Research Article

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Domesticated Water: Four Early Neolithic Wells in Moravia (CZ)

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Abstract: Water wells are the most unique finds from the Early Neolithic period in Central Europe. These features provide unusual insight into societies and their settlements, as well as into the water management process. This article presents the updated results of material analyses and excavations of Early Neolithic wells at Mohelnice, Brno-Bohunice and Uničov in Moravia, Czech Republic. We studied the possibilities of the spatial and temporal distribution of wells on the example of these settlements. The social relation between the large longhouses and the wells in their immediate neighbourhood has not been proven. On the contrary, they could have been communal wells, serving the inhabitants of the entire settlement. Moreover, it turned out that in the Moravian region, geomorphological conditions were a key factor for choosing the location to build a well. By comparing radiocarbon dates, we estimated the time span of the existence of wells with respect to each other and to the settlements. Sealing and repairs of the well constructions prove that the first farmers maintained the wells over a long period of time. Studies of the well's vertical sections shed light on its usage and decline; intentional backfilling of the well seems to have been common. Water management covered an entire cycle of activities, including the making of wooden buckets, which were mainly used for the pulling of water from wells.

Keywords: Linearbandkeramik, water supply, spatial organisation, social behaviour, eastern Central Europe

1 Introduction

Around the mid-sixth millennium BC, the transition to the Neolithic way of life took place in the Middle Danube region (Bánffy & Oross, 2010). This brought the onset of what we now refer to as the Linear Pottery

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Culture (*Linearbandkeramik*, LBK), which has been dated for the region of Central Europe to the period of c. 5400–4800 BC (Manning et al., 2014, p. 1077). The uniformity of architecture, artefacts, burials, subsistence and settlement plans that characterised these communities is extraordinary and represents a further extension of the Neolithic way of life. The sedentary way of life was related to plant cultivation and livestock breeding, and, as a result, the first farmers lived in larger groups and constructed permanent settlements (Barker, 2011; Price, 2000).

Securing a sustainable water source is an important part of the construction of every new settlement. Adequate access to water is essential for human dignity and well-being. Water is not only required for basic daily activities such as hydrating, cooking, washing or hygiene, but is also a key input for food security (United Nations, 2015). The first farmers settled near watercourses, which were not only an important landmark in the landscape, but also a source of water. They needed permanent freshwater sources in close neighbourhood. Other natural sources of water were springs and lakes near settlements (Rulf, 1983). The role of water management increased, entailing the planning, development, distribution and managed usage of water resources. Storage and land-use are the key socioeconomic sectors in which new water techniques influence, trigger and protect new modes in sedentary life. It is especially the storage aspect that makes water a subject of domestication, not to mention the "neolithisation of water" (Gebel, 2004). Enthusiastically, we can say that this was the beginning of taking control over water. The active digging of permanent wells reaching the groundwater level reflects an innovative approach to water provisioning in the first farmers' communities. Such wells provided them with their own water supply. Water in a well can be controlled, unlike water in a river, which is open to pollution. It is a testimony to the hydrological knowledge and technological capacities of the first farmers (Garfinkel, Vered, & Bar-Yosef, 2006).

It can be assumed that socioeconomic behaviour determines how people organise space in a settlement area. How the spatial organisation of the first farmers' settlements was linked to their social organisation is a long-discussed matter (Boelicke, 1982; Lüning, 2005; Rück, 2009). Household was a social and economic unit that was based on production, consumption, distribution and transmission and was not necessarily based on kinship. The social organisation of settlement probably was complex, dynamic and unsteady (Hohle, 2017). So, wells and wells-related architecture could be considered indicators of social complexity and behaviour. Some wells are found in central open spaces within a settlement; therefore, it seems reasonable to classify them as communal installations with unrestricted access. The location of other wells, however, in a variety of enclosed spaces ranging from domestic to ritual buildings, suggests that access rights to their water may have considerably varied. The differences in the location of wells relative to the houses could reflect nuances of social organisation rooted in different regional and cultural traditions within the LBK (Wollenweber, 2016). The egalitarian and non-egalitarian relations are present in all societies, along dimensions of sex, age, ability, health and so on. The food production, including water, was a question of commitment and social relations, about alliance structures and the individuals operating within such structures, not about technology or demography. The leadership, alliance and exchange gave rise to a need for surplus production (Bender, 1978, p. 206). Such evidence strongly suggests that agriculture and hereditary social inequality may be moving hand in hand across the European continent. It may be assumed that the principle of social equality had disappeared by the time of the first farmers and the succeeding periods. However, archaeological evidence for social inequality in early farming societies is inherently difficult to prove (Price, 1995, p. 130), but the general idea of (social) uniformity in the LBK is frequently and critically questioned (Modderman, 1988; Müller, Herrera, & Knossalla, 1996; Shennan, 2018, pp. 86-88).

More than 100 wells from 53 Early Neolithic sites have been documented throughout Europe (Figure 1). In the Czech Republic, LBK wooden wells have been found so far only rarely. The first among the wells dated to the LBK was found at Mohelnice in Moravia (Tichý, 1972a, 1998). One more well was excavated at Most in Northwest Bohemia (Rulf & Velímský, 1993) and another well was discovered in Brno-Bohunice (Přichystal, 2008). Over the past 6 years, three more wells were uncovered: Uničov in Moravia (Vostrovská et al., 2020), Velim in Central Bohemia (Chlup, 2017) and Ostrov in East Bohemia (Rybníček et al., 2020). In this article, we will focus on the Moravian region. We can compare and update the results obtained over the past 50 years. The primary aim is (1) to explore the distribution of wells within the first farmers' settlements,

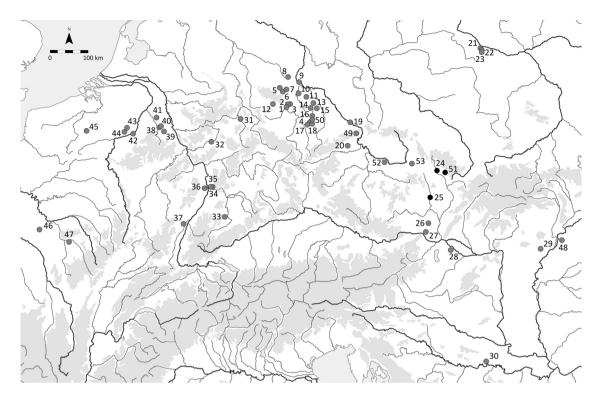


Figure 1: Locations of Early Neolithic wells in Central Europe: (1) Niederröblingen; (2) Riestedt; (3) Emseloh; (4) Rehmsdorf/Rumsdorf; (5) Halberstadt-Sonntagsfeld; (6) Quedlinburg; (7) Gatersleben; (8) Elbeu; (9) Schönebeck (Elbe); (10) Peißen/Bernburg; (11) Weißandt-Gölzau; (12) Nordhausen; (13) Brodau; (14) Altscherbitz; (15) Leipzig-Plaußig; (16) Eythra/Zwenkau; (17) Droßdorf-Peres; (18) Meuselwitz-Zipsendorf; (19) Dresden-Cotta; (20) Most; (21) Smólsk; (22) Kruszyn; (23) Ludwinowo; (24) Mohelnice; (25) Brno-Bohunice; (26) Schletz/Asparn (a. d. Zaya); (27) Würnitz; (28) Lébény; (29) Füzesabony-Gubakút; (30) Zadubravlje; (31) Hesserode; (32) Wetzlar-Dalheim; (33) Gerlingen; (34) Mannheim-Wallstadt/Straßenheim; (35) Mannheim-Vogelstang; (36) Fußgönheim; (37) Ittenheim; (38) Arnoldsweiler-Ellebach; (39) Müddersheim; (40) Morschenich; (41) Erkelenz-Kückhoven; (42) Hollogne-Douze Bonniers; (43) Oleye-Al Zèpe; (44) Darion-Colia, Hesbaye; (45) Ormeignies; (46) Échilleuses; (47) Cheny; (48) Sajószentpéter; (49) Dresden-Nickern; (50) Großstolpen; (51) Uničov; (52) Velim; and (53) Ostrov (nos. 1–49 according to Wollenweber, 2016).

inclusive of these particular questions: how did the first farmers choose the location to build a well?; geomorphological and social parameters were decisive for the selection, but which prevailed?; do wells hold some clues regarding the phenomenon of social inequality? Second, we aim (2) to study how water was managed at the beginning of the Neolithic, which encompasses the use of surface water resources, construction, use and decline of wells, and water handling.

2 Material and Methods

2.1 Sites and Fieldwork

2.1.1 Mohelnice-U Cukrovaru

The town of Mohelnice lies in the north-eastern corner of Central Moravia, at the foot of the Nízký Jeseník Upland (Culek et al., 2005). Neolithic settlement was situated about 200 m away from the present-day bed of the Morava River and about 2 km east of Mohelnice. The subsoil is composed of sandy-gravelly fluvial deposits, which are mostly surrounded by loess covered with fertile soil. The Morava River 1,000 m away

represented the closest surface water source in the Early Neolithic period. The settlement extended around a hilltop at an elevation of 270 m a.s.l. The hill sloped down to the Morava River, to the elevations of 252–255 m a.s.l.

The settlement area is today already dug off by gravel mining. Archaeological rescue excavations were carried out here in 1953–1971. The excavations have yielded 81 large features and 256 small pits dating from the periods of the LBK and Lengyel Cultures. Intrusions were represented by pottery of the Bell Beaker Culture and Urnfield Culture. At least 21 longhouse layouts were detected. Functionally seen, the archaeological features can be divided into clay pits, ovens, postholes and four water wells. Four prehistoric wells were discovered in areas of about 2 ha, which were excavated in 1971–1972 (Figure 2). This paper is mainly dealing with feature No. 224 (CCXXIV), belonging to LBK. Another two explored wells (Nos. 254 and 255) are dated to the Eneolithic and the last well No. 256 with no artefacts in the fill probably falls within the Bronze Age. All wells were arranged in a row running from north to south, where the Early Neolithic well was situated some distance apart from the others. All wells were located in the northern half of the total examined area. This part of the site was uncovered as a whole (Tichý, 1977). The Early Neolithic settlement therefore seems to fade out in the northern part.

The well No. 224 was discovered as a "ring ditch" sized 300 cm × 300 cm. Annular form has already appeared on the ground surface and a loess ring of 1 m in diameter was then visible in the dark fill (Figure 3). The feature was cleared out to the depth of 230 cm. The well pit has narrowed step-like down to the bottom. The fill consisted of black-gray coloured loess; a light-coloured loess intrusion of about 100 cm in diameter was only visible in the middle of the pit ground plan. The dark fill sloped funnel-like down to the bottom of the feature. At the depth of 150 cm already, resin-black fill appeared in the middle. The builders of the well had to dig through two layers of gravel. Gravel cobbles were scattered within all layers of the well fill. This upper part of the well was mechanically removed to the depth of 300 cm for safety reasons, in order to enable further digging. However, this action has damaged the wooden posts, which were detected at the depth of 480 cm. The bottom part of the well was filled with sticky mud containing finds from organic substances and a rectangular wooden casing was preserved. The casing was made from oak boards 3-5 cm thick, with the preserved length of about 20 cm. These boards were embedded between 16 wooden posts so that a space of about $100 \text{ cm} \times 100 \text{ cm}$ was created. The type of corner joints in this framing is not known with certainty. However, there was a protruding board on the northern side. The walls exhibited vertical cavities of 15-20 cm in diameter, probably from rotten posts. A total of 52 LBK ceramic fragments were found in the whole fill from the uppermost layers down to the bottom, both out- and inside the wooden casing, also between the pit wall and the timber framing (Figures 4 and 5). A saddle quern was found 140 cm deep inside the feature. The well fill has also yielded unique finds of wooden objects - ca. 90 remnants of water buckets. Animal bones were mainly found at the depth of 450-500 cm (Tichý, 1970, 1971, 1972a, 1977).

Mechanical digging in the second layer on the groundwater in well No. 254 has yielded Eneolithic pottery and preserved pieces of wood. A mechanical digger disturbed another well No. 255 with wood remnants. The construction of this well consisted of a hollow oak tree trunk of 60 cm in height and 65 cm in diameter, with distinct traces of fire. This well was also recessed into the same gravelly-clayey subsoil as the other wells. Another wood remnants were found outside the tree trunk in the north-western wall. Inside the tree trunk, fragments of a large storage jar of Funnel Beaker Culture were found. Fragments of jug-shaped vessels were also found outside the tree trunk. The well No. 256 was detected south of the well No. 254. However, there was a danger that the bank could slide down, so that only several large wood pieces were saved and the shape of the feature was not identified in its entirety. Only a few ceramic shards were found (Tichý, 1970, 1971).

2.1.2 Brno-Bohunice

Settlement activities were mainly concentrated in the Bohunice plateau, slightly inclined to the northeast, with elevations between 276 and 292 m a.s.l. This loess-covered triangular plateau is bordered on the north-



Figure 2: Linearbandkeramik settlement and all the prehistoric wells at the Mohelnice site.

eastern side by the rugged Červený kopec hill (Culek et al., 2005). On the northern side slope relatively steeply down to the river Svratka and on the eastern side they rather moderately fall down to the river Leskava. The height difference above the valley bottoms of both above-mentioned rivers varies between 60

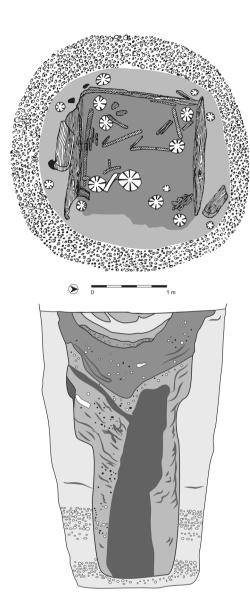


Figure 3: Ground plan and vertical section of the Mohelnice well No. 224.

and 70 m. Easier accessible surface water sources were represented, for example, by the Čertík stream about 1,000 m away in the northern part of the plateau.

The site was already discovered in 1971 during construction of the motorway D1. To this day, more than 4,400 sunken archaeological features, at least 50 longhouse layouts, storage pits and ovens were detected on a total area of about 11 ha (Figure 6) during implementation of individual investment and construction projects (Přichystal, 2008; Tichý, 1972b). The existing research results show that this strategic location was occupied most intensively in the Neolithic (LBK, Lengyel Culture) and Eneolithic periods (Jordanów Culture, Jevišovice Culture, Bell Beaker Culture) and sporadically also in the Palaeolithic, Bronze Age, Hallstatt period and Early Middle Ages. The central part of the site was enclosed by a 250–400 cm wide and up to 100 cm deep U-shaped ditch (feature 513) with flat bottom, which was paralleled at a distance of about 300 cm by a simple internal wooden palisade. The enclosure had the form of a half ellipse sized ca. 265 m \times 285 m with the main axis oriented in SW–NE direction. The central enclosed area was only entered through two gaps in the ditch; one on the northern side and the other on the south-eastern side. Apart from these two main entrances, another four gaps were detected on the northern and eastern sides of the palisade,

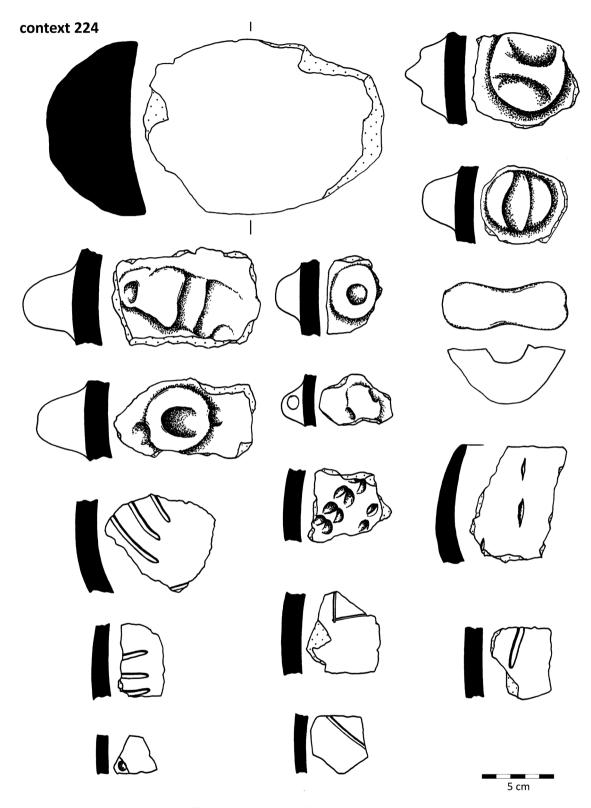


Figure 4: Finds of LBK pottery from the fill of the Mohelnice well No. 224.

where always one of its ends was bent inwards and was extended behind the other end, forming a short and very narrow corridor (Přichystal, 2008). Although the studied area is relatively large in spatial extent, we still lack any burial ground. A small segment of population was buried directly within the settlement, which

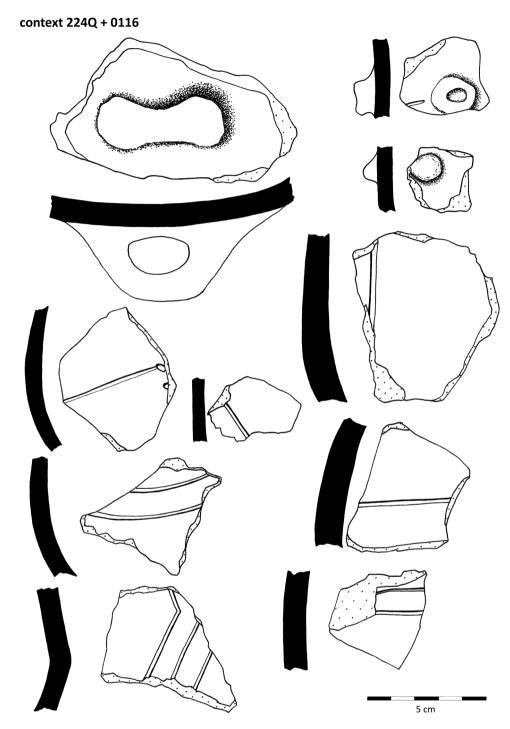


Figure 5: Finds of LBK pottery from square No. 116 above the Mohelnice well No. 224.

is illustrated by one supposed cremation grave and 12 inhumation graves (Dočkalová & Čižmář, 2008, pp. 43–46).

A water well (feature 3579) was uncovered and partly explored in 2007. After removal of about 50 cm thick soil layer, it appeared on the surface of the subsoil loess as an irregularly oval ground plan sized ca. $820 \text{ cm} \times 690 \text{ cm}$, which was disturbed on the north-eastern and southern sides by pits from a later chronological horizon (Figure 7). The upper part of the well pit was funnel-shaped and filled with thick layers of dark earth sinking down in the middle, containing a large amount of archaeological finds. From



Figure 6: Linearbandkeramik settlement at the Brno-Bohunice site.

the depth of 150 cm, the walls then fell vertically down and formed an approximately cylindrical shaft of less than 500 cm in diameter. The fill contained many layers, which probably emerged by gradual backfilling of the defunct well combined with spontaneous sedimentation and destruction of its mouth. At a depth of 350 cm, the stabilised groundwater level was detected, which initially complicated and then totally hindered the continuation of research works, despite using a pump. The total depth of the well can thus only be estimated based on a manual test borehole as more than 550 cm below the topsoil removal level, which is also indirectly confirmed by small lumps of gray clay in the middle and bottom parts of the fill. This clay, according to a geological survey, is found in the immediate neighbourhood at the base of the underlying loess soil, approximately 640–690 cm below the original ground surface. This well was undoubtedly fed by groundwater resting on the boundary between permeable Quaternary loamy sediments and impermeable Tertiary clays. A total of 3,450 pieces of LBK pottery, 2,111 pieces of clay daub, 829 pieces of bones, 240 stone artefacts and a few charcoal pieces are registered from the well.

More than 90% of the finds come from the upper part of the backfill (depth 0–110 cm; contexts 3473, 3490, and 3491; Figures 8 and 9).

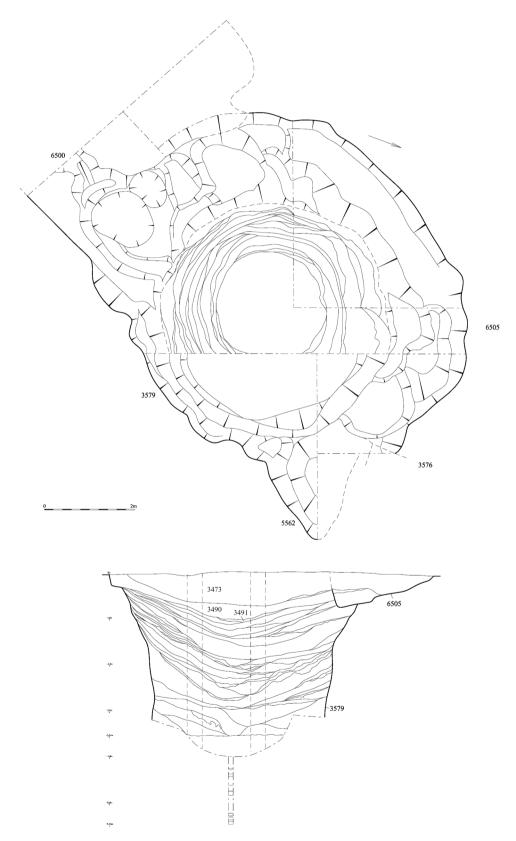


Figure 7: Ground plan and vertical section of the Brno-Bohunice well.

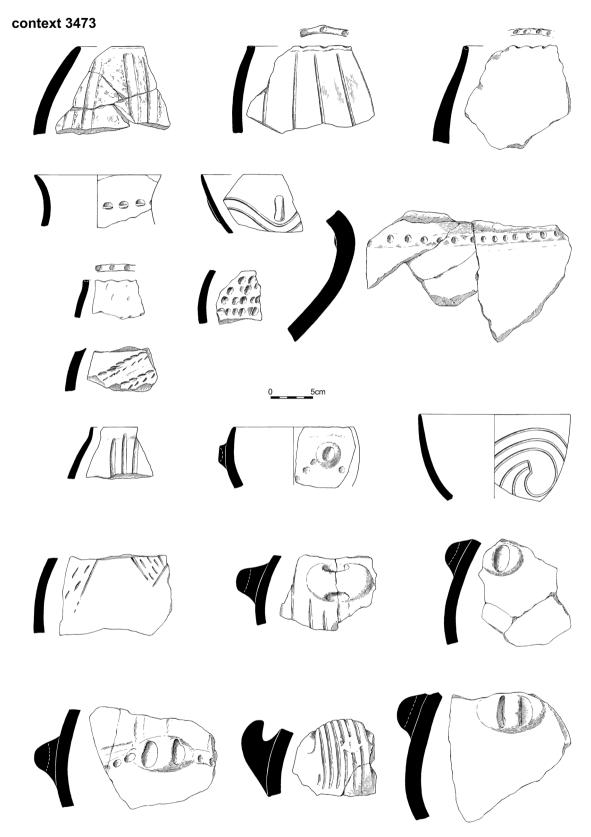


Figure 8: Finds of LBK pottery from the fill of the Brno-Bohunice well (context No. 3473).

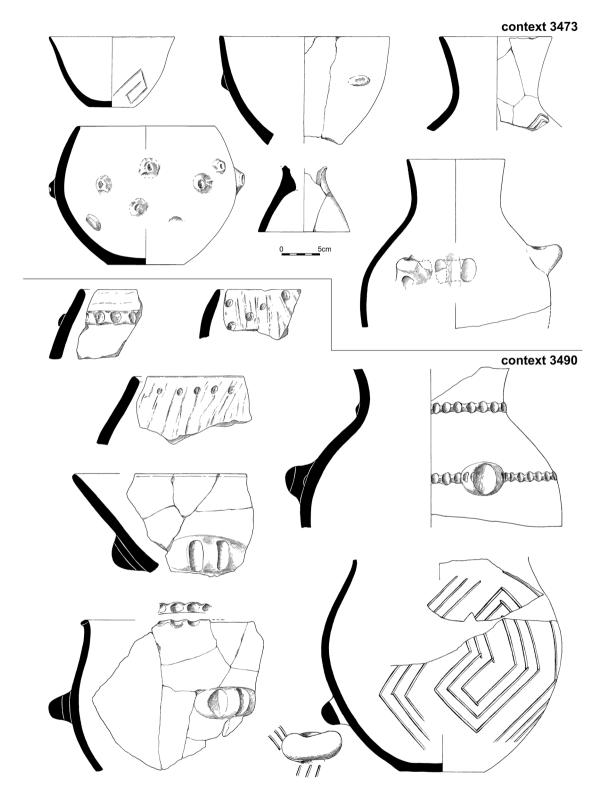


Figure 9: Finds of LBK pottery from the fill of the Brno-Bohunice well (contexts Nos. 3473 and 3490).

2.1.3 Uničov-U Kravína

The town of Uničov is situated in the north-eastern tip of Central Moravia, at the foothills of the Nízký Jeseník Upland (Culek et al., 2005). The bedrock consists of gravelly-sandy fluvial deposits mostly overlaid by loess, which is covered with fertile soil. The site is situated ca. 230 m from the now regulated riverbed of Lukavice and the Oskava stream is located about 1,100 m away. It is a tributary of the river Morava and comprises a broad alluvium at elevations of 233–234 m a.s.l.

In 2015, archaeological rescue excavation was conducted on the southwest border of the town of Uničov at a place called U kravína. On an area of 0.7 ha, 556 features of the LBK and two settlement pits of the Jordanów Culture were explored (Kalábek, 2016). The excavation unearthed one part of a settlement area of the LBK with 12 longhouse layouts, building pits, irregular composite pits, storage pits and ovens. An exceptional find was a water well with a preserved timber lining (feature 184). The excavation was supplemented by a geophysical survey of an area of 11.7 ha in total (Figure 10).

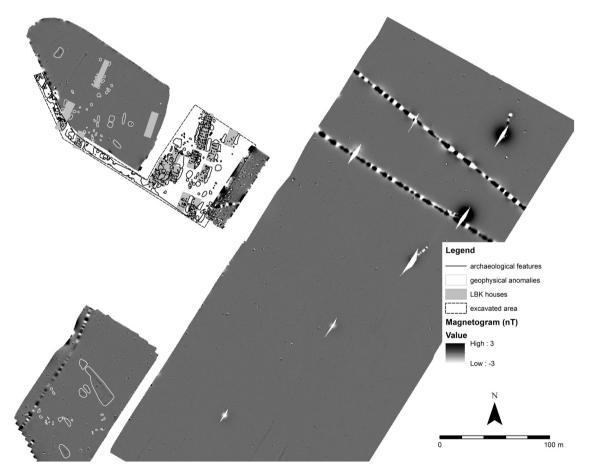


Figure 10: Linearbandkeramik settlement at the Uničov site.

After the removal of the topsoil layer, the well had the form of an oval pit sized $580 \, \text{cm} \times 550 \, \text{cm}$, oriented in the northeast-southwest direction (Figure 11). The uppermost layer of the feature consisted of dark brown silty soil 80 cm in thickness (context 300). About 1 m deeper, the moderately inclined funnel-shaped mouth of the pit turned abruptly into a nearly vertical wall falling down to a depth of 325 cm. This funnel was filled with yellow-brown compacted clayey soil (context 302). At a depth of 120 cm below the surface, a dark black, clayey, irregular rhombic ground plan was detected, indicating the original timber

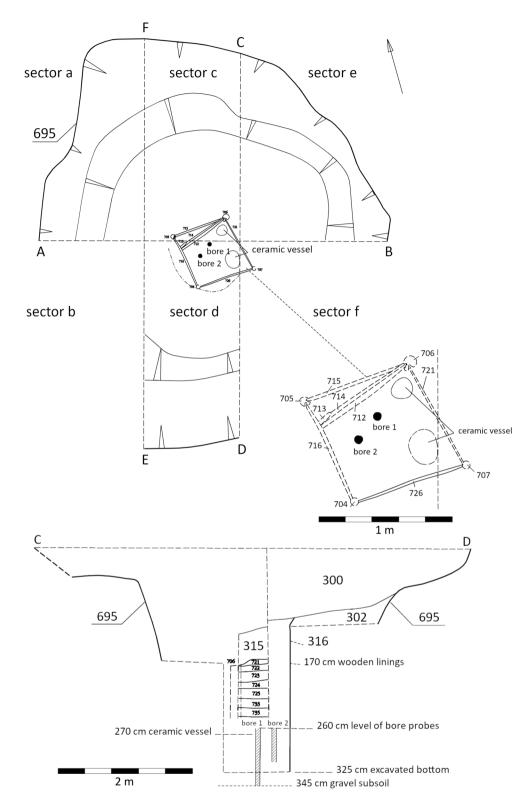


Figure 11: Ground plan and vertical section of the Uničov well.

lining of the well shaft. The length of its sides was 90–100 cm and the fill consisted of water-saturated brown-black silty clay with many organic remains (context 315). The outer side of the timber lining of the well shaft was daubed with an approximately 6 cm thick layer of gray clay (context 316). The upper

groundwater level was reached at a depth of 170 cm below the surface after the removal of topsoil, where the preserved wooden lining began to appear. This construction was gradually dismantled and continued to the depth of 320 cm. At a depth of 260 cm, two parallel cores were sampled from the wet well fill to obtain a precise stratigraphy of the well fill. The first core reached the gravel bedrock at a depth of 345 cm (Vostrovská et al., 2020, p. 65). A total of 124 LBK ceramic fragments were found in the fill of the funnel-shaped well pit and in the well shaft (Figure 12).

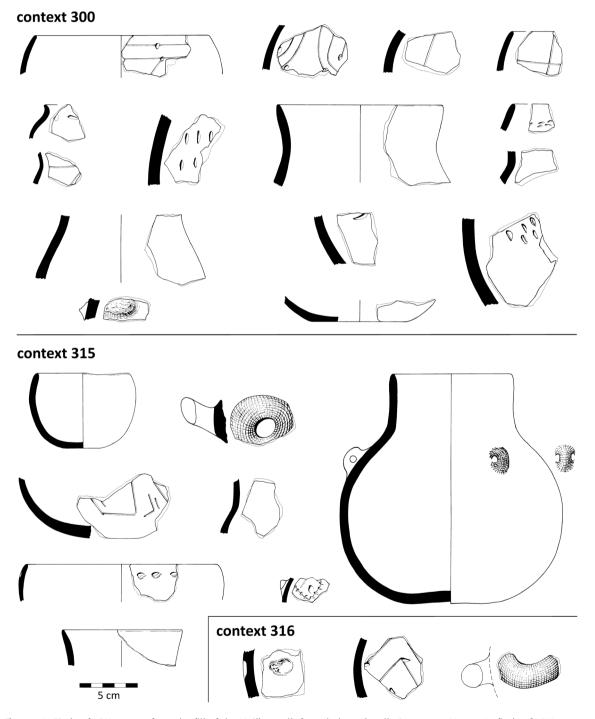


Figure 12: Finds of LBK pottery from the fill of the Uničov well: funnel-shaped well pit (context No. 300); finds of LBK pottery from the well shaft (context No. 315); finds of LBK pottery from the daub layer of gray clay (context No. 316).

2.2 Methods

In the period 1964–2019, a total of 71 samples for radiocarbon dating were taken from the lining or fill of all wells and also from the settlement features. They comprised charred and uncharred plant macro remains, uncharred wood, charcoal, animal and human bones and tar. The material was analysed by accelerator mass spectrometry at the Laboratory of the German Academy of Sciences in Berlin (Kohl & Quitta, 1964), Centre for Isotope Research at the University of Groningen (Tichý, 1970), Laboratory of Applied Nuclear Physics in Most (Neustupný & Veselý, 1977), Centre of Accelerator Mass Spectrometry at the University of Cologne (Schmidt & Gruhle, 2003), Institut für Radiumforschung und Kernphysik Wien, Poznań Radiocarbon Laboratory, Isotoptech Zrt. Debrecen, Labor für Ionenstrahlphysik ETH Zürich, Curt-Engelhorn-Zentrum Archäometrie Mannheim and at the Gif-sur-Yvette Tandetron Facility. The obtained dates were calibrated using IntCal 20 (Reimer et al., 2020) and OxCal version 4.4.2 (95.4% \pm 2 σ ; μ \pm 1 σ ; Bronk Ramsey, 2020).

A total of about 90 bucket fragments were found at the bottom of the Mohelnice well No. 224. Technomorphological analyses were restricted to finds after conservation treatment and visual comparison with scale drawings. No investigation was possible for Brno-Bohunice due to the lack of wooden remains. Dendroarchaeological investigation of tool marks on the wooden finds was performed on the freshly excavated timber from Uničov (Rybníček et al., 2018; Vostrovská et al., 2020, p. 68).

A total of 21 cord fragments from the Mohelnice well No. 224 were scanned with a portable handheld USB microscope Dino-Lite Basic AM2111 (using the $10-70\times$ and $200\times$ magnification). The images and their interpretation were made with the help of the DinoCapture programme. The torsion (twist) of threads was determined. Each thread is spun with a left (S torsion) or right twist (Z torsion). Individual threads might have also been twined together; in this case, we use an alphanumerical code containing the twist symbol. For example, an S-twisted thread is twined from two strands with Z-torsion: 2Z/S. In the case of tablet weaving technique using a band loom, the letters "S" and "Z" also identify the twist of warp threads. The thread thickness is measured in both warp and weft in millimetres (Bravermanová, Březinová, & Urbanová, 2011). Identification of raw material was done with an Arsenal transillumination stereo-microscope at a 500× magnification at the Faculty of Science of the Palacký University in Olomouc.

3 Results

3.1 Internal Structure of the Settlements

All three sites have been studied to various extents. Uničov and Mohelnice settlements were only partially excavated in areas of about 1-2 ha. However, in the case of Brno-Bohunice, we can assume that a larger portion with an area of 11 ha has been uncovered. The size of the examined area corresponds to the number of uncovered houses. A total of 21 houses were discovered in the settlement of Mohelnice and 12 houses in the settlement of Uničov, whereas at least 50 houses were identified in the settlement of Brno-Bohunice. The houses in all settlements are distributed with low density, regularly in several rows. All types of longhouse layouts consist of five rows of wooden posts, which can be complemented in the northern part by foundation trenches, and in the southern part, the inner trio of posts can be multiplied. The inner posts were placed in threes and formed longitudinal rows that served as the load-bearing structure for the roof. These posts have a larger diameter and are recessed deeper in the ground. The inner posts were found only in longitudinal alignment so that they were most probably connected only by longitudinal purlins. The houses in Mohelnice and Uničov have an average width of 7–8 m; according to their length, they can be divided into two groups: very long 27-36 m and medium 15-18 m. The houses in Brno-Bohunice have an average width of 5-6.5 m and length of 7.5-26 m.

Excavations of the LBK settlements that represent the subject of this article have revealed four water wells. We also analysed other sunken features according to the shape of the section, the sequence of layers,

the depth, etc. From this point of view, it was not possible to interpret any of the features as water reservoirs. In Brno-Bohunice, the well was located inside the settlement, at the western wall of a house in superposition with its building pit so that the older well was disturbed during the construction of the younger pit. Another two houses with building pits were found northwest of the well. The central part of the settlement was enclosed by a ditch (Figure 6). In the case of Mohelnice and Uničov, we can assume that the wells were built at the edge of the settlement. In Mohelnice, the area where the wells were found was only explored in the form of archaeological watching brief (Figure 2). Therefore, we can say nothing about the appearance of the area around the wells. Geophysical prospection in Uničov did not prove any continuation of the settlement to the east of the excavated area; only in the northern direction two more houses were found and the continuation of one house was documented. The well was located in the immediate neighbourhood of houses S2 and S3 at the eastern edge of the settlement area. In the vicinity of the well, apart from the building pits of the mentioned houses, no other features were detected (Figure 10).

3.2 Dating

A total of 71 samples for radiocarbon dating were taken from the lining or fill of all wells and also from the settlement features. Some dates from Mohelnice have already been published (Kohl & Quitta, 1964, p. 315; Neustupný & Veselý, 1977, p. 185; Schmidt & Gruhle, 2003, p. 56) and others were obtained recently. Most of the dates from Brno-Bohunice have not yet been published and several others were obtained recently. Except for one date from the Uničov well fill, all the remaining dates have already been published (Vostrovská et al., 2020, pp. 69–70) and new dates from the settlement are presented here.

A total of 24 radiocarbon dates were excluded from the dataset (Table 1). From the Mohelnice well No. 224, we did not include the date MOC-91; the date was modified by the laboratory and is already combined in the date MOC-70 + 91. Dates DeA-13991 and DeA-13992 were suspiciously too old; more than c. 7100 BC. The wood was preserved, but at first, no information was passed on to the laboratory. So the same samples were measured again (DeA-26544 and DeA-26545), including the pre-treatment for preserved wood, but the results were almost as old as in the previous measurement; not LBK. We consider these dates strange. A possible explanation is that this is subfossil wood deposited in river terraces or oxbows and subsequently found by the first farmers. Furthermore, we did not include the non-LBK dates: GrN-6607 from the Late Eneolithic Mohelnice well No. 254 (probably Bell Beaker Culture), MOC-69 and GrN-6604 from the construction and the early medieval DeA-14344 from the fill of the Funnel Beaker Culture Mohelnice well No. 255, MOC-71 and GrN-6605 from the construction of the Early Bronze Age Mohelnice well No. 256. From the fill of the Uničov well we did not include the dates DeA-15368, DeA-21499, DeA-13936-DeA-13940, DeA-13942-DeA-13945, DeA-13947-DeA-13950 and DeA-13952-DeA-13953. In the model for the Czech Republic and northern Lower Austria, the dates appear as two events; the second one corresponds to Stroked Pottery Culture (Trampota & Květina, 2020). This is a surprising situation, as no evidence of Stroked Pottery Culture has been found on the site.

Out of the total dataset, 47 calibrated dates were used for summation modelling (Figure 13). These dates cover the interval of about 5530–5085 BC. In the model, the dates are divided chronologically by sites; the oldest dates from Brno-Bohunice, then Mohelnice and finally Uničov. Dates from each site are further divided according to the context (wells, graves, ditch, settlements). First, in Brno-Bohunice, the fill of the well is one of the oldest dated contexts in the settlement; only grave No. 4689 was contemporaneous. The dates are related to subsequent filling of the well rather than to its origins and operation; just like Early LBK pottery from a depth of only about 120 cm below the surface of the feature (Figures 8 and 9), which was accidentally flushed into the fill of the upper part of the well in the form of settlement waste. Afterwards, one part of the settlement was enclosed. More accurate dating of the enclosure is problematic, because the partly filled depression of the ditch was subsequently used as a stoking pit for ovens built into its walls and a suitable place for dumping waste. Until now only one date is available from the ditch fill, so it is not objective to use it as the basis for considerations about the dating of the enclosure. It is a proof that the well

Table 1: Radiocarbon results; dates excluded from the model are marked in gray (Bln-102, Bln-102A: Kohl & Quitta, 1964; MOC-70 + 91, MOC-69, MOC-71, MOC-91: Neustupný & Veselý, 1977; KN-4339: Schmidt & Gruhle, 2003)

Sample	Context details	Material	Lab Code	¹⁴ C age	Oxcal cal 95.4% interval (±2σ)	Oxcal cal μ (±1σ)
Brno-Bohunice, f. 3579/07	Well, context 3473	Charcoal	VERA-4476	6435 ± 35 BP	5476-5330 BC	5412 ± 42 BC
Brno-Bohunice, f. 3579/07	Well, context 7278, depth 150–200 cm	Animal bone	DeA-13725	6370 ± 40 BP	5472-5221 BC	5346 ± 63 BC
Brno-Bohunice, f. 3579/07	Well, context 7293, depth	Animal bone	DeA-13726	6380 ± 39 BP	5474-5223 BC	5355 ± 61 BC
Brno-Bohunice, f. 3651/07	Settlement pit, context 3414	Animal bone	DeA-18339	6265 ± 41 BP	5321-5068 BC	5253 ± 67 BC
Brno-Starý Lískovec, f. 513/05	Ditch, section D, context 184	Animal bone	DeA-18380	$6314 \pm 40 BP$	5371-5212 BC	5277 ± 51 BC
Brno-Starý Lískovec, f. 2565/07	Burial, context 800	Human bone	Poz-27382	$6220 \pm 40 BP$	5305-5046 BC	5152 ± 74 BC
Brno-Starý Lískovec, f. 4689/07	Burial, context 801	Human bone	Poz-27383	$6400 \pm 40 BP$	5475-5235 BC	5376 ± 56 BC
Brno-Starý Lískovec, f. 5575/07	Burial, context 802	Human bone	Poz-27384	$6330 \pm 40 BP$	5461-5214 BC	5303 ± 56 BC
Brno-Starý Lískovec, f. 5697/07	Burial, context 803	Human bone	Poz-27385	$6180 \pm 50 \text{ BP}$	5298-4996 BC	$5124 \pm 73 BC$
Brno-Starý Lískovec, f. 7714/08	Burial, context 805	Human bone	Poz-26805	$6160 \pm 40 \text{ BP}$	5216-4994 BC	$5111 \pm 66 BC$
Brno-Starý Lískovec, f. 7731/08	Burial, context 806	Human bone	Poz-26806	$6240 \pm 40 BP$	5309-5061 BC	5212 ± 77 BC
Brno-Starý Lískovec, f. 7799/16	Burial, context 807	Human bone	DeA-18381	$6197 \pm 41 BP$	5299-5015 BC	$5134 \pm 67 BC$
Mohelnice, f. 037/61, sq. 0114	Settlement pit	Charred <i>Triticum dicoccon</i>	DeA-13990	$6191 \pm 31 \text{ BP}$	5287-5040 BC	$5129 \pm 56 BC$
Mohelnice, f. 054/61, sq. 0114	Settlement pit	Charred <i>Triticum dicoccon</i>	DeA-13989	$6216 \pm 30 \text{ BP}$	5300-5052 BC	$5144 \pm 68 BC$
Mohelnice, f. 054/61, sq. 0114	Settlement pit	Charred <i>Triticum dicoccon</i>	Bln-102	$6285 \pm 100 \text{ BP}$	5473-5007 BC	5245 ± 123 BC
Mohelnice, f. 054/61, sq. 0114	Settlement pit	Charred <i>Triticum dicoccon</i>	Bln-102A	$6405 \pm 100 \text{ BP}$	5612-5083 BC	5372 ± 104 BC
Mohelnice, f. 224/70, sq. 0126	Well	Uncharred timber	MOC-70 + 91	6220 ± 80 BP	5363-4954 BC	$5157 \pm 103 BC$
Mohelnice, f. 224/70, sq. 0126	Well	Uncharred timber	MOC-91	$6330 \pm 140 \text{ BP}$	5605-4951 BC	5282 ± 156 BC
Mohelnice, f. 224/70, sq. 0126, K11	Well	Uncharred timber (pile)	GrN-6608	$6200 \pm 65 \text{ BP}$	5312-4992 BC	5139 ± 88 BC
Mohelnice, f. 224/70, sq. 0126	Well	Uncharred timber (pile/board)	GrN-6610	$6305 \pm 65 \text{ BP}$	5471-5063 BC	5273 ± 87 BC
Mohelnice, f. 224/70, sq. 0126	Well	Uncharred timber	KN-4339	6580 ± 75 BP	5636-5376 BC	$5531 \pm 67 BC$
Mohelnice, f. 224/70, sq. 0126	Well	Uncharred <i>Chenopodium album</i>	DeA-13986	$6165 \pm 28 \text{ BP}$	5212-5015 BC	$5116 \pm 56BC$
Mohelnice, f. 224/70, sq. 0126, 6-1	Well	Uncharred wood (rod) from bucket	DeA-13992	11113 ± 37 BP	11156-10971 BC	$11087 \pm 45 BC$
Mohelnice, f. 224/70, sq. 0126, 6-1	Well	Uncharred wood (rod) from bucket	DeA-26545	12977 ± 58 BP	13770-13357 BC	13571 ± 108 BC
Mohelnice, f. 224/70, sq. 0126, 9-1	Well	Uncharred wood (bark)	DeA-13991	8144 ± 33 BP	7314-7051 BC	$7127 \pm 62 BC$
Mohelnice, f. 224/70, sq. 0126, 9-1	Well	Uncharred wood (bark)	DeA-27544	11562 ± 52 BP	11623-11368 BC	11473 ± 57 BC
Mohelnice, f. 254	Well	Uncharred timber	GrN-6607	3875 ± 35 BP	2465-2209 BC	2360 ± 67 BC
Mohelnice, f. 255	Well	Uncharred timber	69-DOM	4800 ± 70 BP	3708-3374 BC	3570 ± 84 BC
Mohelnice, f. 255	Well	Uncharred timber	GrN-6604	4985 ± 40 BP	3941-3650 BC	3755 ± 76 BC
Mohelnice, f. 255	Well	Uncharred <i>Polygonum aviculare</i>	DeA-13987	6296 ± 30 BP	5331-5211 BC	5263 ± 37 BC
Mohelnice, f. 255	Well	Uncharred <i>Chenopodium album</i>	DeA-13988	$6222 \pm 29 BP$	5301-5056 BC	$5151 \pm 71 BC$

Sample	Context details	Material	Lab Code	¹⁴ C age	Oxcal cal 95.4% interval (±2σ)	Oxcal cal μ (±1σ)
Mohelnice, f. 255 Mohelnice, f. 256 Mohelnice f. 256	Well Well Well	Uncharred <i>Rubus idaeus</i> Uncharred timber	DeA-14344 MOC-71 GrN-6605	1205 ± 31 BP 3340 ± 50 BP 9970 + 90 BP	703-944 AD 1743-1505 BC 9860-9382 BC	827 ± 51 AD 1614 ± 68 BC 9519 + 156 BC
Uničov, f. 184	Well, context 315, depth 120–130 cm	Charred Cerealia, Sambucus, Canium	DeA-21499	6005 ± 39 BP	4997-4794 BC	4895 ± 56 BC
Uničov, f. 184	Well, context 315, depth 180–190 cm	Uncharred <i>Cerealia</i>	DeA-13934	6208 ± 30 BP	5297-5049 BC	5146 ± 62 BC
Unicov, f. 184	Well, context 315, depth 180–190 cm	Uncharred <i>Onopordum acanthium</i>	ETH84332.1.1	6130 ± 25 BP	5210-4991 BC	5086 ± 72 BC
Uničov, f. 184, 17/2015-316-4	Well, context 316, depth 200–210 cm	Tar from pottery	DeA-17682	6151 ± 40 BP	5215-4989 BC	5104 ± 69 BC
Uničov, f. 184	Well, context 315, depth 220–230 cm	Uncharred <i>Onopordum</i>	DeA-13933	6129 ± 30 BP	5210-4957 BC	5084 ± 73 BC
Uničov, f. 184	Well, context 315, depth 220–230 cm	Uncharred Carpinus betulus	DeA-17378	6338 ± 34 BP	5461-5216 BC	5302 ± 54 BC
Uničov, f. 184	Well, context 315, depth 220–230 cm	Charred <i>Cerealia</i>	ЕТН84333.1.1	$6185\pm25~BP$	5215-5045 BC	5127 ± 49 BC
Uničov, f. 184	Well, context 315, depth 230–240 cm	Uncharred <i>Onopordum</i>	DeA-13932	6138 ± 30 BP	5209-4996 BC	5095 ± 69 BC
Uničov, f. 184	Well, context 315, depth 230–240 cm	Charred <i>Triticum dicoccon</i>	ETH84334.1.1	6220 ± 30 BP	5301-5054 BC	5164 ± 70 BC
Uničov, f. 184	Well, context 315, depth 230–240 cm	Charred <i>Triticum monococcum</i>	ЕТН84335.1.1	6195 ± 30 BP	5289-5043 BC	5134 ± 56 BC
Uničov, f. 184, 714 B1	Well, context 714, depth 260–275 cm	Uncharred timber (board)	MAMS-26872	6166 ± 30 BP	5213-5013 BC	5118 ± 57 BC
Uničov, f. 184, 714 B2	Well, context 714, depth 260–275 cm	Uncharred timber (board)	MAMS-26873	6165 ± 29 BP	5212-5014 BC	5118 ± 56 BC
Uničov, f. 184, 734-1	Well, context 734, depth 260–275 cm	Uncharred timber (board)	MAMS-26874	6205 ± 30 BP	5296-5047 BC	5143 ± 61 BC
Uničov, f. 184, 734-2	Well, context 734, depth 260–275 cm	Uncharred timber (board)	MAMS-26875	6168 ± 31 BP	5213-5012 BC	5119 ± 57 BC
Uničov, f. 184	Well, context 315, depth 280–300 cm	Uncharred <i>Onopordum</i>	DeA-13930	6168 ± 31 BP	5213-5012 BC	5120 ± 57 BC

(Continued)

Table 1: Continued

Sample	Context details	Material	Lab Code	¹⁴ C age	Oxcal cal 95.4% interval (±2σ)	Oxcal cal μ (±1σ)
Uničov, f. 184	Well, context 315, depth 280–300 cm	Uncharred Drepanocladus aduncus	DeA-15368	5865 ± 41 BP	4838-4612 BC	4734 ± 55 BC
Uničov, f. 184	Well, context 315, depth 300–325 cm	Uncharred <i>Chenopodium</i>	DeA-13931	6145 ± 29 BP	5209-5001 BC	5103 ± 66 BC
Uničov, f. 184	Well, context 315, depth 300–325 cm	Uncharred <i>Drepanocladus aduncus</i>	DeA-15401	$6101 \pm 40 \text{ BP}$	5209-4856 BC	5037 ± 84 BC
Uničov, f. 184	Well, context 315, depth 300–325 cm	Charred <i>Triticum monococcum</i>	ЕТН84336.1.1	6230 ± 25 BP	5302-5064 BC	5187 ± 74 BC
Uničov, f. 184	Well, context 315, depth 300–325 cm	Charred <i>Triticum dicoccon</i>	ЕТН84337.1.1	6200 ± 25 BP	5286-5050 BC	5136 ± 53 BC
Uničov, f. 184	Well, context 315, depth 300–325 cm	Charred chenopodiaceae	Echo 2659.1.1	6260 ± 30 BP	5314-5076 BC	5242 ± 57 BC
Uničov, f. 386, 17/2015-1120-53	Context 1120	Tar from pottery	DeA-18092	$6206 \pm 42 BP$	5303-5034 BC	5148 ± 71 BC
Uničov, f. 397	Settlement pit, context 1133	Charred Triticum dicoccon	DeA-13936	5974 ± 30 BP	4948-4732 BC	4858 ± 48 BC
Uničov, f. 466	Settlement pit, context 1203	Charred <i>Cerealia</i>	DeA-13937	$6007 \pm 29 BP$	4992-4800 BC	4896 ± 46 BC
Uničov, f. 467	Settlement pit, context 1204	Charred Triticum dicoccon	DeA-13938	$5881\pm30~BP$	4836-4688 BC	4754 ± 36 BC
Unicov, f. 468	Settlement pit, context 1205	Charred <i>Cerealia</i>	DeA-13939	4762 ± 30 BP	3637-3383 BC	3562 ± 59 BC
Uničov, f. 470	Settlement pit, context 1207, 1208	Charred <i>Cerealia</i>	DeA-13940	5955 ± 28 BP	4935-4727 BC	4833 ± 46 BC
Uničov, f. 479	Settlement pit, context 1218	Charred <i>Fallopia</i>	DeA-13941	$6115 \pm 30 \text{ BP}$	5209-4943 BC	5062 ± 77 BC
Uničov, f. 500	Settlement pit, context 1239	Charred <i>Cerealia</i>	DeA-13942	5949 ± 29 BP	4931-4725 BC	4825 ± 47 BC
Uničov, f. 502	Settlement pit, context 1241	Charred Triticum dicoccon	DeA-13943	6025 ± 30 BP	5002-4804 BC	4916 ± 49 BC
Uničov, f. 504	Settlement pit, context 1243	Charred <i>Cerealia</i>	DeA-13944	6046 ± 30 BP	5030-4845 BC	4942 ± 52 BC
Uničov, f. 505	Settlement pit, context 1244	Charred Triticum dicoccon	DeA-13945	5963 ± 29 BP	4939-4730 BC	4844 ± 47 BC
Uničov, f. 506	Settlement pit, context 1245	Charred <i>Cerealia</i>	DeA-13947	5893 ± 31 BP	4841-4701 BC	4764 ± 38 BC
Uničov, f. 507	Settlement pit, context 1246	Charred <i>Cerealia</i>	DeA-13948	5897 ± 31 BP	4842-4706 BC	4767 ± 38 BC
Uničov, f. 524	Settlement pit, context 1263	Charred <i>Cerealia</i>	DeA-13949	5929 ± 32 BP	4899-4718 BC	4800 ± 47 BC
Uničov, f. 528	Settlement pit, context 1268	Charred Triticum monococcum	DeA-13950	$6019 \pm 30 \text{ BP}$	4998-4803 BC	4909 ± 48 BC
Uničov, f. 530	Settlement pit, context 1270	Charred <i>Cerealia</i>	DeA-13952	5845 ± 30 BP	4793-4612 BC	4713 ± 49 BC
Uničov, f. 530, 17/2015-1270-10	Settlement pit, context 1270	Tar from pottery	DeA-17683	6385 ± 61 BP	5476-5218 BC	5361 ± 71 BC
Uničov, f. 533	Settlement pit, context 1273	Charred <i>Pisum sativum</i>	DeA-13953	6027 ± 32 BP	5007-4802 BC	4918 ± 51 BC

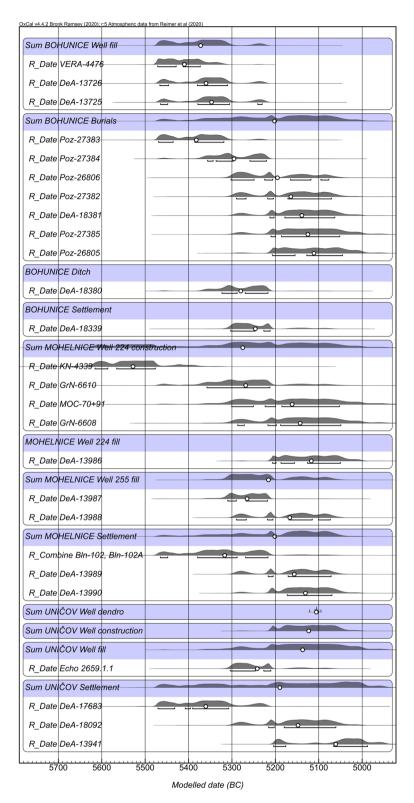


Figure 13: Summary of calibrated dates from timbers of the well constructions, their fills, graves and settlement pits.

was already defunct when the central enclosure was backfilled. Subsequently, individuals from the remaining graves were gradually buried. Settlement pit No. 3651 is younger than the well and even younger than the enclosure. Second, in Mohelnice, the construction of well No. 224 is the oldest dated context in the

settlement. The dates from its fill are slightly younger and coeval with the later phase of the settlement. The situation of well No. 255 is very specific; in fact, there were two wells. The construction of Funnel Beaker Culture well consisted of a hollow oak tree trunk. Another wood remnants were found outside the tree trunk in the north-western wall (Tichý, 1970, 1971). They probably belonged to a rectangular construction similar to that of LBK well No. 224. It seems that the older LBK well was probably disturbed during the construction of the Funnel Beaker Culture well. It is confirmed by the dates from its fill, which rather correspond to both phases of the LBK settlement. The younger phase of the fill of the well No. 255 also corresponds chronologically to the fill of the well No. 224. It is possible that both were filled at a similar time and their simultaneous use cannot be excluded. The pottery corresponds to the Middle LBK and it is a settlement waste, which got into the fill of the well at the time of its use and decline (Figures 4 and 5). Third, in Uničov, the well-preserved wooden construction provided nine absolutely dated TRW series of oak (*Quercus* spp.). The samples originate from the well's lining as well as from the infill. The oak trees used for the construction were felled between 5093 and 5085 BC (Rybníček et al., 2018, pp. 100–101). The radiocarbon dates from the wooden lining and the well fill are comparable (Vostrovská et al., 2020, pp. 69–70). The construction of the well is contemporaneous with the later phase of the settlement; however, the material corresponding to the older phase of the settlement also got into the well fill. The pottery corresponds to the Middle LBK and it is a settlement waste that got into the fill of the well at the time of its decline. The only exception might be a storage jar, which could have been used to draw water from the well. It was found almost intact in the lower third of the shaft and we assume that it fell into a functional well by accident (Figure 12).

The oldest LBK well in Moravia was found in Brno-Bohunice. The timber construction of the Mohelnice well No. 224 might be older than the grooved construction of the Uničov well. The content of the fills of the Mohelnice well No. 224 and the Funnel Beaker Culture well No. 255 is contemporaneous with the fill of the Uničov well; although well No. 255 began to fill up earlier. We cannot say with certainty how long the individual wells have been used, but their fill was made of settlement material from the period of 100–200 years; Brno-Bohunice in the time interval ca. 5450–5300 BC, which corresponds to the Early LBK, while Mohelnice and Uničov in the time interval ca. 5250–5050 BC, which is the Middle LBK. Other European LBK wells also fall within the Middle LBK. Settlement activities correspond to the entire course of LBK.

3.3 Construction and Decline of the Wells

The wells from Mohelnice and Uničov had a preserved wooden lining; however, the Brno-Bohunice well did not include any wooden construction. At the bottom of the Mohelnice well No. 224, the lower part of a rectangular timber construction has been preserved, consisting of oak boards embedded between sixteen oak posts. The field documentation does not contain any evidence of repairs or the aboveground construction of the well. Another wood remnants were found outside the tree trunk in the north-western wall of the well No. 255. They probably belonged to a rectangular construction similar to that of well No. 224 (Tichý, 1970, 1971). The internal construction of the Uničov well was composed of four oak corner posts with longitudinal grooves, in which horizontal oak boards were embedded. However, one post was found at the bottom of the shaft, on which leaned three boards, whose right end dropped out from the groove of the corner post. This is a direct evidence that the construction was repaired at a time when the well was in operation. The whole wooden lining was daubed from the outside with a thick layer of gray clay. The water level was accessed through the mouth of a wide funnel-shaped pit. The wooden lining itself most probably originally reached down to its bottom. No evidence of any aboveground construction was detected in the upper part of the well.

All studied LBK well pits have a funnel-shaped neck and they gradually slope down into a vertical shaft. The filling of the features with settlement waste can be identified in the funnel-shaped neck to a depth of about 100–150 cm, although the bottoms of all wells reached different depths. In the case of Mohelnice and Uničov, this phenomenon can only be observed on the vertical sections of the wells; the well from Brno-Bohunice was literally overflowing with settlement waste in the upper part (Figure 14). The walls of the well

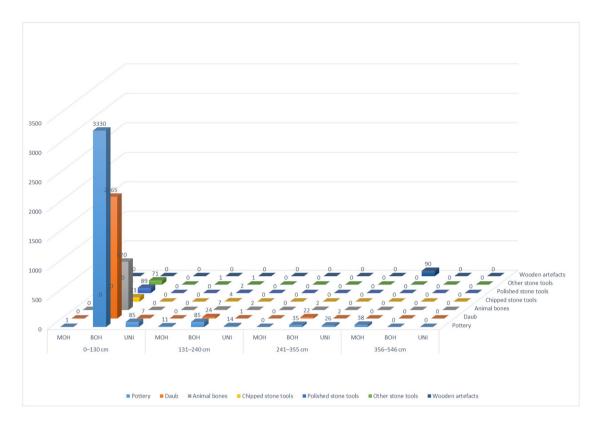


Figure 14: Quantity of archaeological finds along the vertical section of the wells' fills.

then fell vertically down and formed an approximately cylindrical shaft. Most of the shaft fill of the Uničov well was homogeneously accumulated as a consequence of one event; the well was probably intentionally backfilled. Similarly, the dark fill fell down to the bottom of the Mohelnice well No. 224. But the fill of Brno-Bohunice well shaft contained many layers, which probably emerged by gradual backfilling of the defunct well combined with spontaneous sedimentation and destruction of its mouth. Almost no finds were detected at the bottom of the wells. The only objects found were related to the use of the well, such as a ceramic storage jar or fragments of wooden buckets.

3.4 Water Buckets

A total of about 90 wooden fragments were found at the bottom of the Mohelnice well No. 224. The basic skeleton of water buckets consisted of lengthwise split rods, which had notches at both ends. The layer of bast was unrolled and its two ends were inserted between the split halves of the rods so that they formed the wall of the bucket. The ends of the halved rods were then tied together by cords. Cords were also found lying along the whole length of the rods, thus reinforcing the bucket construction. The bottom of the bucket was probably folded. This way, no water was lost through the seam. Traces of any bracing or handles at the upper rim of the buckets were not detected.

The raw material for the bucket skeleton is 230-280 mm long hazel, ash or dogwood rods with a diameter of approximately 25-30 mm (Figure 15). Some rods, especially those made of hazel and dogwood have a preserved bark, so they were probably split fresh. From the perspective of use-wear analysis, there are no traces of heavy tools (e.g., adzes). The end grains show a rounded surface; therefore, we assume that the objects were cut to length using knife blades. The rods were split lengthwise to obtain the semi-circular cross-section, in a few cases, it looks like the split surface was additionally smoothed but this could also be the result of use, i.e. traces of wear. In a separate step, the rods were also notched close to the ends using

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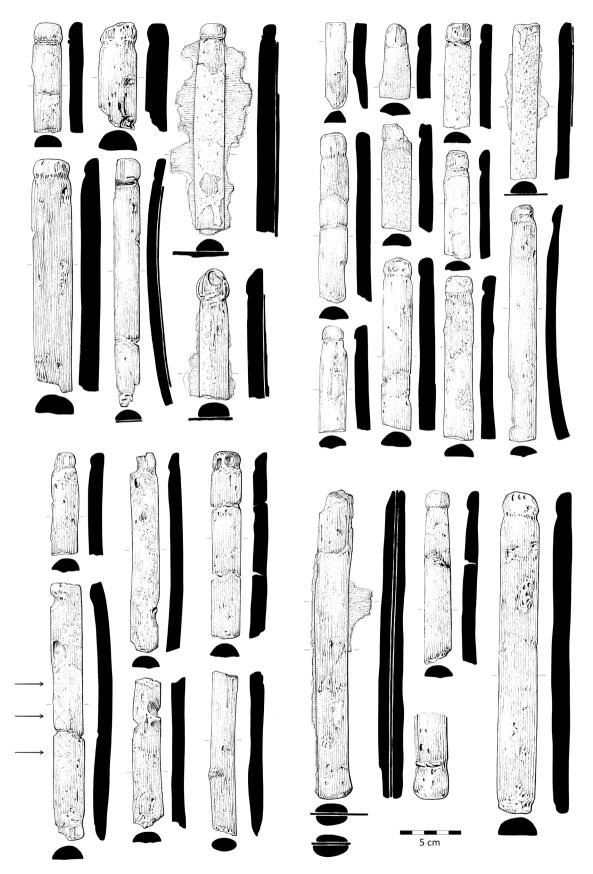


Figure 15: Fragments of wooden buckets from the fill of the Mohelnice well No. 224; smoothing traces marked with arrows.

small blades (knives) to secure a cord, which is also preserved in some cases. These notches only appear on the outer (rounded) side of the halved rods. It cannot be decided if the rods were notched before or after being split. Some of the objects display their original assembly of two halved sticks with 1–2 mm thick layer of oak bast in between. Under the microscope, it was possible to determine the corresponding fibre orientation of all these fragments of bast. The plane of the bast takes a tangential direction towards the annual rings of the trunk. The basts were peeled off the narrow side of the boards, which were split radially off the logs with a larger diameter, or directly from a tree trunk (Opravil, 1972). The peeling of the bast was undoubtedly done with some type of knife blades.

The cords served to reinforce the bucket structure. A total of 21 studied samples of cords were braided into a 2Z/S torsion (Figure 16). This means that both strands were twisted into a Z bend (right) and then together into an S bend (left). The length of the preserved remnants of cords ranged from 20 to 90 mm; the width varied from the thinnest 2.1 mm up to 9 mm. Simple knots are preserved on two fragments. The braiding technique is a very simple skill, which does not demand any special tools. Handmade production is also indicated by the twists of cords and by a moderate Z torsion at an angle of about 27° in individual strands, which were not spun with a spindle. Thanks to fragmentation, it was not necessary to intrude the braided cords. All of them exhibited a heavy fibre damage, which complicated the identification. The

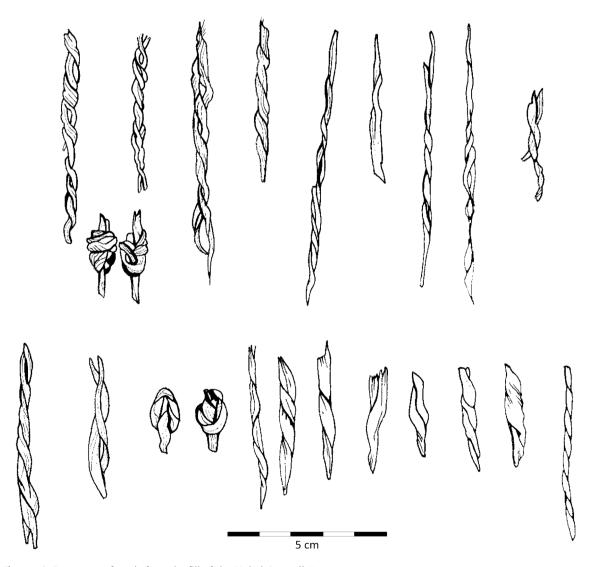


Figure 16: Fragments of cords from the fill of the Mohelnice well No. 224.

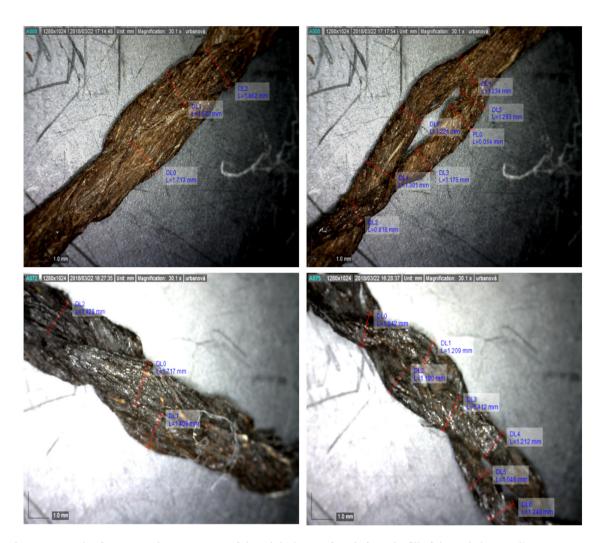


Figure 17: Details of torsion and measurement of thread thickness of cords from the fill of the Mohelnice well No. 224.

detected characteristics most likely refer to plant fibres, but any more detailed specification is not possible. A question remains whether the cords were braided from bast or linen fibres (Figure 17).

4 Discussion

4.1 Distribution of Wells within the Settlements

In the settlements of the first farmers, several different models for the location of wells can be distinguished: in-house wells, house group's own wells and shared communal wells (Balkowski, 2018, p. 314). The reconstruction of settlement development shows that the location of the well was not random and not dependent only on geomorphology but it had also social reasons. The location of houses and wells in the settlement created domestic and public spaces. In the first case, the wells are located near particular houses and can be considered private. The size, or length, of the house and the presence of the wooden lining of the well could also be significant. In the latter case, wells are located in open spaces within a settlement and can be considered public. Finally, a well may have functioned as a status symbol, indicating the superiority of certain settlements over others (Wollenweber, 2016).

The large and prominent longhouses in Niederröblingen were regularly associated with wells in their immediate neighbourhood. It might seem that smaller houses were rarely equipped with wells of their own. There were more than 20 other wells that were in use over some part of the same period. It is therefore envisaged that wells were used in households, where not every house had its own well and therefore there could be social differences between households with or without a well (Wollenweber, 2016). In the Arnoldsweiler-Ellebach, a total of four wells with partially preserved wooden lining as well as 14 possible water reservoirs were documented. In this settlement, mainly the house group's own wells model is proposed. On average, one well or water reservoir was created for every three houses; not every house had its own water source. The number of water sources seems to depend on the number of houses concerned. From this, it can be concluded that the water supply in settlements was not always designed uniformly (Balkowski, 2018, pp. 305–320). On the other hand, the hydrogeological conditions enabled the inhabitants to build wells over the entire area of the settlement, as in Niederröblingen. In Wedringen, a settlement was discovered with a large number of houses, the remains of fences, 18 various wells, and seven pits serving as short-term water reservoirs. It seems that almost every household had its own well or water reservoir (S. Friederich, personal communication, November 22, 2019).

On the other hand, the state of research has rather shown the non-concurrence of multiple wells in one settlement. The studied Moravian sites belong to settlements with one or two wells: the settlement in Mohelnice had one to two wells for approximately 21 houses, in Brno-Bohunice one well was built for less than 50 houses and in Uničov one well for 12-14 houses. In Mohelnice, unfortunately, we can say nothing about the relationship between the wells and the houses due to the unexcavated part of the settlement. In Brno-Bohunice, the well is located inside the settlement. The well certainly did not belong to the inhabitants of the nearest house, as demonstrated by the superposition with its building pit. The well can be considered communal, with no relation to a specific house. According to radiocarbon dates, the well probably declined before the construction of enclosure. Moreover, it is possible that the well was filled intentionally. So we can assume that the enclosure no longer had anything to do with the well. In Uničov, the well may have belonged to the inhabitants of two houses. It is also possible that these layouts originally represented only a single very longhouse. However, we cannot rule out that it may have been a communal well, serving the inhabitants of the entire settlement. In both Moravian sites, we can assume a model of shared communal wells similar to that in Droßdorf-Peres and Schkeuditz-Altscherbitz, where only a single large well was built for 70-75 houses within 250-300 years, specifically at the end of the settlement period. Both settlements were quite distant from the watercourse (Stäuble & Schell, 2020). The Schönebeck settlement was also used to investigate the relations and connections between houses and wells. The wells were created one after the other, and a new well was built near the abandoned one, because from this part of the terrain it was known that the groundwater can be reached at shallow depths (Bogen, 2012). Even in the settlement of Erkelenz-Kückhoven, only one well was documented. Due to the special location, it can also be assumed that it was used together. The well was built in an area, which was intentionally left free but closed and is interpreted as a semi-trailer (Lehmann, 2004, pp. 267, 296).

The communal wells were located in open spaces within a settlement, either in central position or at the edge of the settlement area. Such a situation was detected in Füzesabony-Gubakút, where two rows of houses faced each other and the well was located in a central position as in the communal area (Domboróczki, 2001). In Schkeuditz-Altscherbitz, some wells and rich pits were situated at the periphery of the settlement and far away from houses. Houses from settlement phases before the well was built and used seem to respect the space around the future well. Maybe this can be seen as the remains of a (special communal) event (Hohle, 2017). The Uničov well was located relatively close to houses, but in fact it was also at the edge of the settlement area. The wells seem to be located at a considerable distance from the houses also in other LBK settlements; for example, Sajószentpéter (Király & Tóth, 2015), Eythra (Stäuble & Veit, 2016), Leipzig-Plaußig (Friederich, 2017) or Tiszakürt-Zsilke-tanya (Fülöp, Lömhardt, Szabó, & Váczi, 2018).

The uneven distribution of wells over the settlement area could also be caused by environmental conditions. The first farmers were familiar with the landscape and they probably had the basic knowledge of hydrology (Pavlů & Zápotocká, 2013, p. 56). In Mohelnice, three out of four prehistoric wells are

concentrated in one place. There might have been a surface spring or a small quagmire, so a place easily recognisable in the landscape and suitable for the construction of a well. This hypothesis is supported by the dating of wells: No. 224 belonged to LBK, No. 254 probably belonged to Bell Beaker Culture and No. 256 to the Early Bronze Age. In well No. 255, there were two constructions: an older one from the LBK period and a second one from the time of Funnel Beaker Culture. We can therefore prove that this waterlogged place was regularly used to build wells from the Neolithic to the Bronze Age. The location of the Brno-Bohunice settlement is today called Rybnická (the toponym means pond in English). Hypothetically, this may also indicate the existence of a visually identified waterlogged place here in Early Neolithic period. In Droßdorf-Peres, six LBK wells were uncovered in a similar shallow and wet depression (Kretschmer et al., 2016). The location for the water well in the settlement in Uničov was also selected probably based on geomorphology. The builders of the well probably supposed that the groundwater level at this place would be easily accessible because of the nearby stream. The presence of groundwater was also indicated by vegetation (Vostrovská et al., 2020, pp. 85–88).

4.2 Water Management at the Beginning of the Neolithic

The role of water management increased, entailing the planning, development, distribution and managed usage of water resources at the beginning of the Neolithic. LBK settlements were located on the edges of valleys, on low terraces with a gentle slope. The proximity of a water source was of key importance. The settlers occupy a certain segment along a smaller waterway, utilising the entire space, even unsettled areas, for necessary social and farming activities. The settlements were mostly supplied with surface water from rivers and streams (Pavlů & Zápotocká, 2013, p. 56). In Mohelnice and Brno-Bohunice, the nearest source of surface water is located ca. 1,000 m away; in Uničov, it is located 230 m away. Nevertheless, even with unlimited running water available, the first farmers dug their own water sources. They built short-term water reservoirs and wells directly in the settlement. This indicates that other factors were taken into consideration. It is much more convenient to draw water from a well or water reservoir within the settlement than to go to the watercourse bank which is much farther away. In general, the water obtained from both types of sources was probably of substantially similar quality. However, the complexity of the wells could indicate different uses – water, which looked largely free of other particles, was probably more used for food production and water from reservoirs more for watering livestock or for agricultural activities. The use of surface water on the one hand and groundwater on the other could have been different. Regarding the organisation of the use of wells and water reservoirs, they were probably used by households or groups of certain households. In the case of surface water, there appear to have been free access points to the watercourse used by several groups of people. Anyway, the main difference compared to wells is that the watercourse has always been used by several settlements (Balkowski, 2018, p. 323).

It is possible that the first farmers emphasised the special nature of wells and did not use them for the standard settlement water supply (Tinapp, Schneider, & Stäuble, 2013, p. 533). Furthermore, a well was not just a water source, but it also became a cultural symbol, related to local religion and customs. Numerous ethnological examples show that the strict separation of, for example, profane and sacred meanings of water does not correspond to reality (Hahn, 2012). At the same time, the use of groundwater on the one hand and surface water on the other should not be seen as a completely different water extraction strategy. Rather, it can be assumed that both were important in profane and ritual contexts, which cannot be clearly separated. Moreover, the use of groundwater was very important, if the watercourses were not waterbearing. Wooden linings were preserved in some of the uncovered wells (Rybníček et al., 2018, 2020; Stäuble & Schell, 2020; Tegel, Elburg, Hakelberg, Stäuble, & Büntgen, 2012; Vostrovská et al., 2020). The wooden lining of the well was intended to reinforce the walls of the well shaft and prevent them from collapsing. One of the prerequisites for getting clean water is to protect the wellspring from contamination. The space between the wooden lining and the wall of the well pit was usually very thoroughly filled with some additional material. The wooden lining of the Uničov well was daubed from the outside with a layer of

gray clay (Vostrovská et al., 2020, p. 95). We suppose that it was a shield sealing of the well construction. In log-built wells, on the other hand, the chinks between logs were filled with moss, for example, in Erkelenz-Kückhoven (Weiner, 1992, p. 32), Zipsendorf (Einicke, 1998, p. 77), Eythra (Stäuble & Campen, 1998, p. 8), Schkeuditz-Altscherbitz (Elburg & Herold, 2010, pp. 24–27) and Leipzig-Plaußig (Friederich, 2017, pp. 404–405). The well builders wanted to avoid seepage from surrounding sediment and they knew that it was necessary.

The repairs and dendrochronological dating demonstrate the enthusiasm with which the first farmers took care of the wells for decades of their use. The wooden lining of the Uničov well constitutes direct evidence that the construction was repaired during its use; there was the one post leaned on three boards, whose right end dropped out from the groove of the corner post. Lateral pressure of the water-bearing sediment disrupted the integrity of the wooden lining and the first farmers solved this problem by creating a post barrier (Vostrovská et al., 2020, pp. 70–72). Evidence of repairs is known from several LBK sites. The second and third constructions of the well in Erkelenz-Kückhoven were built due to damage to the first wooden lining after a maximum of 33 years (Weiner, 1998). Eythra No. 21 was repaired after about 70 years of usage (Tegel et al., 2012). The well in Leipzig-Plaußig is the longest documented functioning well, about 180 (!) years (Friederich, 2017, pp. 421–440). The repair of well No. 1368 in Arnoldsweiler-Ellebach, i.e. the construction of the second external well lining, took place 23 years later (Balkowski, 2018, pp. 247–254). In the case of Uničov, we can also observe other evidence of the maintenance of the well during its use. After it was damaged and repaired, the well lasted for a longer period of time. Evidence is known that water was pulled from the well daily, that the well was cleared out and that the original fill was removed during the repair (Vostrovská et al., 2020, pp. 72–84).

Pulling the water from a well required additional technology, such as an aboveground construction, for example, with winch. During the excavations of all Moravian wells, no postholes or anything alike were detected in the upper part of the well. Such finds are only known from the LBK well at Erkelenz-Kückhoven (Weiner, 1995). The layout of the well shaft at Uničov was identified at a depth of 120 cm below the hidden surface. So it is possible that first, groundwater was accessed through the mouth of a wide funnel-shaped pit, or second, this funnel is a remnant of construction processes. There is still a possibility that structures on the surface to pull the water are not preserved. Nevertheless, we can say with certainty that the mouth of the Uničov well was not completely covered with a lid during its operation period. The plant species detected in the well-fill are mostly light-demanding and they grew there spontaneously (Vostrovská et al., 2020, p. 95). If we look at the vertical sections of the Mohelnice well No. 224 and Brno-Bohunice well, we can assume a similar principle.

The first farmers managed water in a certain rhythm. Water management covered an entire cycle of activities from bringing water from the source, through its storage and use to waste water disposal. Containers made from organic materials were mainly used for the pulling of water from reservoirs or wells. They were pulled up with the help of a winch or were lowered on a cord directly by hand. Fragments of wooden buckets were found at the bottom of the Mohelnice well; while no containers made from organic material were found in Brno-Bohunice or Uničov. Fragments of Mohelnice buckets exactly correspond to Schkeuditz-Altscherbitz buckets (Stäuble & Schell, 2020, p. 13). Wooden containers of different construction were documented in the wells in Erkelenz-Kückhoven (Weiner, 1997) and Eythra (Stäuble & Campen, 1998). It is obvious that pottery also played a role in this cycle. Two whole ceramic vessels, a storage jar and a bowl were found in the Uničov well. Bottles may have been intended for drinking water; storage jars, on the other hand, were used to keep water ready for use over a longer time. Bowls may have been used for food preparation, and also for hygienic purposes. Smaller containers were used to collect water and drink it (Pavlů, 2008).

The involvement of the first farmers with their environment incorporated not only plants, animals, raw materials for making tools, objects and constructions, but also hydrological and geological knowledge. They had the technological capacity to dig wells from the surface into aquifers, thus reaching the water level. The clear expression of their engineering abilities adds another aspect to the domestication of their landscape (Garfinkel et al., 2006). The mental concept of water could be part of a domestication package. The first farmers appropriated waterscape and got control over the water, as did plants and animals.

Artificial creation of their own water sources could also be a prestigious matter associated with the social hierarchy of LBK settlements. From post-Neolithic period, we know water reservoirs and wells with wooden lining, but the findings are not as numerous as in the Early Neolithic. The construction of wells can be considered a cultural phenomenon, which does not depend on the availability of surface water and in younger periods of Prehistory, it was not repeated. But we do not have any data that could explain it clearly and distinctly.

5 Conclusions

One of the most important parts of human life is the water supply. Around the mid-sixth millennium BC, the first farmers settled down near watercourses. Storage and land-use are the key socioeconomic sectors in which new water techniques influence, trigger and protect new modes in sedentary life. However, they needed permanent freshwater sources in close neighbourhood, so they started digging permanent wells and water reservoirs within the settlement. The possibilities of spatial and temporal distribution within settlements were considered; whether each household, or at least each settlement, had its own well and how long the well was used. It turned out that in the Moravian region, the social relation between the large longhouses and the wells in their immediate neighbourhood has not been proven. On the contrary, there may have been shared communal wells, serving the inhabitants of the entire settlement. Moreover, geomorphological conditions were a key factor for choosing the location to build a well. All studied wells were located in open spaces within a settlement, therefore it seems reasonable to classify them as communal installations, so they were not a sign of social inequality. The finds of the Moravian wells rather support the hypothesis that one well supplied the current settlement with sustainable water. Sealing and repairs of the well constructions prove that the first farmers maintained the wells over a long period of time. On the contrary, it appears that the wells were intentionally filled in and this act could have had a symbolic meaning. Water management covered an entire cycle of activities. We can assume that groundwater was accessed through the mouth of a wide funnel-shaped pit, so the well was apparently open. Containers made from organic materials were mainly used for the pulling of water from pits or wells, while ceramic vessels were used for food preparation, storage and drinking of water.

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