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From LBK to SBK: Pottery, Bones, Lithics and Houses at the Neolithic site of Hrdlovka, Czech Republic

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Abstract: The paper is focused on the period of cultural change at the turn of 6th and 5th millennia BC, when the uniform Linear Pottery Culture (LBK) occupying an extensive area disintegrated in several local groups or cultures, including the Stroked Pottery Culture (SBK) emerging in the regions of Bohemia and Saxony. The data comprising pottery, animal bones, lithics, as well as architectural attributes from Hrdlovka site, situated in northwest Bohemia, are presented. In accordance with the sites of Hrbovice-Chabařovice and Dresden-Prohlis a rather uninterrupted LBK/SBK transition has been observed, which contrasts with the image of “LBK crisis” observed in other regions. Lithics production and distribution networks of raw material seem to be stable. The change in stockkeeping strategies correlating with the transitional period are considered rather as modification of local environmental conditions. On the level of households, a similar architectural development has been documented at the Hrdlovka and Dresden-Prohlis sites. The processes of LBK/SBK transition in terms of cultural change are also discussed.

Keywords: Neolithic longhouse, ceramic analysis, chipped stone industry, animal bones, culture change, northwest Bohemia

1 Introduction

The Linear Pottery Culture (Linearbandkeramik, LBK, 5600/5500–5000/4950) occupied in the phases of its largest extension a wide area reaching the Paris Basin in the west and the banks of the Dniepr river in the east. This “Bandkeramia” (van de Velde 2007, 122) may be seen as one cultural milieu formed by shared attributes, particularly the longhouses expressing the status and economy of the early Neolithic farmers (Coudart 2015, Borić 2008, Hodder 1990). The uniformity, real or seen through the distorted mirror of material culture (cf. Modderman 1988), apparently disintegrated at the turn of 6th and 5th millennia, when several local groups with specific stroked vessel decoration emerged in different regions.

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The scope of this article is the onset of Stroked Pottery Culture (Stichbandkeramik, SBK, 5000/4950–4400). There are several sites in Saxony and northwest Bohemia published in the last decade displaying a rather smooth transition from linear to stroked decoration (Zápotocká, Muška 2007, Zápotocká 2009, Link 2012, 2014a). The transition is documented particularly in terms of pottery production, where the development from late LBK linear techniques to the earliest types of strokes was recorded. Also the architecture of longhouses reveals a similar trajectory of smooth transition in construction attributes.

The issue will be studied on the example of the Hrdlovka Neolithic site (northwest Bohemia, Czech Republic). The chronological analysis confirmed the long-term Neolithic occupation of LBK and SBK cultures, therefore new data for the decline of LBK, and the emergence of SBK, will be presented in the categories of ceramics, lithic industry, animal bones as well as longhouse architecture.

The Hrdlovka site was excavated from 1987 to 1990 during a salvage archaeological campaign. The major part of Podkrušnohoří basin, where Hrdlovka was located, was actually affected by large-scale open cast mining aiming at the tertiary coal seams. On the one hand, the overburdens in the mine forefields represented a good opportunity for archaeologist to investigate the large archaeological terrains, and on the other the excavations often suffered from a lack of time (Beneš et al. 1993). The excavated area comprising in total 8.4 hectares was divided into four separate areas (Figure 1). Whereas the V and Z areas were sampled only by 3-meter-wide mechanical trenches of several extensions, the areas SJ and B were excavated extensively. On the overburden area a total of 2057 sunken features were recorded. The majority can be assigned to the Neolithic period, but the settlement and burial activities from the Eneolithic (Late Neolithic), Bronze Age, La Tène and the Early Medieval period were also investigated (Beneš, Dobeš 1992, Beneš 1998, Beneš 1999). The long-term occupation during the Neolithic period, comprising the LBK and SBK components, was already recorded in the preliminary evaluation published after the field work (Beneš 1991). This fact is reflected in the total number of 59 identified Neolithic longhouses; however, due to the above-mentioned overburden strategy, only part of them were excavated and investigated to a full extent. In particular, the area SJ offers the best insight into the spatial arrangement of the Neolithic settlement.

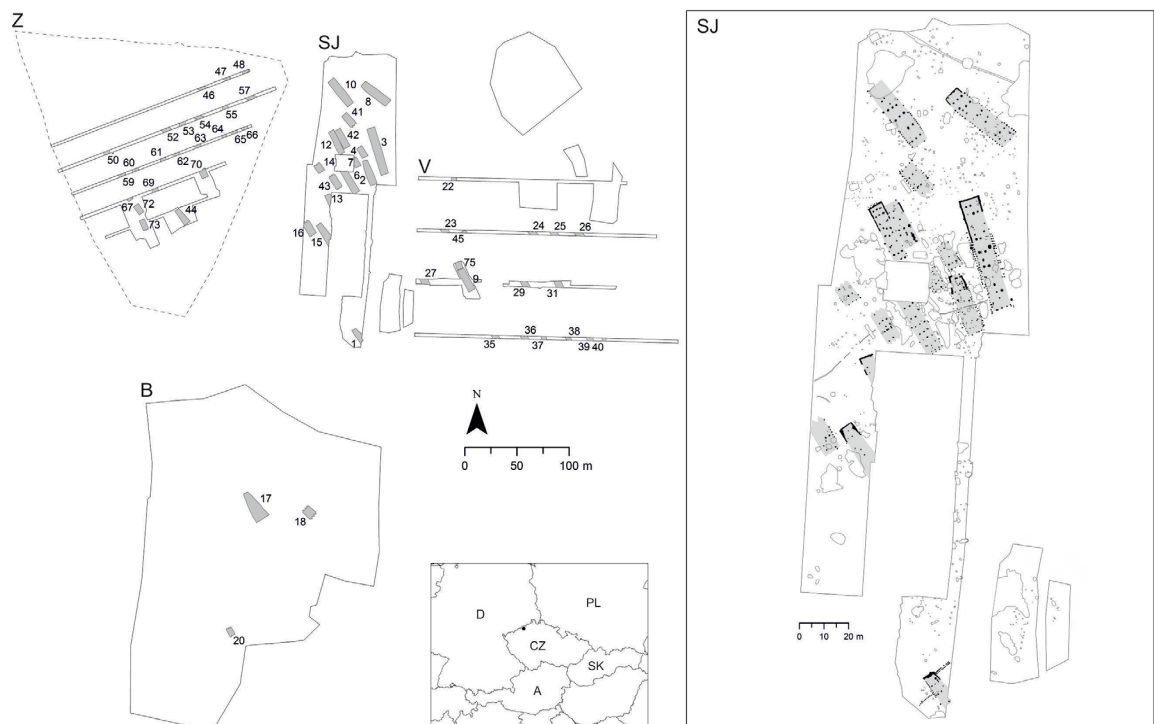


Figure 1. Plan of Hrdlovka settlement with marked overburden areas and numbers of longhouse ground plans. Detail of SJ area on the right.

2 Material and Methods

The site processing and data analysis are focused on crucial aspects of settlement archaeology, namely on artefacts and ecofacts, general site evaluation, chronology, longhouse architecture and regional development.

The essential entity of analysis represents the entire sunken feature as a comprehended contextual unit. Theoretically, this is not the most suitable attitude. In the frame of many features further partial contexts could have been distinguished (layers, additional pits, projections, lobes, pit complexes etc.), and these should have created a basic unit for the analysis. Unfortunately, the capabilities of the field excavations were influenced by the salvage character of the whole campaign. The detailed excavation of individual features suffered by lack of time and on that account many of them was excavated by “surface to bottom” system (labelled as “0-bottom”) and material from the feature infill was not separated according to any stratigraphic units.

2.1 Ceramics Analysis

Ceramic fragments were assigned to ceramic individuals at the level of their archaeological context (layers or features). For the linear pottery description the system developed at the Bylany site, Czech Republic, was used (Soudský 1967, Pavlů 1977, Květina, Pavlů 2007). Stroked ornamented pottery was described according to the system of M. Zápotocká (1978, 1998). The ceramics analysis is a crucial source of data, particularly for establishing the settlement chronology, and the decoration of the vessels is the most critical attribute in that system, especially the techniques forming the individual styles (Figure 2, Květina, Končelová 2013, 2-3); however, the vessel shape also adds supplementary value. The total assemblage of Neolithic ceramics, comprising 13.866 ceramic individuals from 187 sunken features was analysed.

GAM	gamma		INCIS	incised decoration in the frame of SBK pottery	
AL12	alpha 12		INDIV	individual strokes	
AL13	alpha 13		DBL_PARA	parallel double strokes	
AL20	alpha 20		DBL_S_ALT	small alternating double-strokes	
AL30	alpha 30		DBL_W_ALT	wide alternating double-strokes	
BETA	beta		DBL_S_TRE	small double-strokes made by tremolo technique	
DEL12	delta 12		DBL_W_TRE	wide double-strokes made by tremolo technique	
EPS10	epsilon 10		MUL_PARA	parallel multiple strokes	
EPS20	epsilon 20		MUL_TRE	multiple strokes made by tremolo technique	
EPS30	epsilon 30		ROSS	Rössen strokes	
THETA	theta		STRI	striated strokes	
ZETA	zeta		TRE	tremolo strokes	

Figure 2. Linear and stroked pottery decoration styles recorded at Hrdlovka.

2.2 Lithic Analysis

The stone industry was evaluated using the method published by P. Šída (2007). Raw material determination was based on A. Přichystal (2013). Highest attention was paid to the technotypological description and raw material determination. The assemblage was specified on the basis of chronological analysis (horizons B-H), and features dated correspondingly, but on a more general chronological level (see below).

2.3 Archaeozoological Analysis

All animal remains from the archaeological features were retrieved by hand. Animal bones and teeth were identified at the Laboratory of Archaeobotany and Palaeoecology in České Budějovice. The fundamental unit by which faunal remains were tallied was the Number of Identified Specimens (NISP) determined for each taxon. Undetermined broken bone fragments were split among large, medium or small-sized mammals. Although the assemblage only had a modest number of bones of caprines, a few of them could be morphologically differentiated (Zeder, Pilaar 2010, Zeder, Lapham 2010). Measurements were taken as described by von den Driesch (1976). For Bovinae, the acquired measurements have been compared to aurochs (*Bos primigenius*) discovered in pre-Neolithic contexts (Degerbøl, Fredskild 1970). The methodology of wild-domestic assignment was based on size reduction of either dental or skeletal elements (Payne, Bull 1988, Evin et al. 2013). Several remains of Bovinae and Suinae could not be assigned, and therefore, they were joined with genus *Bos* sp. and *Sus* sp. The stage of mammal bones weathering was described according to Behrensmeyer (1978). Whereas the animal bone specimens categorized in weathering stages 1-2 were simply marked as “slightly weathered”, the specimens in stages 3-4 were considered as “heavily weathered”. In order to work with sufficient amount of data, the analysis comprised not only the assemblages chosen on the basis of chronological analysis (horizons B-H), but also features dated correspondingly, but on more general chronological level (see below).

2.4 Chronological Analysis

The chronology of the Hrdlovka settlement area, with its palimpsest of sunken features and longhouse ground plans, represents a complex issue that extend beyond the limits of this paper; thus, only a brief overview of the methodology is presented here (for more details, see Vondrovský 2015).

The chronological analysis was performed in two subsequent steps – by way of chronological models. *The first chronological model* was based on the Detrended Correspondence Analysis (DCA) of ceramic assemblages from individual sunken features representing essential units with no regard to their spatial relationships. The result should clarify essential trends of the Hrdlovka chronological development and provide data for the subsequent analytical step. The statistical analyses were performed in Canoco 5 interface (ter Braak, Šmilauer 2002, Šmilauer, Lepš 2014).

The second chronological model has integrated previous data and spatial setting of sunken features to separate particular settlement horizons. An important evidence of non-contemporaneity brought the negative spatial relations of features, which were recorded by the mutual overlapping observed already in the ground plans of the features (sometimes called horizontal stratigraphy). However, the dark infill usually did not allow the identification of interfaces of individual depositions, therefore law of superposition (Harris 1989, 30-31) indicating the earlier and later feature could not be always employed. Furthermore, the overlapping of sunken features and house ground plans (functional conglomerate of sunken features – postholes and wall trenches) were only sporadically noticed at Hrdlovka.

The quantitatively higher source of spatial information introduced to the chronological model the concept of house *construction complex*. It can be defined as an essential chrono-spatial entity in the settlement area pattern comprising the longhouse ground plan itself and the associated sunken features, which are spatially delimited by the external area of the house defined as the area in the house 5 meter surroundings (Pavlů 1977, 13-14). Mutual overlapping of external areas can be considered as a negative

spatial relation and thus it should indicate different chronological levels of particular construction complexes – house ground plans as well as adjacent features. On the other hand, the concept of a construction complex can also provide positive chrono-spatial relations. There is a supposed functional linkage between the house and sunken features situated within the external area of the house. While this procedure seems to be applicable in the case of LBK and early SBK longhouses, the settlement organisation has changed at the turn of the late SBK, and the building pits are fading away from the house closest surroundings (Burgert et al. 2014).

Combining all the sources mentioned above, it was possible to establish the conclusive chronological outline. A kind of Harris matrix was used for displaying the relative sequence of stratigraphic units in time, which means plotting all the identified stratigraphic relationships (Harris 1989, Fig. 12:B). Such a diagram is not a Harris matrix in essence, because the latter outlines a simplified view on direct stratigraphic relations according to the law of stratigraphic succession (Harris, Reece 1979). However, the Neolithic settlement areas are characterised particularly by the superposition observable only in a horizontal direction (see above). Although they indicate the non-contemporaneity of spatial structures, they do not reflect the chronological sequence.

The last step of the chronological analysis was performed by the synchronisation of local Hrdlovka chronology with the general sequence of the Neolithic in Bohemia. Referential assemblages were intentionally chosen only from the Podkrušnohoří region if possible (Table 1), thus a regional pattern was preferred to the generalized pottery development from the wider area of the Bohemian region. According to our opinion, it should bring more accurate results. The DCA method seems to be most suitable for synchronisation.

Unfortunately, the relative chronology could not be significantly adjusted by absolute radiocarbon dating. Here, we are facing the lack of suitable samples. The rescue excavation methodology in the 80s and early 90s did not comprise sediment flotation or wet sieving, therefore no archaeobotanical macroremains are available for radiocarbon dating. Thus the animal bones were chosen for ^{14}C , which appeared to be also problematic, because of bad bone preservation resulting in low collagen content.

Table 1. The referential assemblages from Neolithic sites, which were used for synchronisation.

Chronology	Assemblage	Reference
LBK Ib	Nové Dvory 2, construction complex 39 Nové Dvory 2, construction complex 11	Pavlů 2002
LBK IIa	Březno u Loun, horizon I	Pleinerová, Pavlů 1979
LBK IIb	Malé Březno, sunken feature 11 Březno u Loun, horizon II	Šumberová 1995 Pleinerová, Pavlů 1979
LBK IIIb	Chotěbudice, sunken feature 77	Šumberová 1994
LBK III	Krbice, construction complex D 94/2 Krbice, construction complex D 95/1 Krbice, construction complex D 95/8	Káčerik 2011
LBK IV	Hrbovice-Chabařovice, sunken feature 36/78 Hrbovice-Chabařovice, sunken feature 47/78	Zápotocká, Muška 2007
LBK IV/ SBK I	Hrbovice-Chabařovice, sunken feature 31/78	Zápotocká, Muška 2007
SBK II-III	Hrobčice, features of Early SBK Vchynice, sunken feature 37 Hrbovice-Chabařovice, features of Early SBK	Rauerová 2013 Řídký et al. 2013 Zápotocká, Muška 2007
SBK IV	Hrobčice, feature of Late SBK Vchynice, sunken feature 20	Rauerová 2013 Řídký et al. 2013

3 Results

3.1 Hrdlovka Settlement Chronology

The first chronological model comprises 73 sunken features with a total number of 1722 ceramic individuals bearing a determinable style of decoration. The important intervention in the correspondence analysis represents the reduction of weight in the case of the simply incised line decoration style (delta 12), which became only a supplementary variable. This decoration style was common during the large part of LBK period (Pavlů, Zápotocká 2013, 30-38), therefore it might introduce an undesirable distortion to the model. The assemblage of feature 559 will also be excluded from the analysis, as it is the only case in which the gamma decoration style occurred. Therefore, its presence in the DCA ordination space would cause an undesirable line effect. Moreover, it appeared to be a significant outlier in the chronological model, which caused a significant increase in the ordination gradient, and consequently made it difficult to distinguish some of the details in the ordering of other ceramic assemblages. Nevertheless, according to the ceramics decoration and treatment attributes characteristic to the early LBK pottery, we can consider that feature 559 forms an independent, as well the earliest chronological horizon (Hrdlovka A). This assumption was consequently confirmed by the synchronisation analysis (see below).

In the ordination space of the first chronological model (Figure 3:A) there can be observed that the ordering of decoration styles according to their presence in particular features significantly respects the chronological pattern of the Neolithic Bohemia (Pavlů, Zápotocká 2013, 29-55). The horizontal dimension seems to represent a chronological gradient. The sequence starts by the linear pottery styles typical for the developed LBK culture: variants of wide filled-in bands (alpha 12, alpha 13, alpha 20), triple-line bands (beta) and music-notes sparsely placed along the line (epsilon 10). It is followed by decoration typical for the LBK final stage (LBK IV) in the area of northwest Bohemia (Pavlů, Zápotocká 1979). Particularly thin filled-in bands (alpha 30) were frequent at Hrdlovka, seeming to significantly accompany the music-notes placed thickly along the line (epsilon 30, zeta). The contact zone, where linear decoration is vanishing and new styles are arising, is occupied by the early SBK styles: individual strokes and small double-strokes. Incised lines, which partially persisted in the frame of stroke ornamented pottery, appeared to be an outlier. Its position is caused by the heterogeneity of this category uniting elements appearing in the SBK onset, as well as the technique of incising by multiple-point instrument, which is derived from the ordinary technique of multiple strokes used during the developed SBK period. The chronological sequence is enclosed by the styles of late SBK: wide double-strokes, multiple, tremolo and Rössen strokes. Displaying the individual sunken features in the same ordination space (Figure 3:B), the first image of the relative chronology of Hrdlovka settlement was acquired.

In the subsequent step – the second chronological model – there were the negative spatial relations recorded either by features overlapping, or on the basis of construction complex principle implemented in the DCA ordination space. It allowed the preliminary separation of some settlement horizons (Figure 4). However, according to the plot integrating negative and positive spatial relationships with data of ceramics chronological pattern, the eleven settlement horizons (Hrdlovka A-K) were identified (Figure 5). Only part of the excavated features (26 longhouses, 52 sunken features) was dated on such a precise chronological level, the rest was dated on a more general level or remained without dating.

The interconnection of Hrdlovka local sequence with the general chronology was performed in the DCA ordination space (Figure 6). The first horizontal dimension might represent the decoration style shift in time here also. As it is apparent from the position of referential assemblages in relation to assemblages of Hrdlovka horizons, the site was occupied since the early LBK I stage (Hrdlovka A horizon). The subsequent LBK II period seems to be a hiatus in the chronological sequence, but it might be caused by only merely partial excavation of the initial settlement area. Starting with the Hrdlovka C horizon (LBK III), the development seems to continue till the classic (H and probably also I horizons) and late SBK period (J and K horizons), when the Neolithic occupation of Hrdlovka site ended. Attention should be paid to Hrdlovka F horizon created by construction complexes 3 and 44 and also to the G horizon, where the assemblage

of construction complex 2 dominates. Their position in the DCA ordination space could point to the transitional phase between the use of linear and stroked decoration. Therefore, the following analysis will focus on these chronological levels.

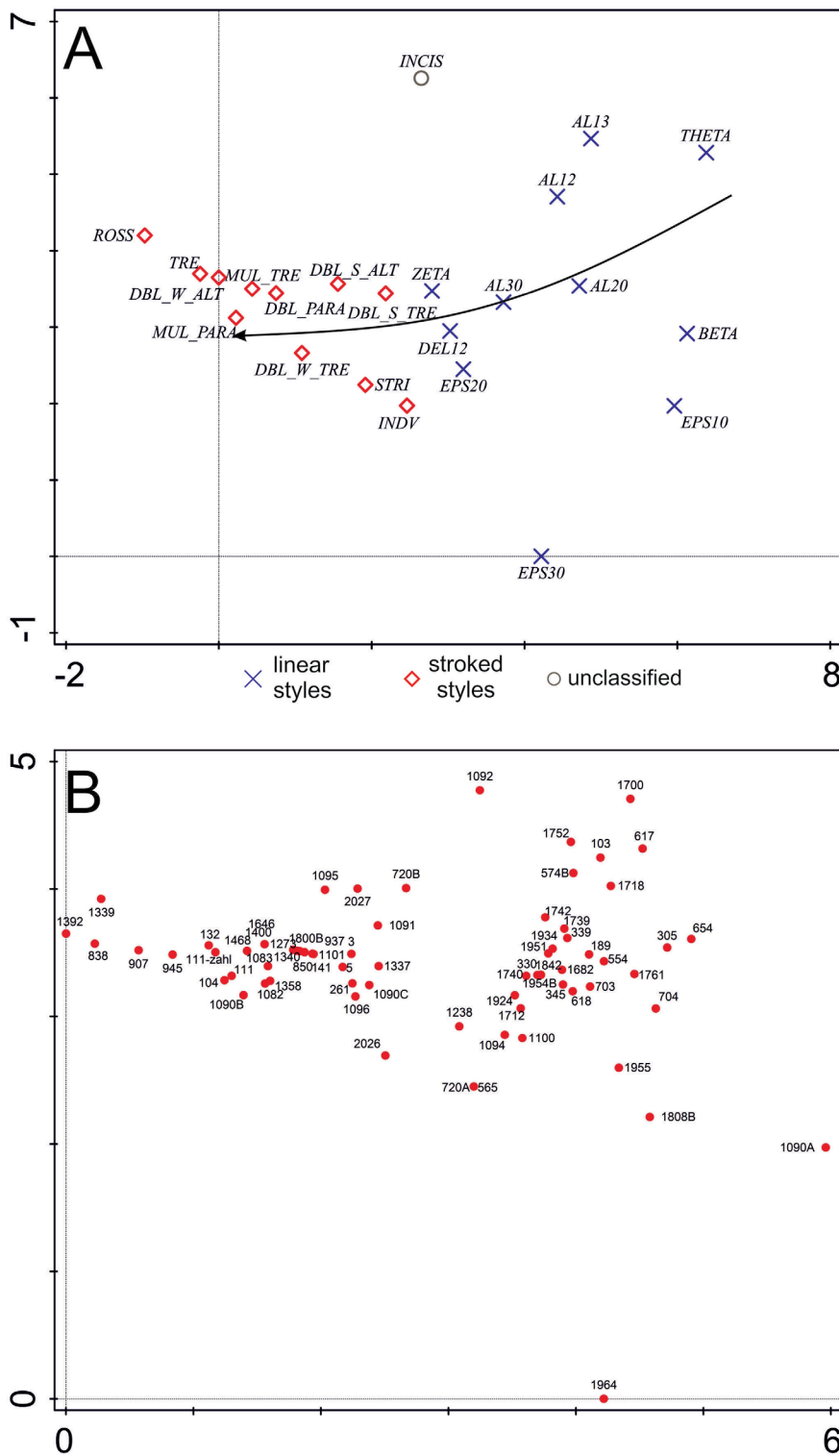


Figure 3. Detrended correspondence analysis of decoration styles (A) and Neolithic sunken features (B). The first axis explains 17.9 %, the second 10.7 % of the variability. The arrow indicates chronological gradient. For styles abbreviations see Figure 2.

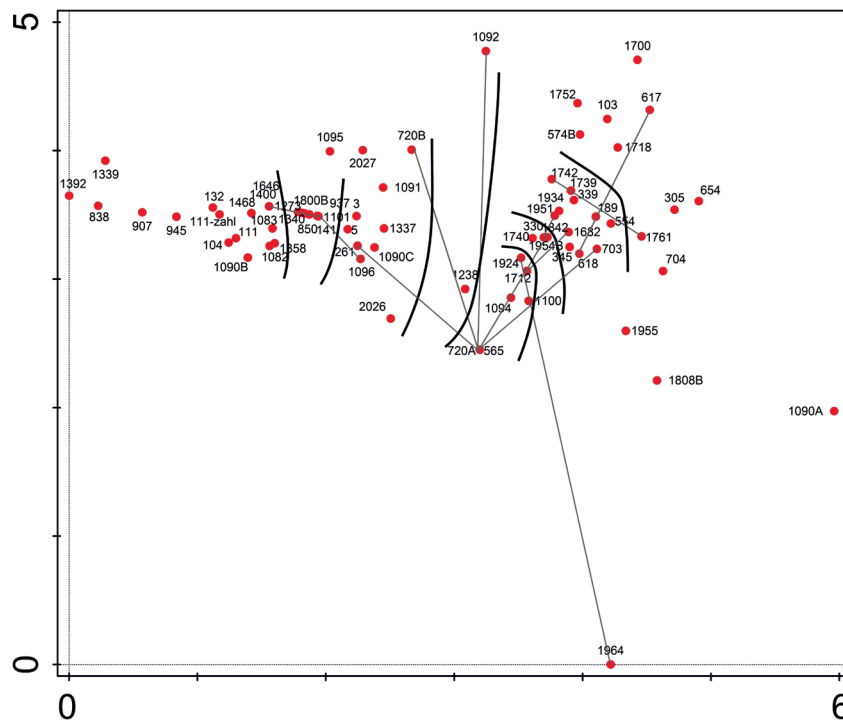


Figure 4. Detrended correspondence analysis of sunken features and their negative spatial relationships (grey line) based on direct overlapping or affinity to construction complexes. Supposed separation of settlement horizons is displayed (black line).

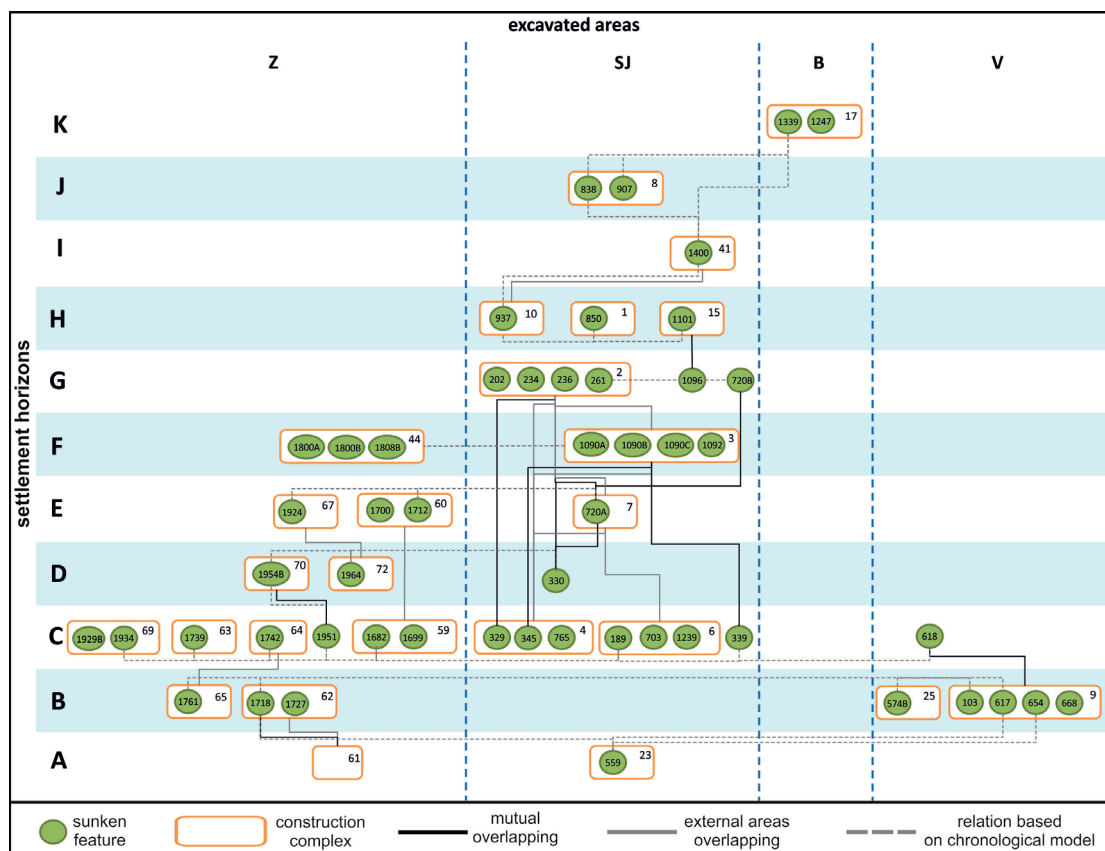


Figure 5. The second chronological model of Hrdlovka site established on the principle of Harris matrix.

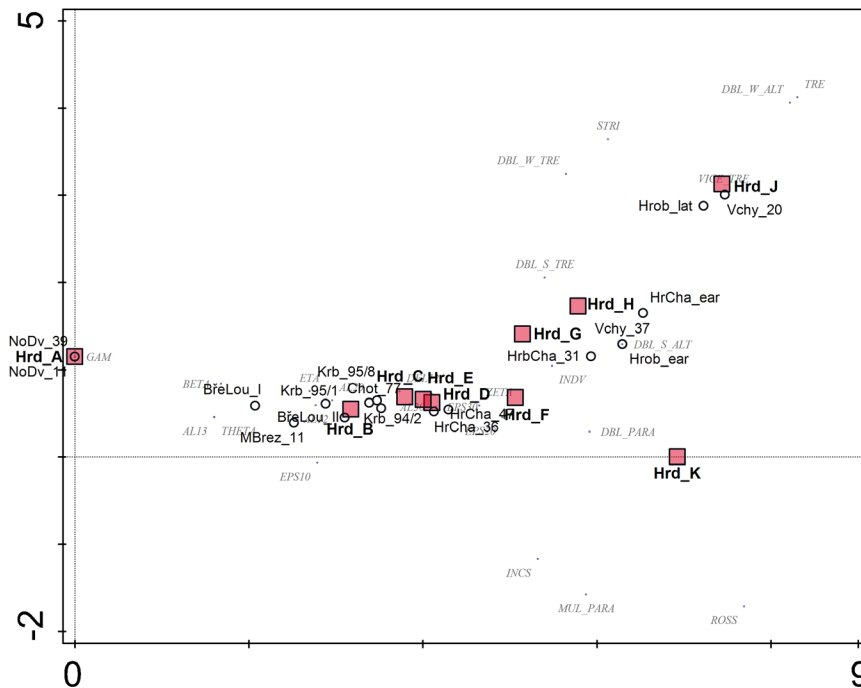


Figure 6. Detrended correspondence analysis of referential and Hrdlovka settlement horizons assemblages. First ordination axis explains 19.6 %, second 8.5 % of variability. The delta 12 decoration style is supplementary variable.

3.2 Pottery Decoration

The majority of decorated ceramics in the assemblage of Hrdlovka F horizon comprised the linear decoration (22%), while the stroke ornamented ceramics was in a slight minority (9%). Styles of linear pottery were represented particularly by the thin filled-in bands, the so-called ladder type (alpha 30) and thick music-note lines (epsilon 20, zeta). Stroked ornamentation occurred in the form of individual strokes, small double-strokes, and occasionally, multiple strokes were also recorded (Figure 7). On the level of individual decoration techniques the incised line accompanied on one side by thick individual strokes (Figure 8: 1840, 1845), which was organised in a curvilinear motif, should be noted. Pear-shaped vessels took up 46% of the total number of classified ceramic individuals (N=13). The rest comprised hemispherical vessels. Linear decoration motifs can be characterised by spirals running around the vessel with complementary decoration on the vessel upper part.

In the subsequent Hrdlovka G horizon assemblage linear techniques still persisted to a certain degree (4%). Apart from the common simple incised line (delta 12), ladder type band (alpha 30) or thick and medium thick music-notes (zeta, epsilon 20), together with small amount of subsiding wide filled-in band (alpha 12), were also recorded. The wide groove (gamma), a typical decoration of early LBK period, found in sunken feature 202, is considered to be intrusive (see Discussion). The stroked ornamentation was much more frequent (15%) in comparison to the linear decoration. The more commonly recorded were the small alternating double-strokes, but individual strokes were also frequent, and both were usually organised in chevron motifs. The decoration technique of a line accompanied by individual strokes was also recorded in this assemblage. The fully developed pear-shaped vessels dominated (58%) the assemblage of determined ceramic individuals (Figure 9: 20, 264, 668), accompanied by hemispherical vessels and bowls.

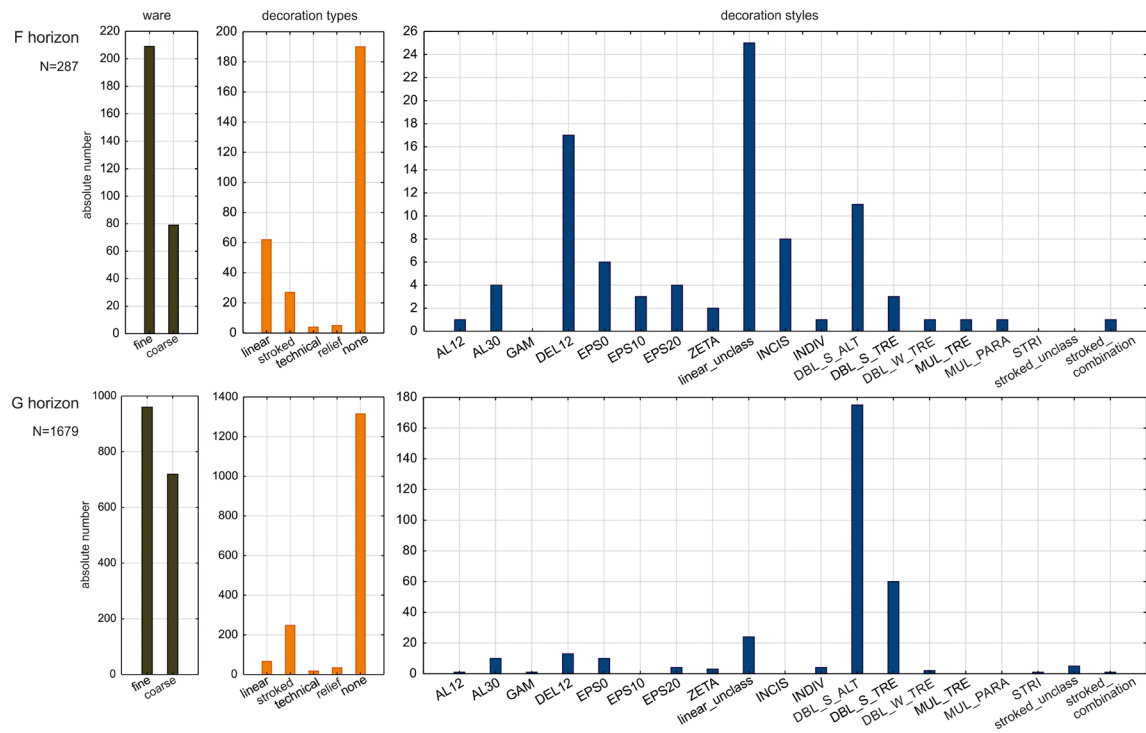


Figure 7. Attributes of F and G horizons ceramic assemblages. For styles abbreviations see Figure 2.

3.3 Stone Industry and Raw Material Sources

Having look at the overall composition of the stone industry (Figure 10), a continuous increase of chipped industry in time is apparent. The polished and other industry occurred nearly equally except for the final phase, when the percentage declined. The proportion of querns decreased more significantly.

Raw material composition of all chipped stone industry was in principal similar throughout the whole study period (Figure 11) in which the same raw materials occurred. However, the ratios of individual raw materials differed in various phases significantly. The local quartzites of northwest Bohemia dominated, being accompanied by erratic flint. A local limnosilicite and porcelanite appeared to a very limited extent at the LBK/SBK transition, and an artefact from the Bavarian chert was documented in the LBK III stage. Skršín quartzites (72.2 %), along with erratic flint (19 %), prevailed at the beginning of the study period (LBK III), while other quartzites were represented at less than 5 %. The most significant change in raw material composition can be found in the LBK IV stage, when the most frequently recorded material was Tušimice quartzite (68.8 %), followed by Skršín quartzite (25 %). Kamenná Voda quartzite (6.3 %) was also noticed, while erratic flint is absent during this phase. Then, in the transitional LBK/SBK period, similar raw materials, including erratic flint, were observed, even though their ratios were changing. The increasing proportion of erratic flint (34.3 %) was exceeding Tušimice quartzite (27.3 %). The amount of Skršín quartzite rose to 29.6 %. The other quartzites were represented at less than 4 %. Occasionally, other local raw materials were recorded. The proportion of erratic flint (56 %) continued to increase and the proportion of Tušimice quartzite (16 %) further declined during the SBK II phase. The percentage of Kamenná Voda quartzite remained at a similar rate as in the previous period (4 %).

The technological composition of the assemblage varied in time only to a small extent, with the most significant change occurring during the LBK IV stage. Three technological groups were observed – waste from chipped stone industry production (debitage without blades), blades, and retouched tools, which represent in fact the waste from other working and living activities at the site (Figure 12). The waste from chipped stone industry production dominated in all phases, which was followed by the blades, whereas

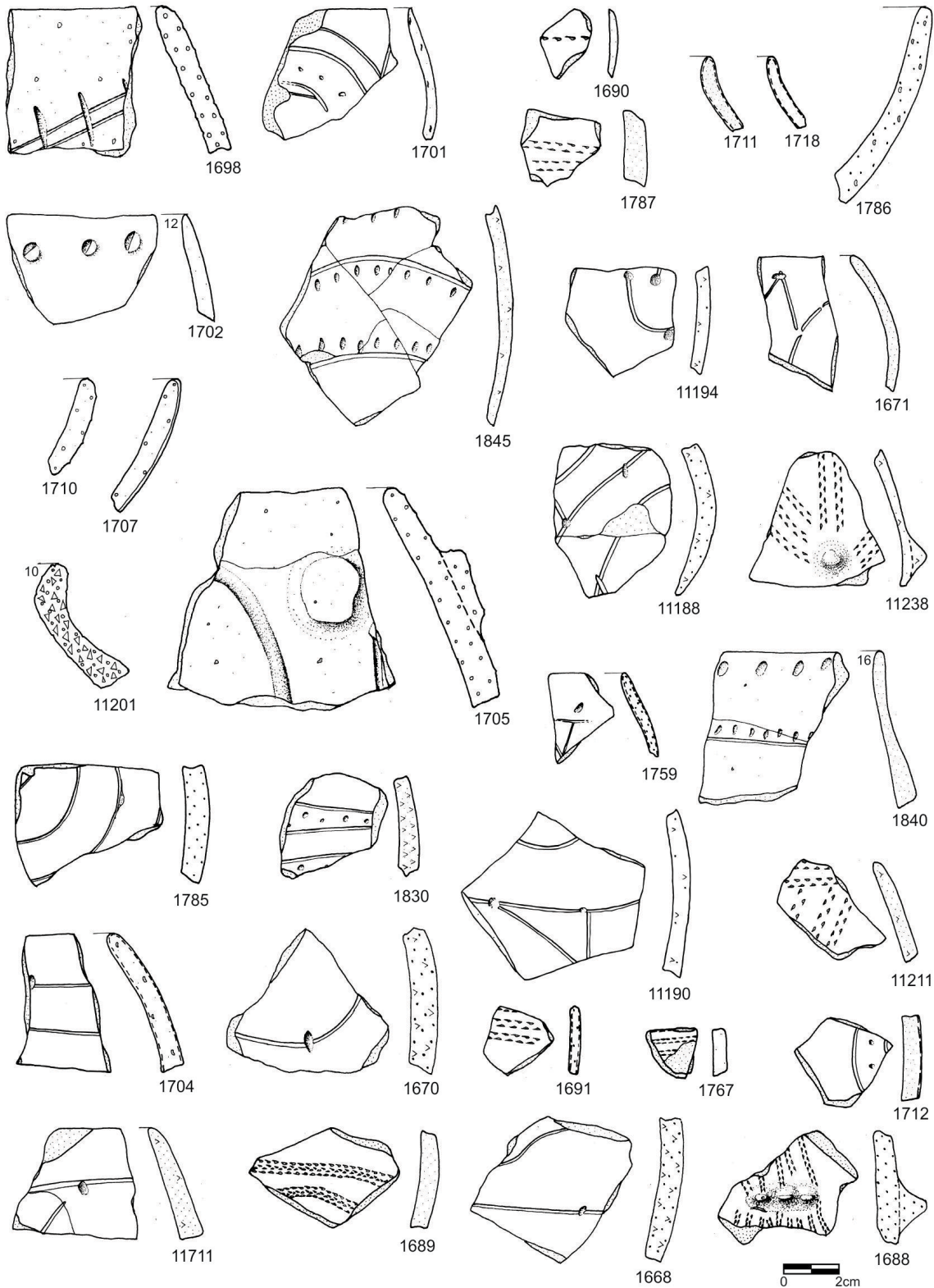


Figure 8. Selected ceramics of Hrdlovka F horizon (drawing M. Divišová, for ceramic fabric and surface treatment graphical codes see Květina & Pavlů 2007, Fig. 1).

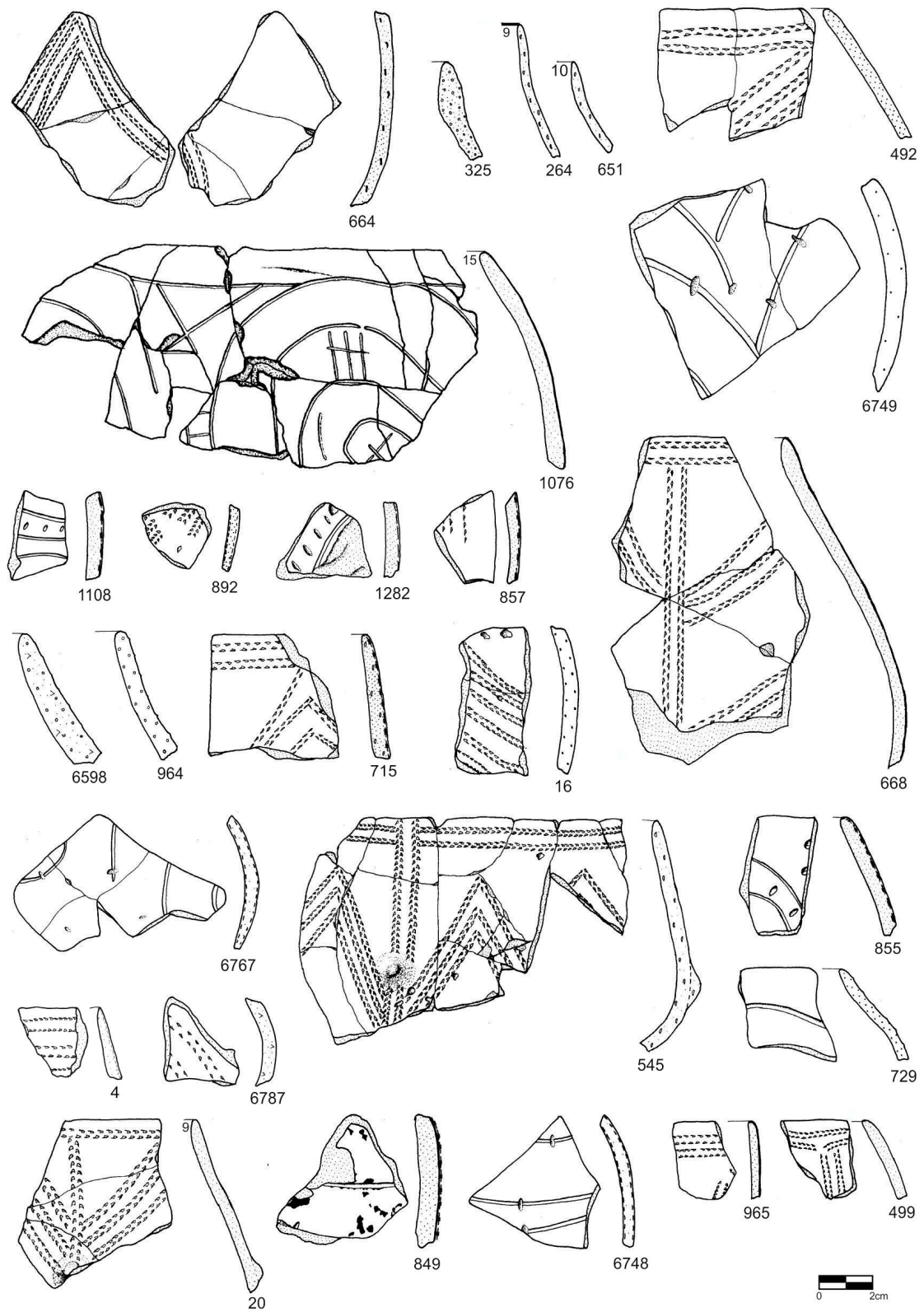


Figure 9. Selected ceramics of Hrdlovka G horizon (drawing M. Divišová, for ceramic fabric and surface treatment graphical codes see Květina & Pavlů 2007, Fig. 1).

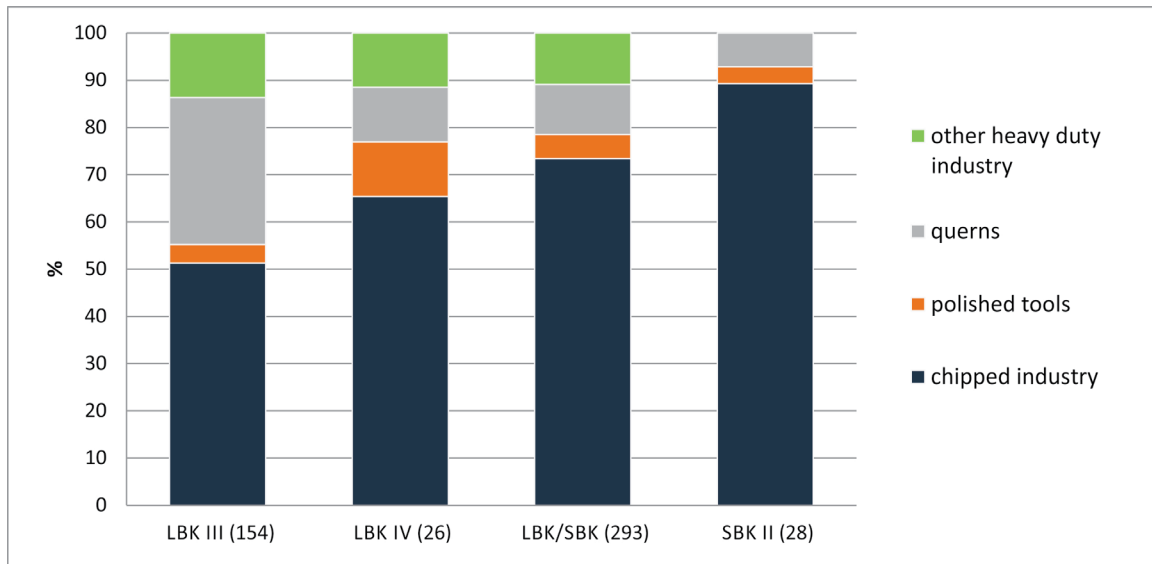


Figure 10. Basic categories of stone industry according to the chronological levels. Totals of determinations for each chronological level are represented in brackets.

the retouched tools exhibited the lowest proportion. The waste from chipped industry production covered 49.4 %, the blades formed 35.4 %, and the waste from other working activities created 15.2 % of the LBK III assemblage. The proportion of waste from chipped industry production declined slightly to 43.8 %, whereas the amount of blades rose to 50 % and the waste from other working activities decreased to 6.3 % in the following LBK IV stage. The LBK/SBK period is then characterized by an increase of waste from chipped industry production to 45.8 %, with blades forming 30.6 %, and a maximum of 23.6 % created by waste from other working activities. A significant increase of waste from chipped industry to 56 %, a decrease of blades to 24 % and waste of other working activities to 20 %, was recorded in the SBK II phase.

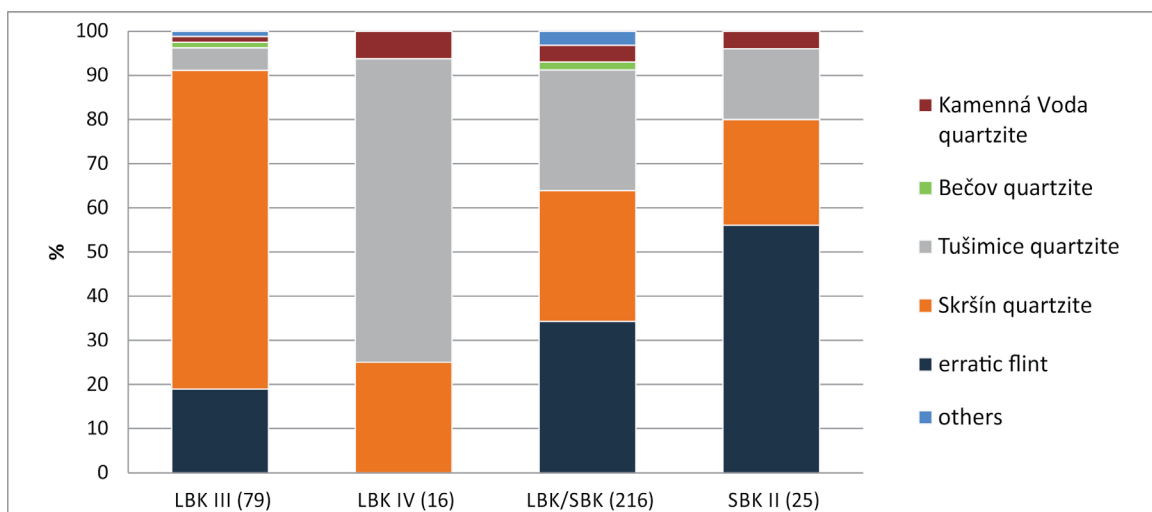


Figure 11. Percentage representation of raw materials used for chipped stone industry production according to the chronological levels. Totals of determinations for each chronological level are represented in brackets.

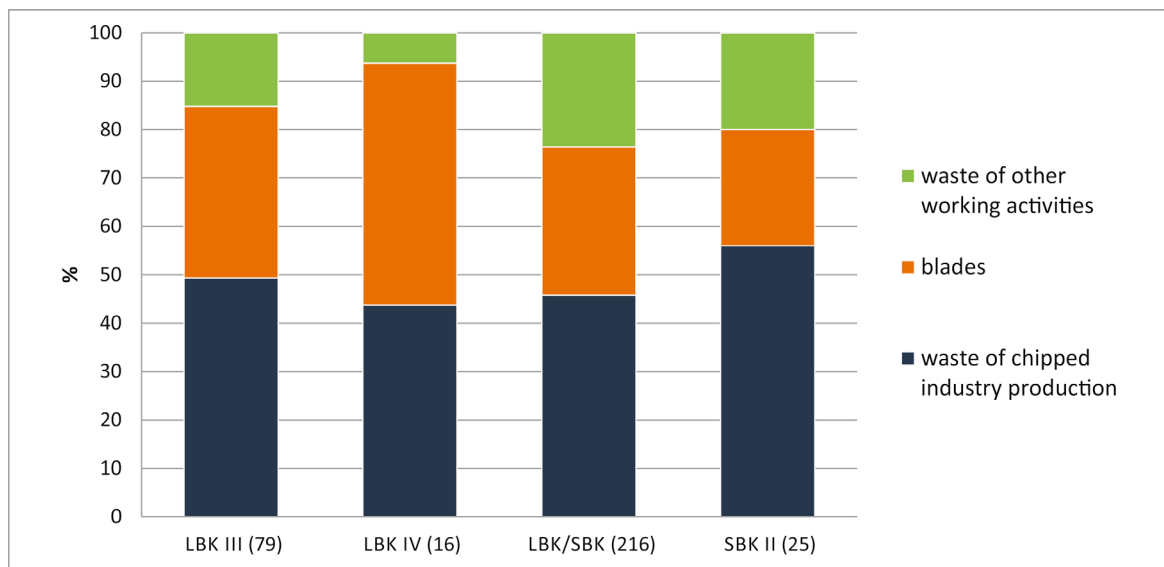


Figure 12. Categories of chipped stone industry according to the types of working activities during the chronological levels. Totals of determinations for each chronological level are represented in brackets.

3.4 Faunal Data

A detailed archaeozoological analysis investigated 2122 animal bones, teeth, and their fragments, namely 712 bones from the LBK III, 318 from the LBK IV, 805 from the LBK/SBK, and 287 from the SBK II period (Table 2). Only a small part of them, on average 18.6 %, could be matched to one of eight species. The poor state of preservation (mainly caused by weathering) and the high degree of fragmentation of the faunal remains seriously affected the identification rates and the comparison of samples with each other. The proportion of damaged and abraded bones caused by chemical and physical agents varied among chronological levels (LBK III: 61.9%, LBK IV: 33.9 %, LBK/SBK: 76.5 % and SBK II: 83.3 %). The share of heavily weathered bone remains expressed in the total amount of osteological material in every chronological stage was highest in the LBK/SBK (37.7 %) and did not exceed 5 % in the LBK IV and SBK II periods (Table 3). The animal bones were usually small. Fragmentation was especially high in the LBK/SBK features, where the large numbers of solid tooth splinters of domestic ungulates were registered (89-100 % of NISP). On the contrary, the proportions of tooth splinters of the same taxa in the LBK assemblages was considerably lower than 20% of NISP, with the exception of numerous caprine teeth in the LBK III stage (69.6%).

The studied osteological material contained primarily bone and teeth fragments of domestic animals (on average 93.4 %): cattle (*Bos taurus*), pig (*Sus domesticus*), sheep (*Ovis aries*) or goat (*Capra hircus*). Very few caprine bones from Hrdlovka could be identified to the species level, and only sheep remains were recorded in the LBK culture (Table 2). A higher proportion of sheep than goats is usually taken as an indicator of good grazing areas (Dahl, Hjort 1976). In three faunal samples (LBK III, LBK/SBK and SBK II) the remains of domestic cattle were the most numerous (Figure 13). On the contrary, the majority of caprine bones were recorded in the LBK IV stage. Two later periods of occupation of Hrdlovka (LBK/SBK and SBK II) were again connected with dominant occurrences of cattle bones. Remains of pigs were identified at the lowest least frequency. Based on the osteological data obtained, local pig rearing played a slightly more important role in the LBK III and LBK IV stages than in the LBK/SBK and SBK II phase.

Wild mammals were not very common at Hrdlovka, they represent less than 5 % of the identified vertebrate fauna and ranged between 4.1 % of NISP (LBK III) and 0.5 % of NISP (LBK/SBK). The identified taxa of hunted mammals were aurochs (*Bos primigenius*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*). We can exclude a continuous decrease of wild game bones in time during the Neolithic occupation of Hrdlovka (Figure 13).

Table 2. List of all taxa recovered in the faunal assemblage from Hrdlovka. NISP (number of identified specimens). N (number of unidentified specimens).

Animal species (NISP)	LBK III	LBK IV	LBK/SBK	SBK II	Total
Cattle (<i>Bos taurus</i>)	30	18	142	28	218
Sheep (<i>Ovis aries</i>)	2	4	0	0	6
Sheep/goat (<i>Ovis/Capra</i>)	21	32	56	15	124
Pig (<i>Sus domesticus</i>)	10	8	1	1	20
Aurochs (<i>Bos primigenius</i>)	2	0	1	0	3
Red deer (<i>Cervus elaphus</i>)	0	1	0	0	1
Roe deer (<i>Capreolus capreolus</i>)	1	0	0	0	1
Wild boar (<i>Sus scrofa</i>)	0	0	0	1	1
Cattle/aurochs (<i>Bos taurus/primigenius</i>)	5	0	1	3	9
Pig/wild boar (<i>Sus</i> sp.)	2	0	8	1	11
Total (determined)	73	63	209	49	394
% (determined)	10.3	19.8	26	17.1	18.6
Animal categories (N)	LBK III	LBK IV	LBK/SBK	SBK II	Total
Large-sized mammal	35	14	51	40	140
Medium-sized mammal	13	22	11	4	50
Small-sized mammal	1	0	0	0	1
Undetermined mammal	589	219	534	194	1536
Undetermined bird	1	0	0	0	1
Total (undetermined)	639	255	596	238	1728
% (undetermined)	89.7	80.2	74	82.9	81.4
Total (all animal remains)	712	318	805	287	2122

Table 3. Proportion of teeth of main ungulates and animal remains damaged by weathering in different chronological stages.

	% teeth (<i>Bos</i> sp.)	% teeth (<i>Ovis/Capra</i>)	% teeth (<i>Sus</i> sp.)	% slightly weathered	% heavily weathered
LBK III	20	69.6	25	37.6	24.3
LBK IV	16.7	19.4	12.5	29.8	4.1
LBK/SBK	100	100	88.9	38.8	37.7
SBK II	67.7	66.7	50	79.1	4.2

3.5 Houses and Architecture

The architecture of late LBK and early SBK periods can be documented by ground plans 3 and 44 assigned to the F horizon, and ground plan 2 to the G horizon (Figure 14). As it is obvious from the formal attributes of ground plans (Table 4), the houses do not form a homogeneous group.

Starting with the earlier horizon F, house 3, with its extraordinary length of 46.4 meters belongs among the longest buildings of Neolithic Transdanubia. The ground plan has a rectangular shape and, according to Modderman's typology (Modderman 1970) it can be described as *Grossbau* 1b type, the large tripartite house with a northern wall trench. The overall large size is reflected also in particular post holes. The maximum recorded dimension of some of the inner-row postholes, where posts supporting the roof were placed, reached up to 1.25 meter in diameter. However, the darker shadow of the original wooden post, which was well visible in contrast to the rest of posthole infill, indicated that its diameter varied between 40 and 45 centimetres. The posts in the central section are arranged in inverse J configuration (Coudart 1998, Fig. 13:3). In comparison, the side-wall posts measured between 15 and 20 centimetres in diameter. The side

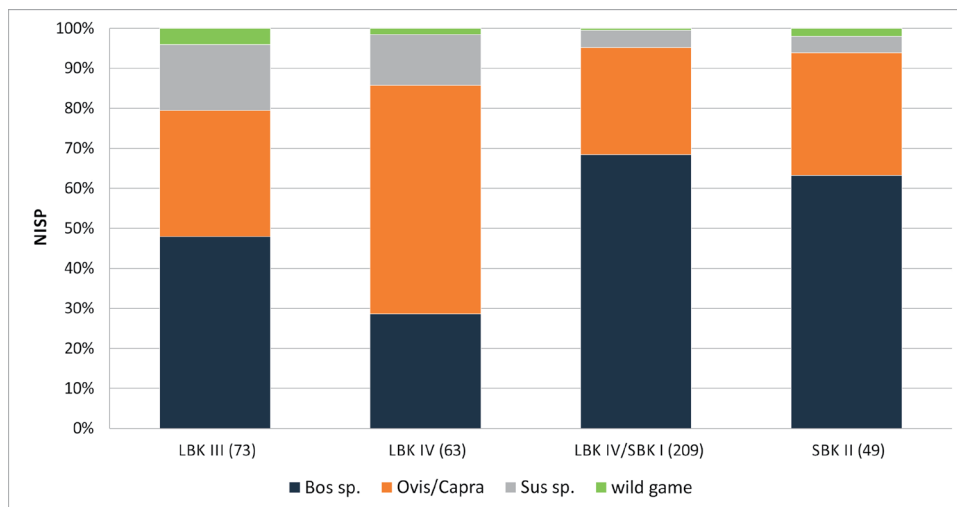


Figure 13. Comparison among the species frequencies (% NISP). NISP totals for each chronological level are represented in brackets.

walls were most probably doubled with regularly arranged posts in their full length. The simple line pattern in the southern (front) section of the house seems to be caused by different overburden depths, because this part was discovered in the 1989 season, unlike the rest of the ground plan, which was excavated in the years 1987 and 1988. However, the simultaneous use of simple and doubled walls at various house sections has also been recorded (Brink-Kloke 1992, 62). Nevertheless, we cannot fully exclude that this situation could indicate some lighter construction or an open space (cf. Stäuble 2005, Coudart 2015). The southern wall was accompanied by two short projections, or so-called *antas*. The northern (rear) section of the house was delimited by a wall trench, which was rectangular in its ground plan. The eastern part of the trench was apparently shorter, resulting in a gap where the house wall could also have been created by some kind of construction that is not archaeologically preserved (for further details see Beneš et al. 2014).

However, house 44, dated on the same chronological level, is trapezoid in its ground plan and quite short in length (16.6 meters). The southern section was missing, and only the central and northern parts were present, which defines this building as *Bau* type (Modderman 1970). Despite the very different dimensions, a very similar ratio of northern and central section lengths can be observed. In ground plan 3, the rear section comprises 31.3 % of total length while in ground plan 44 it is 45.2 %. On the other hand, the northern wall trench of house 44 displayed a rather trapezoid shape in agreement with the whole house construction. The doubled irregular walls were recorded in the southeastern part, unlike the rest of the ground plan, where the original setting was not preserved. No specific post-rows arrangement in the central section has been observed.

House 2 of subsequent G horizon also displays, in congruence with the above-mentioned cases, the doubled side walls, but they are slightly convex, forming an overall naviform shape of house ground plan. Two lines of side-wall postholes can be observed, particularly in the eastern part, while the western part was preserved rather fragmentarily. Although there are two significant posthole rows noticeable by the western wall, we consider them to be rather non-contemporaneous with the ground plan, because house 2 was located in the part of the excavated area with a dense posthole pattern, even if similar rows were observed also in case of house 8 (Beneš et al. 2015, Fig. 3). All three house sections were recorded, which assigned the ground plan to the category of *Grossbau* 1b (Modderman 1970), although the determination of the southern section is slightly questionable. The northern wall trench is trapezoidal, just like the house itself. Additionally, the setting of the inner post rows differs from the previous two longhouses. Even if no special arrangement was observed, we should point to the overall smaller diameters of the posts and their wider spacing. The average distance between rows is 3.54 meters compared to 2.06 metres in the case of house 44, which is similar in its dimensions. House 3 exhibited the greatest distance (3.87 metres), but due to its extreme lengths, it is not comparable with other ground plans.

Table 4. Formal attributes of longhouse ground plans.

Attribute	House 2	House 3	House 44
Length [m]	24.8	46.4	16.6
Maximal width [m]	7.3	8	6.9
Total area [m ²]	162.9	361.5	96
Azimuth [°]	21.17	17.28	36.03
Number of sections	3	3	2
Number of inner rows	7	12	8
Shape	navi-form	rectangular	trapezoid
Side walls	doubled irregular	doubled regular	doubled irregular
Type	Grossbau	Grossbau	Bau

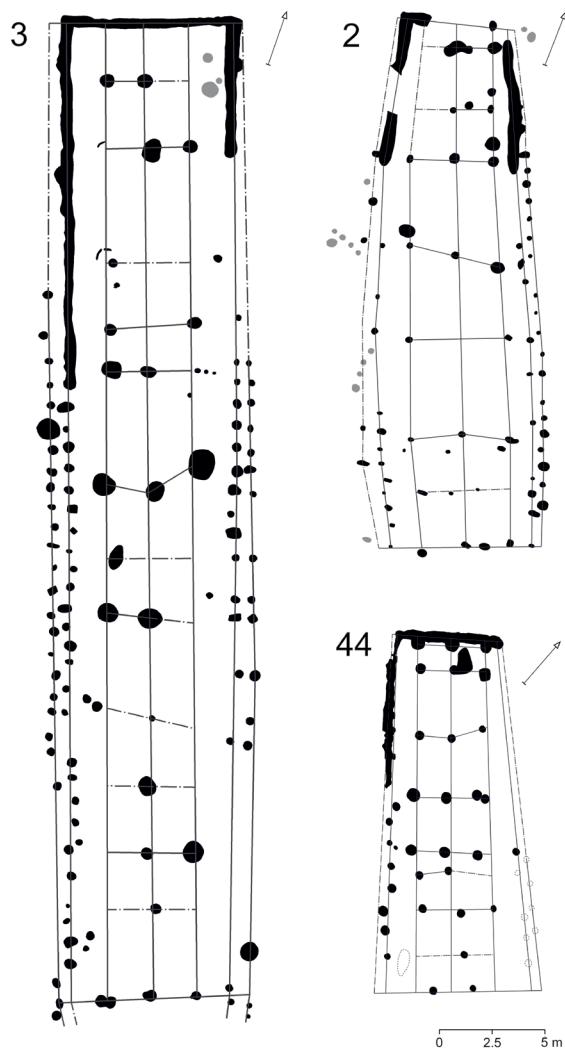


Figure 14. Longhouse ground plans of the F and G settlement horizons at Hrdlovka.

4 Discussion

The combined view on ceramic fragments, animal remains, lithics and households of the Hrdlovka site elicit a set of questions. These include the linkage of Hrdlovka with the regional development built on ceramics decoration and the evaluation of houses in transition, followed by the search for continuity, change or discontinuity based on presented data.

4.1 Lines and Strokes

The position of Hrdlovka F and G horizons in the DCA chronological analysis evokes an image of assemblages, which were created right in the period when linear decoration declined and new distinctive stroked decoration arose. This process has been described in detail by the analysis of ceramic assemblages from Hrbovice-Chabařovice site (Zápotocká, Muška 2007, Zápotocká 2009) and Dresden-Prohlis (Link 2012, 2014a). At these sites, pottery decoration of individual and parallel double-strokes used as an independent technique are significant for the LBK/SBK transition. The strokes were organised in rectilinear motifs, which prefigures the classic SBK chevrons (sometimes as a zigzag). Vessel shapes are mostly represented by hemispherical, hemispherical with S-shape profile and pear-shaped vessels, all with rounded bottom.

The assemblages of horizons F and G at Hrdlovka site display a slightly different pattern. The significant decoration of individual and parallel double-strokes is nearly absent, but there are several linking points. At first, in all three assemblages, the linear decoration still persists (Hrbovice-Chabařovice: 4.7%; Dresden-Prohlis, house 9: 15.2%). Except for the strokes indicating the very onset of SBK decoration, a high ratio of advanced techniques of strokes was also recorded. To compare, at Hrbovice-Chabařovice the small alternating double-strokes form 28% of the assemblage, but they were not identified in Dresden-Prohlis house 9 assemblage. Also, multiple strokes were recorded. The relief ornamentation is still present in F and G horizons as well as at Hrbovice-Chabařovice. This kind of decoration disappeared only in the assemblages of the fully developed SBK culture (Zápotocká, Muška, 2007, 61-62, Link 2014a, 82-86).

To conclude, even without the significant decoration, the Hrdlovka F and G horizons display attributes of late LBK, but also early SBK culture, which leads to the dating in the period of transition. Ceramics of the Hrdlovka G horizon include the advanced techniques in higher proportion, particularly the alternating double-strokes. As a result, this horizon was defined as succeeding the F. It is also reflected in the correspondence analysis, where the Hrdlovka G assemblage is closer to the pottery production of the fully developed SBK from the Vchynice and Hrobčice sites.

Despite the above-listed arguments, we should also bear in mind the possible risk of data distortion caused by formation processes, which might have affected the archaeological material and results in the image of mixed ceramic assemblages with linear as well as stroked pottery (cf. Frirdich et al. 2015). Furthermore, the analysis of all sites is burdened by low numbers of ceramic individuals with determinable decoration. The hypothesis that Hrdlovka F and G horizons represent assemblages of mixed origin can also be supported by the presence of chronologically diverse techniques such as wide groove (gamma style) and multiple strokes. In addition, the taphonomic analysis of osteological material shows a significantly higher degree of damage right in these horizons. Consequently, it was possible to perform the species determination only on the basis of teeth, the most resistant osteological material. Therefore, we cannot exclude that all the material entered the investigated contexts during heterogeneous depositional and postdepositional processes. Unfortunately, the method of excavation (see above) did not allow us to study the formation processes with respect to the individual sunken features.

4.2 Households

Apart from the pottery, the architecture is one of the most significant attributes of the Neolithic. Despite the fact that its development lacks a chronological sensibility, general trends can be outlined (e.g. Modderman 1988, Courdard 1998, Končelová, Květina 2015). At Hrdlovka we should bear in mind that the settlement area was not excavated to the full extent, therefore many houses might remain unrecorded. Ground plans

2, 3 and 44 are most probably only part of the original number of contemporaneously built longhouses. However, we can state that the F and G horizons do not deviate much from the general trend. Except for the C horizon, which is represented by six construction complexes, the number of houses is two per horizon on average.

Searching for comparable assemblages in northwest Bohemia, only one poorly preserved longhouse ground plan was documented at Hrbovice-Chabařovice site, which makes the Dresden-Prohlis site the only suitable option. T. Link considers that the transition between late Linear and early Stroked Pottery Culture could be traced by the shift from regular or slightly trapezoid ground plans with irregular but thicker inner rows to slightly convex ground plans (navi-form) and regularly arranged posts. Both types are constructed with double side-walls. Further *antas* are often recorded (Link 2014a, 182, Link 2015, 355). In addition, longhouse ground plans of the Eythra site can support the above-mentioned trends. Although pottery assemblages pointing to LBK/SBK transition have not been documented here, the ground plans of the late LBK and early SBK were identified on the basis of construction typology (Friedrich et al. 2015). The late LBK houses are characterised by the overall rectangular shape with a larger rectangular northern section. The setting of inner posts is relatively thick and the bent arrangement occurs in the central part. The early SBK ground plans are slightly convex, the number of cross rows is significantly reduced, and the northern section is considerably shorter. Houses of both chronological levels have doubled construction of side walls (Friedrich et al. 2015, Fig. 4).

The architecture of the Hrdlovka settlement area follows the same trajectory. Rectangular or slightly trapezoid ground plans with irregular setting of the inner rows (houses 3 and 44), are transformed in building with slightly convex side walls and loose inner posts. In case of house 3, the inverse J arrangement of cross row in the central section was recorded, which is common in LBK houses of southeast Bavaria (Pechtl 2010). On the other hand, differences can be found in the length of the rear sections of houses limited by the wall trenches. While at Dresden-Prohlis there houses with very short northern sections were also recorded (e.g. houses 4 and 23), at Hrdlovka they are comparable by their size with the central sections. However, the above mentioned attributes themselves cannot be considered as simply determinative. The doubled wall, whether in regular or irregular form, can serve as an example. This element is found to be characteristic particularly since the early SBK period (Končelová, Květina 2015, 435), but it has been noticed even in the LBK horizons at Dresden-Prohlis (ground plans 6, 10 and 17) and also at Hrdlovka (ground plans 59, 63 and 73). We are not able to strictly delimit this phenomenon spatially either. Even if the double-post walls are most common in Saxony and the Eastern Bavaria regions (Link 2014c, Abb. 3), this technique was also used in Bohemia, Rhineland region (e.g. von Brandt 1988, 77, Coudart 1998, 153, Jeunesse et al. 2007, 51), and it was exceptionally recorded also in the distant Chełmno region of Poland (Werra 2010).

Continuing in the comparative approach, the extremely long house 3 from Hrdlovka does not have any analogy at Dresden-Prohlis. The house size could be understood as an expression of economic or social status of its inhabitants, particularly as the northern part is considered as the most expressive one (Pavlu 2014, 22). These northern sections are relatively large in comparison with other parts at Hrdlovka houses. On the other hand, the building of a large house might express the attempt of builders to face the unfavourable situation within the broader community in providing a better economic base. However, there is no direct evidence for any breaking point in socio-economic structure at the site. This assumption is supported by the artefactual and ecofactual assemblages recovered from the pits accompanying the house walls, which is not exceptional in any regard (Beneš et al. 2014).

4.3 Did Anything Change? Testimony of Animal Bones and Lithics

Let us start with the question of strategies in animal husbandry. Cattle was the principal farming species throughout the duration of LBK in settlements in the Czech Republic. The predominance of remains of sheep and goats is not common in this period (e.g. Kovačiková et al. 2012). In general, the evidence for stock keeping can show a regional variation and seems to be mainly dependent on local environmental conditions. Cattle need sufficient drinking water and better pasture than caprines (Dahl, Hjort 1976). The fluctuation in cattle and small ungulates bones representation between the different Neolithic periods can

reflect the availability of these resources. The frequency and species spectrum of wild game recorded for Hrdlovka is very similar to that of contemporary Neolithic settlements in the Czech Republic (Rulf 1991, Kovačiková et al. 2012), where it is interpreted as evidence for opportunistic hunting in proximity of the habitation area.

Focusing on the chipped stone industry, the main change in raw material composition is the shift from the assemblage consisting mainly from Skršín quartzite and erratic flint in the LBK III stage to that of the ensuing LBK IV stage, which is characterized by the dominance of Tušimice quartzite, but still accompanied by Skršín quartzite. Over the course of further development, the raw material composition remains unchanged except for the renewed increase in erratic flint proportion at the expense of Tušimice quartzite. This transformation in the use of raw materials may be connected with the onset of Tušimice quartzite deep quarrying and associated changes of economic ties in the near as well as distant surroundings.

Based on the work studying the workshop areas for production of stone industry in Pojizeří (Šída 2007), a common settlement area was defined as a site, where the proportion of chipped industry waste reached up to 55 %, and the percentage of waste from other working activities varied from 5 to 40 %. Specialized production workshop areas exhibit the representation of waste from chipped industry production over 55 % and up to 15 % of waste from other working activities. In this regard, the Hrdlovka site represents a typical non-productive consumer settlement area with a small differentiation of chipped stone industry. The only abnormality can be observed in the rise of workshop activities during the SBK II phase, when the percentage is just above the selected limit. Comparing the data from Hrdlovka with the development of the Hrbovice-Chabařovice site is rather problematic due to the low quantity of assemblages at this site (cf. Zápotocká, Muška 2007, 103-109).

Particularly interesting is the growth in the number of blades at the expense of retouched tools in the LBK IV stage. This can be related to the increase of Tušimice quartzite, which was deep-quarried. Specialised workshops in the quarry surroundings could have produced the blades, which could easily enter the adjacent settlement areas. Thus, it probably reflects the beginning of mass acquisition of this raw material in the LBK IV stage. This phenomenon is the most significant in the overall stone industry development at Hrdlovka during the whole period of interest.

4.4 On Continuity, Change and Culture

Speaking about the “cultural” change, like in the case of LBK/SBK, it is necessary to distinguish between the notion of *culture* in archaeology (the culture of former people) in the general sense and the *archaeological culture* as an artificial construct of archaeological description. The culture itself can be seen anthropologically as an extra-somatic means of adaptation for the human organism (Binford 1962 sensu White 1959, 8), while archaeological culture is a concept that was a dominant notion in archaeological research oriented towards cultural history for almost the entire 20th century (Malina et al. 1990). This concept did associate material culture from archaeological context with nations and ethnic groups in particular geographical space. Such an artificial construct has been used for the earliest Neolithic period in Central Europe as well. Since W. Buttler’s (1938) publication about *Bandkeramik*, a large majority of scholars regarded Danubian culture as a material expression of a rather ethnically homogenous group of Neolithic incomers. The same idea in theory was proposed earlier in the influential book of V. G. Childe (1929). Such an approach was supported by a majority of archaeologists and other readers of Childe’s books, and this approach was prevalent in Central European literature. Such a tradition clearly stimulated the archaeological view on the LBK culture as a homogenous phenomenon and needs to explain any internal change as fundamental.

It is fruitful to turn our attention back to the classical processual definition of an archaeological culture, where it is regarded as „a polythetic set of specific and comprehensive artefact-type categories, which consistently occur together in assemblages within a limited geographical area“ (Clarke 1968, 666). Such a definition could help us to keep a distance between past humans in their environment on the one side, and their formally defined material remains on the other. In such an approach the formal development of ceramic style as cultural marker is understood as the result of the natural development of a stable society (Shennan, Wilkinson 2001).

Although, current evidence offers only hints about how the LBK terminated and what the transition to the succeeding cultures was like, some scholars have convincingly argued for the rapid end of the LBK (e.g. Faruggia 2002), also associated with an unstable socio-political interlude recognised by violent conflicts. Mass violence is documented, for example, at Talheim, Schletz, or other sites (Wahl, König 1987, Wild et al. 2004, Teschler-Nicola et al. 2006, Wahl, Trautmann 2012, Meyer et al. 2015). Interesting is the fact that all violent or violent-like evidence is recorded only in the western area of the LBK, with the exception of the Schletz site, which is located in the eastern part of Central Europe. Such kinds of ritual performances may point to some level of social change concentrated in the Danubian region, whereas in the Bavarian, Elbe region and eastwards areas, this kind of evidence is missing.

Additionally, one should note a correlation between this ‘crisis’ and climatically changed conditions, which have been reported in support of these abrupt changes of scenario (Strien, Gronenborn 2005, Gronenborn 2006, 2009, Gronenborn et al. 2014) based on the resilience model, which correlates climatic cycles with dynamic development of the western LBK society. Based on such a perspective, climatic development could surely constrain general trends in LBK origins, expansion, stability and transformation in the LBK/post LBK period.

Since then, however, the crisis hypothesis has been seriously challenged, based mostly on chronological uncertainties along with unconvincing evidence for the pattern of extensive warfare, violent practices, and on the possibility that mass graves or the deposition of human bodies could have masked undetectable regular/ritual burials (e.g. Zeeb-Lanz et al. 2008, Meyer et al. 2014, Stäuble 2014, Link 2014b). On top of that, only specific regions report such a sharp decline of LBK. From the perspective of climate fluctuations, Gronenborn and colleagues (2014) note that the above-mentioned changes and their impact on prehistoric society are also more apparent in west-central Europe, whereas the eastern part of the region seems to be more stable.

If we focus on data from Hrdlovka, it is obvious that the significant change dwells mostly in the pottery decoration style. The turn in lithic raw materials and animal husbandry seems rather to be the result of extra-social processes driven by the local environment and the possibilities of resource exploitation. In contrast, the pottery and its decoration can be seen as an expression of cultural identity, not inevitably connected to any significant socio-economic collapse (Link 2015). This can also be inferred from the fact that the most significant change in Bandkeramik is observed in the turn of early and late stages of SBK (Pavlů, Zápotocká, 2013, 44-46, Fridrich et al. 2015).

Based on this perspective, the contemporaneous presence of linear and advanced stroked decoration (alternating double strokes) in Hrdlovka assemblages can be seen as the transmission of techniques and know-how in pottery production developed elsewhere in the frame of region. In this respect, this site does not seem to lie at the epicentre where the new decoration evolved. Moreover, alternating double-strokes are also reported from the transitional period in 20 kilometers distant Hrbovice-Chabařovice, and one should therefore be cautious, when considering the polyfocal model developed by T. Link (2015). It supposes a simultaneous development of stylistic elements in distant regions as a result of communication processes, based on data from Dresden Prohlis and Hrbovice-Chabařovice. The rate of such change, however, cannot be captured precisely due to insufficient amount of radiocarbon data from both the regions of Saxony and northwest Bohemia, and also due to the existence of a radiocarbon plateau corresponding to the period of interest. Therefore, it would be extremely difficult to pinpoint the possible epicenter of the origin of stroked decoration based on the sites of its immediate diffusion. In other words, only other sites with continuous development and precise dating can help to resolve this issue of the origin of SBK decoration and modes of diffusion.

Searching for the processes that exist beyond the transfer of decoration is a complex issue. At first, mechanisms of social learning might be crucial (Tichý 2014). Even if this concept was originally used for modelling the process of Neolithisation, the emphasis is put on the necessary personal contact between the holders of knowledge and “those who are influenced”. The simple imitation based only on the subject (vessel) itself does not seem to be probable, considering the more or less important role of this artefact in the symbolic system. This context should be transmitted only by social communication.

The prevailing role of women in pottery production, which is based on ethnographic observations (e.g.

Arnold 1985), is widely accepted. In combination with the model of patrilocal mobility, the innovations in pottery decoration were introduced by women joining the settlement through the marriage (Strien 2000, 33). This model is deduced at Cuiry-lès-Chaudardes site by the analysis of pottery forming methods and archaeozoological remains (Gomart et al. 2015). However, considering a certain level of acculturation, a slightly different scenario can be assumed. Newly arrived women were first producing pottery using know-how from their original homes, then they partially or fully accepted the standards of their husbands' families. This could modify the style passed on to their descendants (Kolhoff 1999 after Claßen 2009).

To summarize, Hrdlovka may represent another site providing data on uninterrupted development from linear to stroked ornamentation, thus complementing the sites of Hrbovice-Chabařovice and Dresden-Prohlis, where this transitional phase has been well documented. According to our data, the transition can not be seen as a result of crisis, which is fully in agreement with the area of east-central Europe. Similar to Hrbovice-Chabařovice, there are attributes of advanced stroked ornamentation in Hrdlovka, along with linear decoration, which may suggest a slightly different mode of transition than in Dresden-Prohlis, where direct evolution in pottery decoration, even on the household level, has been recorded. This might suggest the possibility of a different mode of SBK style diffusion in both regions. On the other hand, the common occurrence of architectural attributes creating constructions of individual houses is comparable and exhibits a similar shift in time on the larger area of northwest Bohemia Saxony and Eastern Bavaria. This image may be caused by the character of the chronological setting in Neolithic architecture, which does not reach such sensitivity as pottery decoration. Moreover, the durability and life-span of a single house could reach about 100 years (Schmidt et al. 2005). Therefore, the processes of change viewed according to the scope of architecture are hidden in chronological indistinguishability.

Taken altogether, the LBK/SBK transition can surely be traced in the studied regions of Dresden valley and northwest Bohemia. Nevertheless, to track the precise modes of diffusion, the evidence might be hidden in the lower scale of social units such as households and processes of flow of individual persons among particular settlement societies, which is much more difficult to trace in the archaeological record than the shift between whole regions. However, the precise mechanisms and rate of this change cannot be solved at this moment due to the small amount of well documented sites and appropriate radiocarbon dates.

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