proportionately sampled, and allowance made for undated activity made by the modelling approach adopted.

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Fig. 1. Map showing the location of the principal sites mentioned in the text.

Fig. 2. Layout of the eastern part of the Versend settlement, with at least four rows of longhouse clearly visible; whether the northern row is a single unit is open to question.

Fig. 3. The range of pottery styles and other material recovered from the eastern part of Versend. A: Starčevo pottery style; B: early LBK pottery style; C: Vinča pottery style.

Fig 4. The proportions of different pottery styles by row and longhouse in the eastern part of Versend.

Fig. 5. Probability distributions of dates from the settlement at Versend; each distribution represents the relative probability than an event occurs at a particular time. For each of the radiocarbon dates two distributions have been plotted, one in outline, which is the result of simple radiocarbon calibration, and a solid one, which is 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 Versend settlement*' is the estimated date when the settlement was established. Posterior/prior outlier probabilities are shown square brackets. The structure of the model is shown by the brackets and OxCal keywords down the left-hand side of Figs 5 and 6. The model is defined exactly by the OxCal code provided as supplementary information (Versend_Model_4.oxcal).

Fig. 6. Probability distribution of dates from burials at Versend. The format is as for Fig. 5. The structure of the model is shown by the brackets and OxCal keywords down the left-hand side of Figs 5 and 6. The model is defined exactly by the OxCal code provided as supplementary information (Versend_Model_4.oxcal).

Fig. 7. Key parameters for the first and last dated events for houses with more than one radiocarbon date and for the establishment and abandonment of the settlement, derived from Model 4 (Versend_Model_4.oxcal).

Fig. 8. Key parameters for duration of houses with more than one radiocarbon date and the overall settlement, derived from Model 4 (Versend_Model_4.oxcal).

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Table 1. Radiocarbon and stable isotopic measurements from Versend-Gilencsa, replicate measurements have been tested for statistical consistent and combined by taking a weighted mean before calibration as described by Ward & Wilson (1978; T'(5%)=3.8, ν=1 for all).

Laboratory number	Sample reference	Context and associations	Material	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{13}C_{AMS}$ (‰)	$\delta^{15}N$ (‰)	C/N ratio	Radiocarbon Age (BP)
Eastern								
SUERC-67296	Pit 114 S1	Western longpit of H10, in the middle of row 3. With Starčevo-like decoration and shapes, early Vinča-type biconical bowls and red slipped pedestals, some typical early LBK type vessel and incised decoration	Cattle, left first phalanx with articulating second phalanx	−19.9±0.2		9.0±0.3	3.3	6258±32
SUERC-58556	Pit 114 S2 (i)	Western longpit of H10, in the middle of row 3. With Starčevo-like decoration and shapes, early Vinča-type biconical bowls and red slipped pedestals, some typical early LBK type vessel and incised decoration	Cattle, left proximal radius with articulating proximal ulna	−20.2±0.2		8.9±0.3	3.2	6267±34
UBA-22601	Pit 114 S2 (ii)	Replicate of SUERC-58556	Cattle, left proximal radius with articulating proximal ulna	−20.3±0.22		8.8±0.15	3.2	6276±42
^{14}C: 6271±27 BP, T'=0.0; $\delta^{13}C$: −20.3±0.15‰, T'=0.1; $\delta^{15}N$: 8.8±0.13‰, T'=0.1								
SUERC-58557	Pit 114 S3	Western longpit of H10, in the middle of row 3. With Starčevo-like decoration and shapes, early Vinča-type biconical bowls and red slipped pedestals, some typical early LBK type vessel and incised decoration	Cattle, right distal humerus diaphysis with articulating unfused epiphysis	−19.5±0.2		8.1±0.3	3.3	6185±34
UBA-22602	Pit 128 S1	Eastern longpit of H9, in row 3. Some neolithic pottery fragment and chipped stone, no diagnostic pottery associated	Cattle, right distal tibia with articulating proximal astragalus	−20.3±0.22		7.6±0.15	3.2	6109±44
SUERC-58558	Pit 128 S2	Eastern longpit of H9, in row 3. Some neolithic pottery fragment and chipped stone, no diagnostic pottery associated	Cattle, left distal humerus with articulating proximal radius	−19.8±0.2		5.7±0.3	3.2	6306±32
SUERC-67285	Pit 128 S3	Eastern longpit of H9, in row 3. Some neolithic pottery fragment and chipped stone, no diagnostic pottery associated	Cattle, left astragalus with articulating navicularcuboid	−20.3±0.2		8.6±0.3	3.3	6171±30

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SUERC-58559	Pit 148 S1 (i)	Western longpit of H11, in row 3. With Starčevo-like decoration and shapes, early Vinča-type biconical bowls, red slipped pedestals, and early Vinča-type figurine, a few typical early LBK-type incised decoration;	Cattle, articulating right first and second phalanges	−20.6±0.2		7.8±0.3	3.2	6229±31
UBA-22603	Pit 148 S1 (ii)	Replicate of SUERC-58559	Cattle, articulating right first and second phalanges	−20.8±0.22		8.7±0.15	3.2	6198±41
^{14}C: 6218±25 BP, T'=0.4; δ^{13}C: −20.7±0.15‰, T'=0.5; δ^{15}N: 8.5±0.13‰, T'=**7.2**								
SUERC-58560	Pit 163 S1	Eastern longpit of H11, in row 3. With Starčevo-like decoration and shapes, early Vinča-type pedestalled vessels	Cattle, right second phalanx with articulating third phalanx	−19.3±0.2		9.1±0.3	3.3	6257±33
UBA-22604	Pit 167 S1	Western longpit of H11, in row 3, cut by the late Neolithic (Lengyel Culture) enclosure. With Starčevo-like decoration and shapes, early Vinča-type biconical vessels, red slipped pedestals and figurine, a few typical early LBK type incised decoration	Cattle, articulating right first and second phalanges	−20.5±0.22		8.0±0.15	3.2	5021±39
SUERC-67301	Pit 319 S1	Pit 319 is probably associated to the House H21 (part of the longpit, flanking the house?), located next to the House's eastern side. No diagnostic material associated	Sheep/goat left distal humerus with articulating proximal radius	−19.9±0.2		7.2±0.3	3.3	6155±32
SUERC-58564	Pit 342 S1 (i)	Eastern longpit of H7, in row 2. Vessel fragments with typical early Vinča-type incised and dotted decoration; a red-slipped pedestal	Cattle, articulating right first and second phalanges	−19.9±0.2		7.8±0.3	3.2	6270±32
UBA-22605	Pit 342 S1 (ii)	Replicate of SUERC-58564	Cattle, articulating right first and second phalanges	−20.0±0.22		7.6±0.15	3.2	6253±58
^{14}C: 6266±29 BP, T'=0.1; δ^{13}C: −19.9±0.15‰, T'=0.1; δ^{15}N: 7.6±0.13‰, T'=0.4								
UBA-22606	Pit 346 S1	Western longpit of H7, in row 2. With early Vinča-type red-slipped pedestals, a few typical early LBK-type incised decoration	Cattle, articulating right first and second phalanges	−19.9±0.22		9.4±0.15	3.2	6272±44

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SUERC-67286	Pit 345 S1	Pit 345 is the shared longpit of Houses H12 and H13, located between the houses. With early LBK type incised decoration	Cattle, articulating right second and third phalanges	−19.5±0.2		9.3±0.3	3.4	6163±30
UBA-22607	Pit 362 S1	Eastern longpit of H12, in row 3. Eastern longpit of H12, in row 3. Early Vinča-type figurine, biconical bowl and red slipped pedestalled vessels, vessel fragments with early LBK-like incised decoration and goat protome Starčevo-like low pedestal and barbotine decoration	Cattle, left distal tibia unfused epiphysis with articulating proximal astragalus	−19.0±0.22		8.2±0.15	3.2	6251±43
SUERC-58565	Pit 362 S3	Eastern longpit of H12, in row 3. Early Vinča-type figurine, biconical bowl and red slipped pedestalled vessels, vessel fragments with early LBK-like incised decoration and goat protome Starčevo-like low pedestal and barbotine decoration	Cattle, articulating right second and third phalanges	−19.5±0.2		8.8±0.3	3.3	6168±32
SUERC-58566	Pit 395 S1 (i)	Eastern longpit of H19, in row 4, containing an assemblage of Neolithic pottery with a few diagnostic early Vinča sherds	Cattle, articulating left first and second phalanges	−20.2±0.2		7.0±0.3	3.3	6250±33
UBA-22609	Pit 395 S1 (ii)	Replicate of SUERC-58566	Cattle, articulating left first and second phalanges	−20.4±0.22		6.9±0.15	3.2	6348±45
^{14}C: 6285±27 BP, T'=3.1; δ^{13}C: −20.3±0.15‰, T'=0.5; δ^{15}N: 6.9±0.13‰, T'=0.1								
SUERC-67287	Pit 396 S1	Pit 396 is a rounded pit, associated with House H18, dug next to the western wall of the house, and probably belonging to the longpit flanking the house. With early Vinča-type vessel forms and altar fragment	Cattle, articulating atlas and axis	−20.7±0.2		8.3±0.3	3.4	6233±30
SUERC-67288	Pit 396 S2	Pit 396 is a rounded pit, associated with House H18, dug next to the western wall of the house, and probably belonging to the longpit flanking the house. With early Vinča-type vessel forms and altar fragment	Cattle, articulating left first and second phalanges	−20.0±0.2		6.9±0.3	3.3	6227±30
SUERC-58567	Pit 414 S1	Eastern longpit of H18, in row 4. Mainly early Vinča-type pottery and altar fragment; a few typical early LBK-like incised sherds	Cattle, articulating right first and second phalanges	−20.6±0.2		7.8±0.3	3.3	6211±32
UBA-22610	Pit 414 S2	Eastern longpit of H18, in row 4. Mainly early Vinča-type pottery and altar fragment; a few typical early LBK-like incised sherds	Cattle, articulating left first and second phalanges	−20.7±0.22		8.1±0.15	3.2	6141±43

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MAMS-14830	Grave 415	Grave 415, uncovered from a layer below Pit 414, which is the eastern longpit of H18, in row 4	Human, adult female, rib		−14.7		3.2	6321±28
SUERC-58568	Pit 420 S1 (i)	Western longpit of H17, in row 4. Mainly early Vinča-type pottery and bone spoon, a few early LBK type incised pottery fragment	Cattle, articulating right first and second phalanges	−19.9±0.2		7.7±0.3	3.3	6235±31
UBA-22611	Pit 420 S1 (ii)	Replicate of SUERC-58568	Cattle, articulating right first and second phalanges	−20.2±0.22		8.0±0.15	3.2	6201±49
^{14}C: 6225±27 BP, T'=0.3; δ^{13}C: −20.0±0.15‰, T'=1.0; δ^{15}N: 7.9±0.13‰, T'=0.8								
SUERC-67289	Pit 434 S1	Western long-pit of H20. No diagnostic material associated	Cattle, right second phalanx with articulating third phalanx	−20.4±0.2		8.6±0.3	3.3	6220±30
SUERC-58569	Pit 443 S1	Southern part of the western longpit of H15, in row 3. With very typical early Vinča-type biconical bowls, red slipped pedestalled vessels and fragments of a figurine	Sheep/goat, articulating thoracic vertebrae	−20.5±0.2		8.0±0.3	3.2	6247±33
UBA-22612	Pit 451 S1	Western longpit of H6, in the eastern part of row 3. Fragments of early Vinča-type (Vinča A) conical bowls and red-slipped pedestal; early LBK-style (and some Alföld LBK) vessels	Sheep/goat, right proximal ulna with articulating radius	−20.2±0.22		6.8±0.15	3.2	6165±40
SUERC-58570	Pit 451 S2	Western longpit of H6, in the eastern part of row 3. Fragments of early Vinča-type (Vinča A) conical bowls and red-slipped pedestal; early LBK-style (and some Alföld LBK) vessels	Cattle, left unfused first phalanx proximal epiphysis with articulating with unfused diaphysis	−20.6±0.2		10.0±0.3	3.3	6299±32
UBA-22613	Pit 465 S1	Eastern longpit of H6, in the eastern part of row 3. No diagnostic material associated	Cattle, right astragalus with articulating navicular cuboid	−20.3±0.22		9.6±0.15	3.2	6257±41
SUERC-67299	Pit 476 S1	Eastern longpit of H4, in row 2. With a few diagnostic early Vinča and early LBK-type pottery	Sheep/goat atlas with articulating axis	−20.7±0.2		7.1±0.3	3.4	6152±32

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SUERC-58574	Pit 481 S1	Eastern longpit of H5, in row 2. Fragments of early Vinča-type (Vinča A) conical bowls anda red-slipped pedestal	Cattle, articulating left second and third phalanges	−20.1±0.2		8.5±0.3	3.3	6198±32
UBA-22614	Pit 481 S2	Eastern longpit of H5, in row 2. Fragments of early Vinča-type (Vinča A) conical bowls anda red-slipped pedestal	Sheep/goat, left humerus with articulating proximal radius (with refitting unfused epiphysis)	−19.9±0.22		11.9±0.15	3.2	1222±29
SUERC-67297	Pit 481 S3	Eastern longpit of H5, in row 2. Fragments of early Vinča-type (Vinča A) conical bowls anda red-slipped pedestal	Sheep size unfused thoracic vertebra with unfused epiphysis	−19.8±0.2		10.1±0.3	3.3	1211±29
SUERC-67298	Pit 486 S1	Western longpit of H5, in row 2. Fragments of early Vinča-type (Vinča A) conical bowls; vessel fragments with incised and dotted decoration; a red-slipped pedestal, a few early LBK-type incised fragments	Cattle, right first phalanx with articulating second phalanx	−20.5±0.2		6.4±0.3	3.3	6167±31
SUERC-58575	Pit 486 S3	Western longpit of H5, in row 2. Fragments of early Vinča-type (Vinča A) conical bowls; vessel fragments with incised and dotted decoration; a red-slipped pedestal, a few early LBK-type incised fragments	Pig, left distal tibia with articulating astragalus	−20.6±0.2		10.3±0.3	3.3	6264±33
SUERC-58576	Pit 496 S1	Western longpit of H3, at the eastern end of row 3. With a few early LBK-like pottery fragmenst and incised altar fragment	Cattle, left unfused first phalanx proximal epiphysis with articulating with unfused diaphysis	−19.8±0.2		8.2±0.3	3.3	6180±32
SUERC-67290	Pit 496 S3	Western longpit of H3, at the eastern end of row 3. With a few early LBK-like pottery fragmenst and incised altar fragment	Cattle, right first phalanx with arrticulating second phalanx	−20.9±0.2		7.0±0.3	3.3	6198±29
SUERC-67291	Pit 497 S1	Northern part of the western long-pit of House H3, at the eastern end of row 3. With a few early LBK-style incised pottery fragment and a polished stone adze	Cattle atlas with articulating axis	−20.2±0.2		6.3±0.3	3.3	4150±31

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SUERC-67295	Pit 497 S2	Northern part of the western long-pit of House H3, at the eastern end of row 3. With a few early LBK-style incised pottery fragment and a polished stone adze	Cattle, right metacarpal with unfused diaphysis with articulating unfused distal epiphysis	−21.4±0.2		7.9±0.3	3.4	6257±32
UBA-22616	Pit 514 S1	Eastern longpit of H3, at the eastern end of row 3. No diagnostic pottery associated	Cattle, articulating right first and second phalanges	−19.3±0.22		8.2±0.15	3.3	6172±38
SUERC-67279	Pit 522 S1	Northern part of the western longpit of H15, in row 3. With large amount of very typical early Vinča-type pottery and figurine; some fragments with typical early LBK-type incised decoration	Cattle, articulating left first and second phalanges	−20.8±0.2		7.3±0.3	3.4	6247±29
SUERC-67280	Pit 522 S2	Northern part of the western longpit of H15, in row 3. With large amount of very typical early Vinča-type pottery and figurine; some fragments with typical early LBK-type incised decoration	Cattle, right astragalus with articulating navicularcuboid	−20.8±0.2		9.1±0.3	3.5	6260±29
SUERC-58578	Pit 522 S3	Northern part of the western longpit of H15, in row 3. With large amount of very typical early Vinča-type pottery and figurine; some fragments with typical early LBK-type incised decoration	Cattle, left unfused proximal tibia diaphysis with articulating unfused proximal epiphysis	−19.3±0.2		6.6±0.3	3.3	6399±31
SUERC-58577	Pit 532 S1	Shared longpit between H1 and H2, in row 1. Fragments of early Vinča-like biconical bowls and pedestalled vessels, fragments of an incised altar	Cattle, left distal tibia with articulating proximal astragalus	−20.9±0.2		6.0±0.3	3.3	6226±32
UBA-22617	Pit 532 S2	Shared longpit between H1 and H2, in row 1. Fragments of early Vinča-like biconical bowls and pedestalled vessels, fragments of an incised altar	Cattle, left unfused metacarpal diaphysis with refitting distal unfused epiphysis	−18.1±0.22		7.7±0.15	3.2	6198±39
SUERC-67300	Pit 587 S1	Northern part of the western longpit of H15, in row 3. Large amount of very typical early Vinča-type pottery; some Starčevo-like pottery form and decoration; a few typical LBK-type incised fragment	Sheep/goat right unfused first phalanx epiphysis with articulating unfused diaphysis	−18.9±0.2		9.0±0.3	3.2	6238±29
SUERC-58579	Pit 587 S2	Northern part of the western longpit of H15, in row 3. Large amount of very typical early Vinča-type pottery; some Starčevo-like	Cattle, articulating left second and third phalanges	−20.0±0.2		6.5±0.3	3.3	6305±31

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		pottery form and decoration; a few typical LBK-type incised fragment						
Western								
SUERC-58550	Pit 1048 S1	Pit 1048. Contained some typical early Sopot/Ražište-type pottery and some LBK-like (Malo Korenovo-style) pottery	Cattle, left distal humerus with articulating proximal radius	−20.3±0.2		9.6±0.3	3.3	6266±31
SUERC-67281	Pit 1048 S2	Pit 1048. Contained some typical early Sopot/Ražište-type pottery and some LBK-like (Malo Korenovo-style) pottery	Cattle, articulating right second and third phalanges	−20.1±0.2		10.4±0.3	3.3	6162±29
UBA-22598	Pit 1048 S3	Pit 1048. Contained some typical early Sopot/Ražište-type pottery and some LBK-like (Malo Korenovo-style) pottery	Cattle, distal left tibia with articulating proximal astragalus	−20.1±0.22		9.2±0.15	3.2	6166±50
SUERC-67305	Grave 1049 S1	Grave 1049 is a crouched skeleton lying on its left side, which cuts pit-complex 1073.	Human, maturus male, rib	−19.9±0.2		10.4±0.3	3.2	6059±29
SUERC-67306	Grave 1078 S1	Grave 1078 is a crouched skeleton lying on its right side, which cuts pit complex 1113. Pit 1113 contained some typical Vinča-style red-slipped pedestal vessels.	Human, adult male, rib	−19.5±0.2		9.7±0.3	3.3	6047±29
SUERC-67307	Grave 1121 S1	Grave 1121 is a crouched skeleton lying on its right side, which cuts pit complex 1123. Pit 1123 contained large amount of very typical early Sopot/Ražište-type	Human, juvenis, claviculae	−19.5±0.2		9.7±0.3	3.3	6125±29
SUERC-58554	Pit 1123 S1 (i)	Pit complex 1123, in the western part of the excavated area. It contained a large amount of very typical early Sopot/Ražište-type pottery	Cattle, right distal tibia with articulating astragalus	−20.6±0.2		9.4±0.3	3.2	6229±34
UBA-22599	Pit 1123 S1 (ii)	Pit complex 1123, in the western part of the excavated area. It contained a large amount of very typical early Sopot/Ražište-type pottery	Cattle, right distal tibia with articulating astragalus	−20.5±0.22		9.2±0.15	3.2	6172±40
^{14}C: 6205±26 BP, T'=1.2; δ^{13}C: −20.6±0.15‰, T'=0.1; δ^{15}N: 9.2±0.13‰, T'=0.4								
UBA-22596	Grave 1124 S1	Grave 1124 is a crouched skeleton lying on its right side, which cuts the pit complex 1123. Pit 1123 contained large amount of	Human, adult female, right femur	−20.3±0.22		9.8±0.15	3.3	6252±41

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		very typical early Sopot/Ražište-type pottery						
SUERC-58555	Pit 1387 S1	Pit 1387. Contained a large amount of very typical early Sopot/Ražište-type pottery and some LBK-like incised (Malo Korenovo-style) pottery fragment.	Cattle, articulating first and second phalanges	−20.0±0.2		9.1±0.3	3.3	6199±32
UBA-22600	Pit 1387 S2	Pit 1387. Contained a large amount of very typical early Sopot/Ražište-type pottery and some LBK-like incised (Malo Korenovo-style) pottery fragment.	Cattle, articulating left first and second phalanges	−18.7±0.22		9.4±0.15	3.2	6221±40
MAMS-14832	Grave 1394	Grave 1394 is a crouched skeleton lying on its left side, which cuts pit 1387, which contained a large amount of very typical early Sopot/Ražište-type pottery and some LBK-like incised (Malo Korenovo-style) pottery fragment.	Human, maturus female, tibia		−23.4		3.3	6226±30
UBA-22597	Grave 1561 S1	Grave 1561 is a crouched skeleton lying on its left side which cuts the pit-complex 1570, located int he western part of the excavated area.	Human, adult female, left femur	−20.5±0.22		10.2±0.15	3.3	6180±51
SUERC-67308	Grave 1720 S1	Grave 1720 is a crouched skeleton, which cuts pit 1287.	Human, iuvenis, scapula	−19.9±0.2		10.5±0.3	3.2	6166±29
SUERC-67309	Grave 1721 S1	Grave 1721 is a crouched skeleton, which cuts pit 1287.	Human, maturus male, femur	−18.6±0.2		9.4±0.3	3.3	6280±29
SUERC-67310	Grave 1995 S1	Grave 1995 is a crouched skeleton lying on its left side which cuts the pit 1767, located in the western part of the excavated area. It contained a large amount of typical early Sopot/Ražište-type and some LBK-like (Malo Korenovo-style) pottery	Human, adult female, rib	−19.9±0.2		9.6±0.3	3.3	6140±29
MAMS-14833	Grave 2030	Grave 2030 is a crouched skeleton lying on its left side, dug into pit 2034, which contained some typical early Sopot/Ražište-type pottery	Human bone, adult female, cranium		−19.3		3.3	6186±29
MAMS-14831	Unidentified skeleton	The bone material was mistakenly thought to belong to Grave 1163, a child grave	Human, adultus, cranium		−26.8		3.3	6202±31

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		which later proved to be of Avar age. The dated bone was probably came from a Neolithic grave, destroyed by the Avar burial.						

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Table 2. Highest Posterior Density intervals for key parameters from Versend-Gilencsa, derived from Model 4 (Figs 4–5).

Parameter	***Highest Posterior Density interval* (*95% probability*)**	***Highest Posterior Density interval* (*68% probability*)**
start Versend burials	*5395–5225 cal BC*	*5330–5240 cal BC*
end Versend burials	*5040–4815 cal BC*	*4995–4905 cal BC*
use Versend burials	*215–540 years*	*275–415 years*
start Versend settlement	*5305–5280 cal BC (2%*) or *5255–5210 cal BC (93%)*	*5235–5215 cal BC*
end Versend settlement	*5220–5180 cal BC (93%)* or *5150–5115 cal BC (2%)*	*5210–5195 cal BC*
use Versend settlement	*1–70 years (93%)* or *135–185 years (2%)*	*10–35 years*
first H1 or H2	*5245–5200 cal BC*	*5225–5210 cal BC*
last H1 or H2	*5230–5185 cal BC*	*5215–5200 cal BC*
use H1 or H2	*1–40 years*	*1–15 years*
first H3	*5250–5205 cal BC*	*5230–5215 cal BC*
last H3	*5220–5185 cal BC (94%)* or *5170–5140 cal BC (1%)*	*5215–5200 cal BC*
use H3	*1–60 years (94%)* or *75–100 years (1%)*	*1–25 years*
first H5	*5250–5205 cal BC*	*5230–5210 cal BC*
last H5	*5225–5185 cal BC (94%)* or *5175–5155 cal BC (1%)*	*5215–5200 cal BC*
use H5	*1–65 years*	*1–20 years*
first H6	*5255–5210 cal BC*	*5230–5215 cal BC*
last H6	*5230–5180 cal BC*	*5220–5200 cal BC*
use H6	*1–70 years*	*1–25 years*
first H7	*5255–5205 cal BC*	*5230–5215 cal BC*
last H7	*5240–5200 cal BC*	*5225–5210 cal BC*
use H7	*1–25 years*	*1–10 years*
first H9	*5250–5205 cal BC*	*5230–5215 cal BC*
last H9	*5220–5170 cal BC*	*5215–5200 cal BC*
use H9	*1–80 years*	*5–25 years*
first H10	*5260–5210 cal BC*	*5230–5215 cal BC*
last H10	*5230–5185 cal BC*	*5220–5200 cal BC*
use H10	*1–70 years*	*1–20 years*
first H11	*5250–5205 cal BC*	*5230–5210 cal BC*
last H11	*5235–5195 cal BC*	*5220–5205 cal BC*
use H11	*1–35 years*	*1–15 years*
first H12	*5245–5200 cal BC*	*5225–5210 cal BC*
last H12	*5230–5170 cal BC*	*5215–5200 cal BC*
use H12	*1–50 years*	*1–15 years*
first H15	*5285–5265 cal BC (2%)* or *5255–5210 cal BC (93%)*	*5235–5215 cal BC*
last H15	*5230–5195 cal BC*	*5220–5205 cal BC*
use H15	*1–60 years*	*1–20 years*
first H18	*5245–5205 cal BC*	*5225–5210 cal BC*
last H18	*5220–5185 cal BC (94%)* or *5165–5135 cal BC (1%)*	*5215–5200 cal BC*
use H18	*1–70 years*	*1–20 years*

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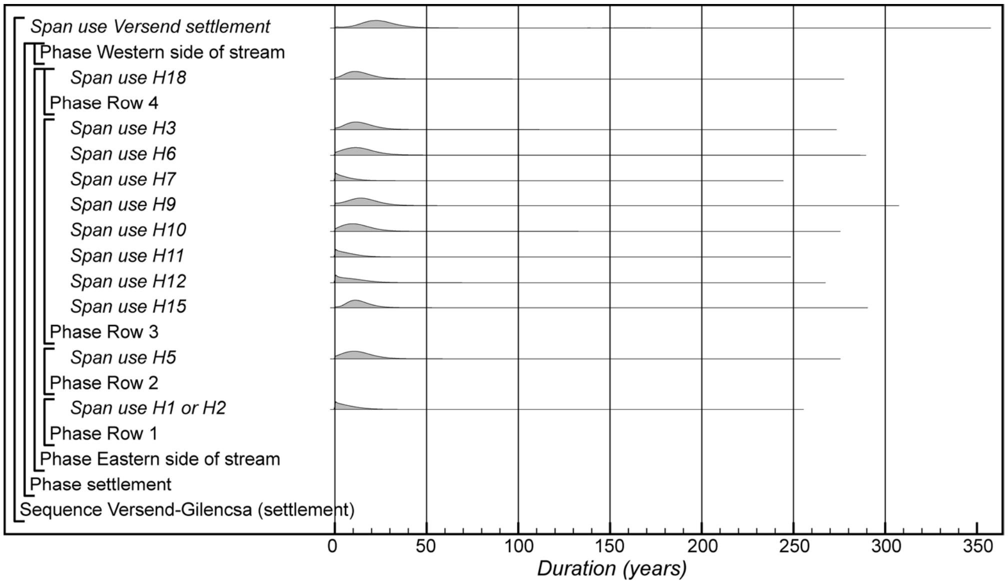

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