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EARLY NEOLITHIC LIFEWAYS IN MORAVIA AND WESTERN SLOVAKIA: COMPARING ARCHAEOLOGICAL, OSTEOLOGICAL AND ISOTOPIC DATA FROM CEMETERY AND SETTLEMENT BURIALS OF THE LINEARBANDKERAMIK (LBK)

ABSTRACT: In the Anthropologie *journal in 2008 (46, 2–3), Marek Zvelebil and an international team of experts presented the results from the* Vedrovice bioarchaeology project*, which detailed the life-histories of individuals buried at the early LBK cemetery. In combining a range of different bioarchaeological methodologies, this project was able to show that the community buried at Vedrovice was formed of a diverse and heterogenous population, leading lives influenced to different degrees by the transition to farming. Drawing on a similar approach – that of using bioarchaeological evidence fully integrated in its archaeological context – a project called* The first farmers of central Europe: diversity in LBK lifeways *was begun in 2008 and ran for four years. Sampling sites across the southern distribution of the LBK for isotopic analysis (carbon, nitrogen, and strontium isotopes primarily) and including osteological study, this project concentrated on issues of regional and site-based diversity in diet, mobility and burial. In this paper, we present a comparison of the Moravian and western Slovakian results from this project, including new data from the cemetery and settlement burials at Vedrovice, as well as from the Nitra cemetery and the settlements of Těšetice-Kyjovice and Brno-Starý Lískovec/Nový Lískovec. Like Zvelebil* et al. *(2008), we find communities formed of heterogenous identities, though we suggest that such diversity was also found alongside evidence for shared practice at different scales of human life.*

KEY WORDS: Moravia – Western Slovakia – Linearbandkeramik (LBK) – Isotopic analysis – Lifeways – Burial practices – Vedrovice – Nitra – Těšetice-Kyjovice – Brno-Starý Lískovec/Nový Lískovec

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INTRODUCTION

In this journal, in 2008, Marek Zvelebil and his team presented the results of the *Vedrovice bioarchaeology project* (Zvelebil, Pettitt 2008), which had combined isotopic, aDNA, osteological and archaeological studies to investigate the community which buried its dead at what was possibly the first cemetery of the *Linearbandkeramik* (LBK; c. 5500–4900 cal BC; Lukes *et al*. 2008). Their central question was one of origins, framed by the larger debate on the spread of farming across the European continent: were the agents of change migrating agriculturalists or indigenous groups overturning their subsistence base (Lukes *et al*. 2008: 117)? The results from the *Vedrovice bioarchaeology project* found a diverse and heterogenous population of multiple origins, both from the local area and from some distance away, leading to the suggestion that the Vedrovice settlement was founded by a group who had migrated from western Hungary on the basis of both the isotope results and the material culture assemblage (Zvelebil, Pettitt 2008: 213). This initial "gateway" settlement had then attracted communities, who were still practising hunting and gathering, from the local area and broader region, primarily to the north-east and the Bohemian-Moravian Uplands (Zvelebil, Pettitt 2008: 213). Rather than a generalised ethnic group spreading farming through the passing on of a single and homogenous LBK culture, they concluded that the very nature of LBK society was itself a complex mixture of different cultural signatures, affiliations and networked contacts (Zvelebil, Pettitt 2008: 214).

The Vedrovice cemetery was an ideal case study to investigate these questions. Not only does it provide a large assemblage of burials, but both the ceramic grave goods and the radiocarbon dating place activity at the site at the end of the earliest LBK and into its middle phase, making it one of the earliest cemeteries in the LBK (LBK phases Ib_1, Ib_2 and IIa; burials mostly spanned the 53^{rd} century cal BC: Čižmář 2002, Griffiths 2013, Pettitt, Hedges 2008). Initially, in a century or two, the LBK developed first in an area that can be broadly defined by the western Hungary or Transdanubia and then extended outwards, appearing in Moravia and Bohemia, as well as possibly following the course of the Danube, reaching the Rhineland c. 5400 cal BC (Bánffy 2000, 2004, Gronenborn 1998, 1999, Lüning 2005, Stäuble 1995). The second phase of expansion, which is often quoted as occurring from c. 5300 cal BC (e.g. Sommer 2001), is accompanied by (amongst other changes) the development of cemetery burial. This funerary practice, that is the bringing of the dead together in a defined location, is often attributed to the scale and significance of community identity – in a place at which broader group identities are expressed, as well as offering an arena for competitive display, where ideas of death can be negotiated and regularised (Frirdich 2003, Hedges *et al*. 2013, Hofmann 2009, Jeunesse 1996, 1997, 2003). This second phase of the LBK is often, however, characterised as increasingly heterogenous, with growing regionalisation of pottery styles (Cladders, Stäuble 2003, Modderman 1988, Sommer 2001), house architecture (Coudart 1998) and subsistence bases (Bogaard 2004). The presence of widely practised norms alongside regional variation was summed up by Modderman (1988) in his well known paper as *diversity in uniformity*, which has become an oft-quoted description of LBK cultural practice.

Inspired by a wish to investigate the extent to which regional differences translated into variation in the lifeways of LBK individuals and communities, the *LBK Lifeways* project set out to explore these issues across a transect of the LBK, ranging from eastern and western Hungary to western Slovakia, Moravia, Austria, Lower Bavaria and Baden-Württemberg, and across the Rhine into Alsace (Bickle, Whittle 2013). Focusing largely on the cemetery assemblages, we chose to concentrate on the integration of 1. archaeological information (grave context and goods); 2. osteological data (age and sex); and 3. isotopic indicators of diet and mobility, investigating the types and extent of variation present in the data, and reflecting on these results in terms of community cohesion and the lifeways of individuals. Primarily, we sampled human and animal remains for the analysis of carbon and nitrogen isotopes, which vary with the plant and animal protein content of the diet (e.g. Hedges 2003, Richards, Hedges 1999), and strontium isotopes, which ultimately derive from the geology from which foodstuffs and drinking water are sourced (Bentley 2006, Budd *et al*. 2004, Montgomery *et al*. 2007). Taken together, these isotopes can provide information about the different dietary groups and levels of mobility within a population, as well as how the diet may have varied over the life-course and between the sexes. The osteological study was carried out by Linda Fibiger and was a selective investigation into the health and demography of LBK cemeteries. Particular attention was paid to evidence for stress levels and disease load within the samples available for osteological investigation (Hamilton *et al*. 2013). The archaeological part of the project focused especially on the funerary context, investigating whether the isotope and osteological data correlated with features of the burial practice and the presence (or absence) of certain of grave goods.

As part of the *LBK Lifeways* project, we sampled the Vedrovice assemblage, following on from the investigation of Marek Zvelebil and his team. We contributed to further understanding of the cemetery by investigating isotopically individuals from the cemetery that the Vedrovice Bioarchaelogy project did not sample, as well as those from the settlement and other parts of the site (see below). Here we present these results and compare them, first to those obtained from settlement burials from the broader Moravian region, from Těšetice--Kyjovice (Dočkalová, Koštuřík 1996, Mateiciucová 2008, Podborský 1988, 1999, 2001) and Brno-Starý Lískovec/Nový Lískovec (Berkovec 2004, Mateiciucová 2008), and then to the cemetery of Nitra (Pavúk 1972) from the neighbouring region of western Slovakia (*Figure 1*). These data are extensively reported in Whittle *et al*. (2013) and this is also where the reader will find a full report of the isotopic data, including the essential quality data (see also Bickle, Whittle 2013; the analytical methodology is reported below in the *Appendix 1* and the supplementary data in *Appendix 2–3*; a database of all the data from the *LBK Lifeways* project will be deposited with ADS in due course). This paper is offered as a summary of the data and, more importantly, a contribution to detailing the complex picture of varied lifeways that constituted the LBK. The selection of sites allows us to investigate, in the first instance, any isotopic variation between the settlement and cemetery burials in the region around the Vedrovice cemetery and, secondly, variation over the course of the LBK.

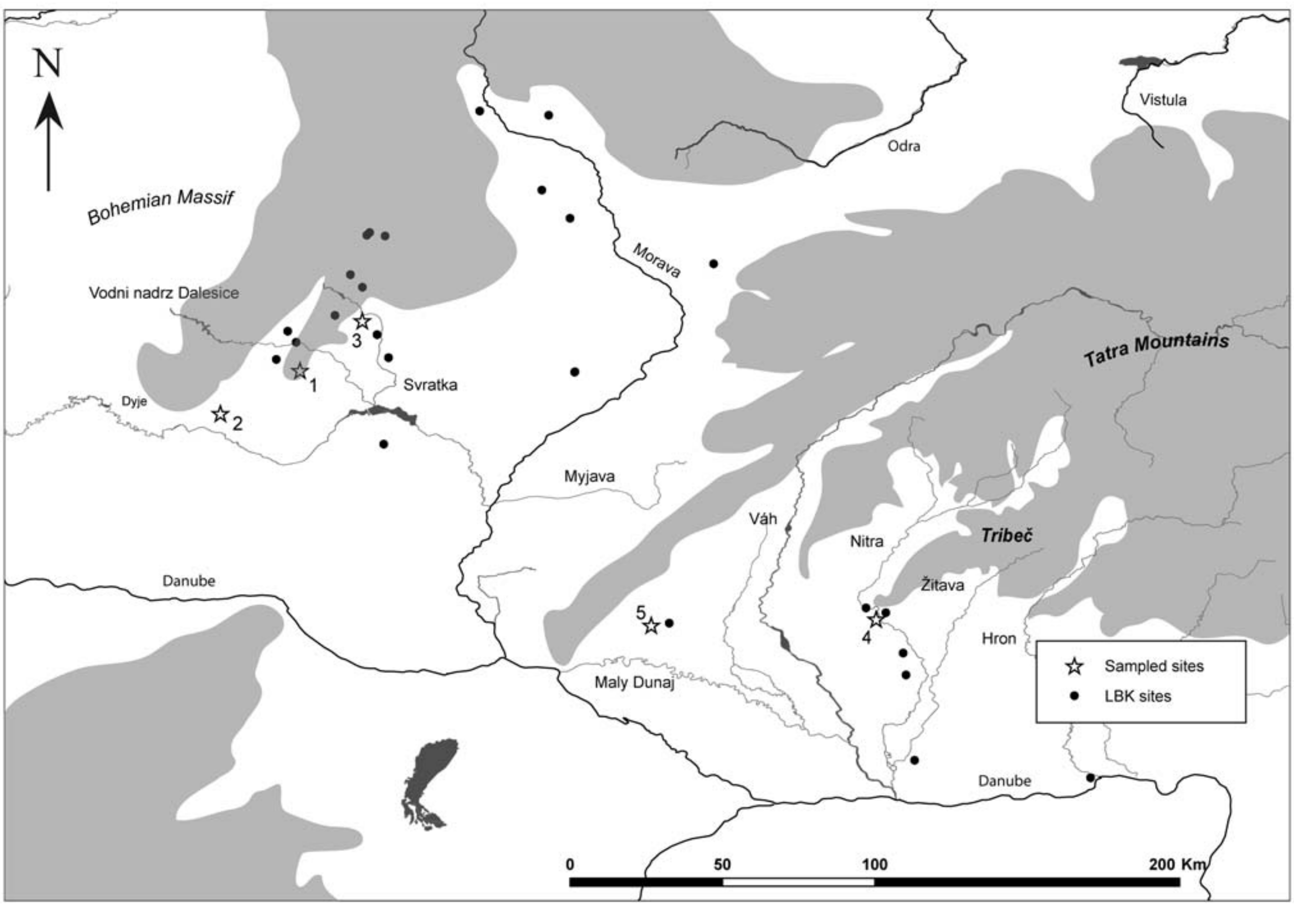

FIGURE 1. Map of sites sampled (1–5) from Moravia and Western Slovakia. Upland areas are in italics. 1, Vedrovice; 2, Těšetice-Kyjovice; 3, Brno-Starý Lískovec; 4, Nitra-Horné Krškany; 5, Blatné.

BURIAL VARIATION IN THE LBK: THE QUESTIONS

This paper considers variation in the LBK through the lens of funerary practices by comparing the isotope, osteological and archaeological data to answer two questions: whether any differences can be identified between first, settlement and cemetery burials and second, two cemeteries from Moravia and western Slovakia. Settlement burials have often been neglected in broader studies of burial in the LBK, particularly when compared to many of the well studied cemeteries (Hofmann 2009), frequently being attributed a very different status to that of cemetery burials (Jeunesse 1997, Modderman 1988, Veit 1993, 1996). Primarily, this has been because a higher proportion of unfurnished graves is found at settlements (50% of settlement graves are unfurnished compared with 30% at cemeteries; Hedges *et al*. 2013: 374), but also because women and children have been thought to dominate the demographic profile of settlement burials (Modderman 1988), though this may be a simplification of more complicated age and sex profiles in the two contexts (Hedges *et al*. 2013: 373). The position the body was placed in is also more variable at settlements. While the classic LBK burial position is left-crouched, variations such as right-crouched, supine and prone as well as more irregular positions are also found across all burial contexts. Overall, 74% of cemetery burials are left-crouched, but this rate drops to 58% at settlements, while variation in orientation is also more variable at settlements and more consistent amongst cemetery burials (Hedges *et al*. 2013: 373). The implication is that individuals buried in cemeteries received a more formalised and "normal" LBK burial rite, not regularly given to those individuals buried outside cemeteries (Bickle *et al*. 2011, Hofmann 2009, forthcoming). We wanted to investigate whether this greater variability seen in settlement burial practices was reflected in differences in the lifeways of individuals buried at cemeteries and settlements, by comparing results from the cemetery at Vedrovice (from the location "Široká u lesa") with those from the settlement and Za dvorem at the same site, as well as with the data from Těšetice-Kyjovice and Brno-Starý Lískovec/Nový Lískovec.

To answer the second question of the paper, we compare the isotope results from the cemetery of Vedrovice, Moravia, with those from Nitra, western Slovakia, in order to investigate potential change in lifeways over time and regional diversity. The Moravian burials listed above all appear to roughly date from the same phase of the LBK, falling around the transition from phase I to the developed phase II. However, in this case it appears that Nitra continued to receive burials after Vedrovice had been abandoned, although the use of both sites may have overlapped (Griffiths 2013). Therefore, the two cemeteries provide different chronological windows into the LBK. Across the LBK, the start of cemeteries is seen as part of the move to the developed phase of the LBK, with its increased regionalisation recognised across different aspects of cultural life (Modderman 1988). It may, therefore, also be of interest to discuss any differences between Vedrovice and Nitra in terms of possible regional variation in the LBK between Moravia and western Slovakia, as burial at the latter site took place as regionalisation became stronger.

METHODOLOGY

In order to discuss variation in lifeways we analysed three different isotopes: carbon and nitrogen isotopes, to investigate diet (Hedges 2003, Richards, Hedges 1999); and strontium isotopes, which carry the same ratio in the human skeleton as the geology from which an individual sourced their diet (Bentley 2006, 2013, Montgomery 2010). We refrain here from establishing precise "local" ranges and provide them only as a guide, because variability in human behaviour and diet does not necessarily correlate to the immediate local geology (Bentley 2006, Bickle *et al*. 2011: 1252, Pollard 2011). The stable isotopes of carbon and nitrogen are investigated from human bone. Where ribs were not well preserved, long bones were sampled. Strontium is investigated in tooth enamel, which grows and mineralises in childhood, allowing the investigation of lifetime mobility (Bentley 2006, 2013, Montgomery 2010, Montgomery *et al*. 2007). The second and third molars are the preferred tooth for sampling as they provide a large surface area and their mineralisation process is likely to have begun when the child is no longer breastfeeding, thereby providing a value from the child's diet alone (Bentley 2006). Where the second and third molars were not available for sampling, the first molar was sampled and in one case, a premolar. Varied food consumption can also be investigated through strontium, by comparing the concentration of strontium found in the tooth. Strontium concentration (expressed as 1/Sr conc., the reciprocal of the Sr concentration in parts per million [ppm]) varies with the types of food consumed, with milk or meat having a lower concentration of strontium than plants (Montgomery 2010, Montgomery *et al*. 2007).

An important aspect of the methodology is the extent to which the results can be directly compared between sites. To do this, the environmental context in which the isotope values arose must be carefully considered. For strontium isotopes, variation in the local biologically available strontium may have contributed to even nearby sites producing different isotopic profiles despite similar mobility and dietary practices (Bentley 2006, Knipper 2011). Carbon isotopes are similarly influenced by local conditions, showing strong variation with climatic factors which may account for a significant degree of inter-site variability (see discussion in Hedges *et al*. 2013 for further details). The isotopic values of animals are also an important aspect of considering variation, on the assumption that they will have contributed in varying proportions to the diet and therefore to the human stable isotope values (Hamilton *et al*. 2013). For the purposes of the article here, it is worth briefly laying out what we take variation in the isotopes as indicating: nitrogen – variation in the amount of animal protein in the diet; carbon – while large differences may represent the consumption of marine vs. terrestrial resources, or C3 vs. C4 plants, variation on the scale shown for the LBK population could represent the consumption of food sourced from areas of different canopy cover (Balasse *et al*. 2012, Hamilton *et al*. 2009); and strontium – smaller variations in strontium isotope ratios are interpreted as representing the sourcing of diet from different locations in the vicinity of the site, and large variations, movement into the local area from other geologies.

THE LBK IN MORAVIA AND WESTERN SLOVAKIA: THE SITES AND DATA

The geography of these regions is formed by the tributaries of the Danube, running off the Bohemian Massif in Moravia and the far north-western end of the Carpathian Mountains in western Slovakia. LBK settlements are located on the terraces of these rivers and in Moravia are situated mainly in the Carpathian Foredeep, which crosses the eastern part of this region connecting the area with south-west Poland and dividing the Carpathian mountains from the Bohemian Massif (Mateiciucová 2008: 20). In western Slovakia, LBK sites are situated between the northern bank of the Danube, west of the bend (known in Hungary as the Danube Knee), and the Carpathian mountain range (Pavúk 2004: Fig. 6). As elsewhere in Europe, LBK communities favoured loess soils for the location of their settlements from the start of the culture in the two regions. Pavúk (2004, 2012) places the first appearance of the LBK in western Slovakia, slightly earlier than in Moravia. However, radiocarbon dates from this region are limited in number and early dendrochronological dates from the well at Mohelnice (Moravia) may suffer from the "old wood effect" (Pavlů 2005, Stäuble 2005, Whittle *et al*. 2013). It is hoped that in the future the consistent application of radiocarbon dating to short-life material of known context and taphonomy will go some way to resolving these issues. In the absence of radiocarbon chronologies, the cultural development of both regions is known through well established pottery typologies (Čižmář 1998). After the initial phase, the developed LBK belongs broadly to the *Notenkopf* ceramic tradition, also found in lower Austria, while later the Želiezovce, related to the sequence in Hungary, and Šárka, found across Moravia and Bohemia, styles develop (Čižmář 1998, Mateiciucová 2008, Pavúk 2004, Whittle *et al*. 2013). The four sites discussed in this paper (Vedrovice, Těšetice-Kyjovice, Brno-Starý Lískovec/Nový Lískovec, and Nitra) date to the late early and middle phases of the LBK sequences in the two regions.

Vedrovice

The site of Vedrovice consists of three different areas of LBK burial: alongside the cemetery named Široká u lesa, burials were also found in the settlement ("Sídliště") and a smaller cluster of 13 graves was uncovered to the south of the cemetery on a tract of land known as Za dvorem (Dočkalová 2008: 241–242). In total, during the excavation campaigns between 1961 and 2000, approximately 110 LBK burials were uncovered alongside a contemporary settlement area, represented by a large enclosure, surrounding the remains of longhouses and their accompanying pits and ovens (*Figure 2*) (Lukes *et al*. 2008: 119). Burial at the cemetery took place over three phases of Čižmář's (2002: Abb. 8) ceramic typology for the Moravian region. On this basis, a series of graves in the main part of the cemetery are attributed to LBK phase Ib_1, with further burials placed on the northern and southern periphery during phase Ib_2, while in the final phase of burial at the cemetery (phase IIa) inhumation mainly took place on the periphery but also in the centre of the cemetery (Čižmář 2002: Abb. 8). Significant numbers of graves could not be as precisely phased (Čižmář 2002). Radiocarbon dates on human bone (discussed by the Zvelebil project) suggested that the cemetery grew over

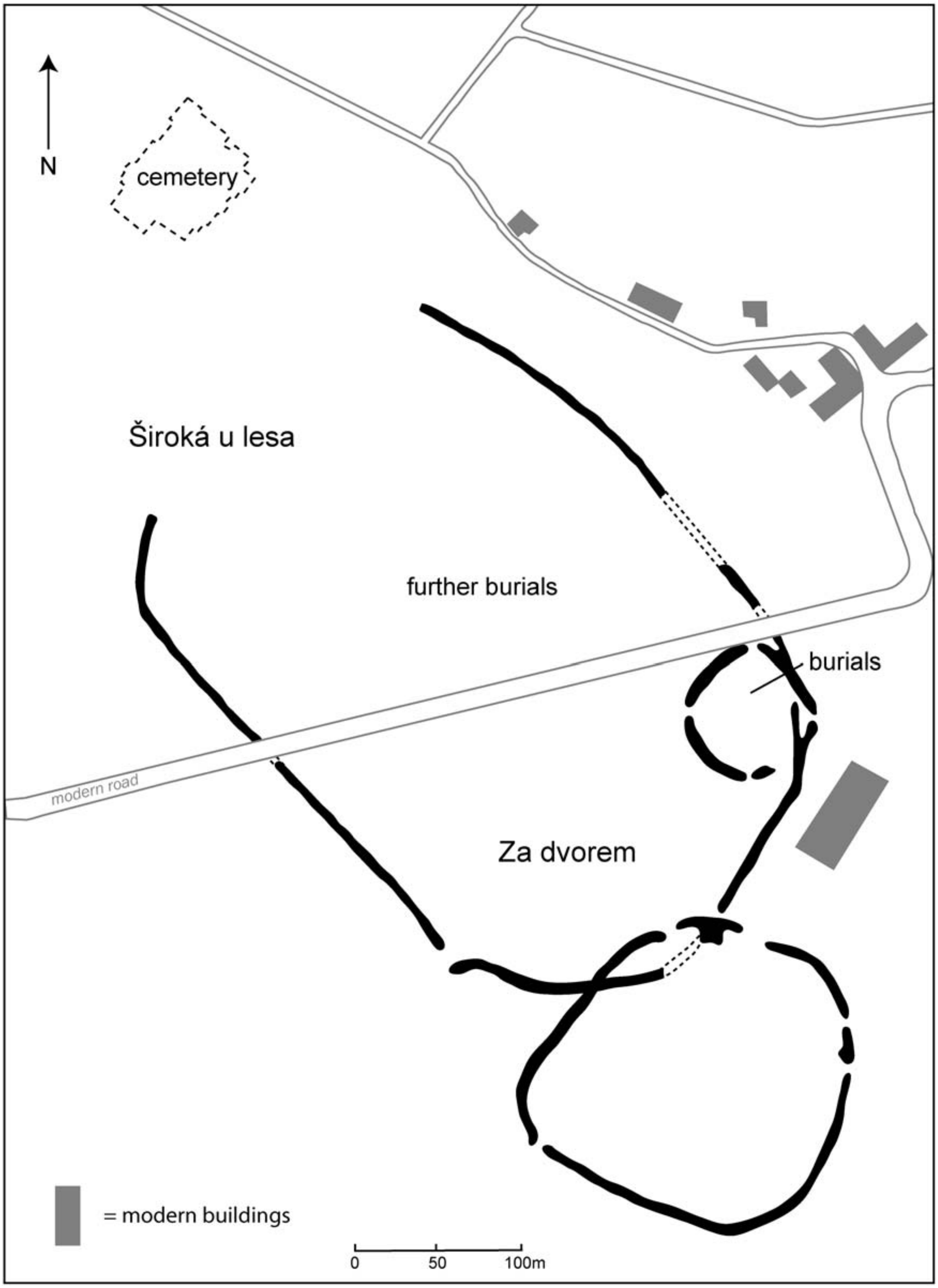

FIGURE 2. Vedrovice: plan of the different locations. In addition to the two areas marked on the plan, the settlement burials were found in the general area north of the road. After Podborský (1998: 10).

some five to six generations (falling between c. 5300–5100 cal BC; Pettitt, Hedges 2008: 126, 130). The probabilistic model of Pettitt, Hedges (2008: 130–131) places the main phase of activity within the 53rd century BC, at the transition between phases I and II at the end of the 53rd or the very early part of the 52nd century BC with a duration of approximately 100 years (see also Griffiths 2013).

Unfortunately, the radiocarbon dates from the settlement and Za dvorem burials have not yet been modelled (radiocarbon dating did not form a major part of the *LBK Lifeways* project), though on the basis of ceramic remains they are thought to be largely contemporary with the cemetery (Čižmář 2002, Podborský 2002). The few pots from the Za dvorem burials could only be attributed generally to the whole of the early phase (phase 1; Grave 2/88), but an adze, which had a profile characteristic of phase Ib_2 (Podborský 2002: 337), suggested the burials were from the latter part of this phase. Otherwise, there is little further evidence to indicate the internal chronology of burials in the settlement and Za dvorem areas, although they are therefore likely to have a similar chronological span to the cemetery. Burials within these two further areas of the site, however, do have some differences to the cemetery itself. The settlement burials appear to have had far fewer grave goods and the demography is skewed towards children. Of the 11 burials in the settlement, eight are children, three were infants under one year and a further five were between the ages of three and nine at death (Dočkalová 2008). The remaining three burials are older or mature adults (one woman and two men), all over the age of 40 when they died (Dočkalová 2008). The distributions of the ages and sexes of the Za dvorem burials are comparable to the cemetery (though five of the nine burials were of adult females) and they are accompanied by a similar range of objects in the graves to the cemetery. However, some of the grave goods found in this part of the site are rare both within the context of the Vedrovice site and in the LBK more broadly, such as the marble beads found in large numbers in graves 8/88 and 9/88 (Podborský 2002).

For the purposes of this project 33 individuals were sampled for carbon and nitrogen values: 22 from Široká u lesa, four from the settlement (Sídliště) and seven from Za dvorem, in addition to the 51 studied by M. P. Richards *et al.* (2008). A total of 72 individuals were sampled for strontium, including five from the settlement, seven from Za dvorem and 60 from the cemetery, 19 values of which originated from Richards *et al.* (2008) (*Table 2*). The breakdown of the data by age and sex is provided in *Table 1* and *Table 2* (under the column *n*).

Těšetice-Kyjovice

This multi-phase site was first discovered in 1956, but has seen a number of excavation campaigns since and is currently the subject of ongoing survey. As a result the understanding of its chronology is likely to undergo significant revisions and refinement in the future. When the *LBK Lifeways* project was undertaken the LBK site at Těšetice-Kyjovice consisted of 13 longhouses, mostly occupied during the developed phase of the LBK, with the pottery styles belonging to phase II (Mateiciucová 2008: 240). Pots from the graves, however, are in the style of the previous phase (phase Ib_1), suggesting that they predated the start of the settlement or perhaps related to an as yet undiscovered phase of occupation at the site (Dočkalová, Čižmář 2007, 2008, Dočkalová, Koštuřík 1996). Four radiocarbon dates from the skeletons in burials 11, 18, 20 and 26 did little to resolve the issue, as they all suggested the inhumations took place broadly during the developed LBK phases (i.e. they all had probability ranges that fell after the start of the 53rd century cal BC; Dočkalová, Čižmář 2007, 2008, Dočkalová, Koštuřík 1996). This raises interesting questions about the relative timings of the developed phase of the LBK, with the possibility that some communities chose to continue earlier styles for longer than others. The graves sampled for this project from Těšetice were mainly found in a small cluster, in amongst settlement pits but not directly associated with any houses (Dočkalová, Čižmář 2008: 41). A further grave of an older adult female was found isolated from these graves, though was possibly associated with a longhouse (Dočkalová, Čižmář 2008: 41). Seven individuals were sampled, including five adults and two juveniles (*Tables 1, 2*).

Brno-Starý Lískovec/Nový Lískovec

The name of this site covers a series of excavations that extend over an area of 20 ha, in which a 90 m-long segment of ditch and five longhouses belonging to the LBK culture were uncovered (Berkovec 2004: 138). In the absence of extensive radiocarbon dates, the chronology of this settlement is known from the pottery. The site is likely to have begun early in phase Ib and continued through to the end of phase II or the beginning of phase III (Berkovec 2004, Mateiciucová 2008). Unfortunately, the burials from this site cannot be placed within this sequence, though as the settlement is at its largest in the earliest phase (Ib), it seems probable that the majority of burials would fall towards the beginning of the LBK in the region and before developed LBK styles came to be widely practised. The final phase of the

TABLE 1. Carbon and nitrogen isotope ratios of humans and animals, with means and standard deviations from the Brno-Starý Lískovec/Nový Lískovec, Těšetice-Kyjovice and Vedrovice sites.

Site	Species	Age/sex	Mean δ^{13}C (‰)	SD δ^{13}C (‰)	Mean δ^{15}N (‰)	SD δ^{15}N (‰)	*n*
Brno-Starý Lískovec	Human	Infant	−18.1	0.25	13.0	0.09	2
	Human	Male (all adults)[a]	−19.7	0.19	10.1	0.30	4
	Cattle		−20.3	0.15	7.3	1.22	7
	Sheep/goat		−20.0	0.20	7.1	1.03	5
	Pig		−20.1	0.32	8.0	0.19	2
Těšetice-Kyjovice	Human	Juvenile	−19.7	0.33	9.4	0.91	2
	Human	Male	−19.4	0.12	8.8	0.28	3
	Human	Female	−19.3	0.36	9.3	0.23	2
	Human	All adults[a]	−19.4	0.20	9.0	0.36	5
	Cattle		−20.3	0.30	6.8	0.65	8
	Sheep/goat		−19.9	0.29	6.1	1.38	4
	Pig		−20.1	0.31	7.5	1.05	4
Vedrovice-Sídliště	Human	Juvenile	−19.8	0.46	9.0	0.74	3
	Human	Male	−20.1		9.9		1
Vedrovice-Široká u lesa	Human	Juvenile	−19.8	0.39	8.8	0.35	5
	Human	Female	−19.7	0.29	9.2	0.27	12
	Human	Male	−19.7	0.25	9.4	0.30	3
	Human	All adults[a]	−19.7	0.27	9.2	0.27	17
Vedrovice-Široká u lesa	Human	Juvenile	−19.7	0.32	9.7	0.46	13
(Richards *et al*. 2008)	Human	Female	−19.7	0.24	9.7	0.37	22
	Human	Male	−19.6	0.28	10.1	0.41	16
	Human	All adults[a]	−19.7	0.35	9.8	0.30	38
Vedrovice-Za dvorem	Human	Juvenile	−20.3		10.8		1
	Human	Female	−20.3	0.30	9.6	0.07	5
	Human	Male	−19.7		10.3		1
	Human	All adults[a]	−20.2	0.34	9.7	0.27	6
Vedrovice-Sídliště	Cattle		−20.2	0.29	6.2	1.04	3
	Sheep/goat		−19.8	0.18	5.9	0.38	3
	Pig		−20.4	0.53	8.2	0.86	2

[a] Includes any unsexed adults sampled. Infants and juveniles are not included in these values because of the potential influence of the breastfeeding signal.

site is represented by the presence of a single feature containing pottery in the Želiezovce-style (Berkovec 2004, Mateiciucová 2008). Of the ten burials found at the site, most are associated with particular longhouses, especially so in the case of the two infant burials (both younger than six months) in feature 800 and the adult male buried in feature 801 (Čižmář, Přichystal 2004). All the adult burials from the site were sexed as male, giving this site a highly unusual demographic profile for the LBK, as female burials are generally thought to outnumber men at settlements and funerary contexts where only one sex is buried are very rare (Dočkalová, Čižmář 2008). Carbon and nitrogen results were produced from six individuals, four adults (all male) and two infants (*Table 1*), while strontium isotope ratios were gained from five adult males (*Table 2*).

TABLE 2. Strontium isotope ratios and concentrations from Brno-Starý Lískovec/Nový Lískovec, Těšetice-Kyjovice and Vedrovice human individuals.

Site	Age/sex	Mean $^{87}Sr/^{86}Sr$	SD $^{87}Sr/^{86}Sr$	Mean Sr. conc.	SD Sr. conc.	*n*
Brno-Starý Lískovec	Males (all adults)	0.71029	0.00048	141	44	5
Těšetice-Kyjovice	Juvenile	0.71140	0.00001	135	16	2
	Male	0.71158	0.00014	162	85	3
	Female	0.71101	0.00117	128	41	2
	All[a]	0.71137	0.00055	145	55	7
Vedrovice-Sídliště	Juvenile	0.71161	0.00062	31	5	4
	Male	0.71010		40		1
	All[a]	0.71149	0.00060	33	9	5
Vedrovice-Široká u lesa	Juvenile	0.71112	0.00025	69	18	14
	Female	0.71084	0.00104	90	49	28
	Male	0.71099	0.00074	72	24	17
	All[a]	0.71094	0.00083	80	37	60
Vedrovice-Za dvorem	Female	0.71050	0.00076	55	10	6
	Male	0.71079		49		1
	All[a]	0.71054	0.00070	54	10	7

[a] Includes any unsexed adults sampled.

Nitra

The Nitra cemetery was found and excavated under rescue conditions in 1964–1965, when 75 graves came to light in an area approximately 50 m by 15 m wide (Pavúk 1972). The 75 burials included 49 adults, six adolescents, 16 juveniles and four infants. The adult assemblage consisted of 27 adult females, 18 adult males and four unsexed adults (Whittle *et al*. 2013). The *LBK Lifeways* project was fortunate to be able to obtain 12 new radiocarbon dates from the Nitra cemetery (results are presented fully by Griffiths 2013), which represents a small sample from the total number of burials found at the site and must be viewed as a pilot study. Until these dates were produced, the chronology of the cemetery was known from the pottery found in the graves, which suggested that the first activity at the site took place at the beginning of the *Notenkopf* phase (inferred on the basis of pottery in graves 12 and 70) with the majority of burials falling throughout the developed phase of the LBK. Use of the cemetery is then thought to end in the Želiezovce phase – covering a span of some two or three centuries. Bayesian modelling of the new radiocarbon dates leads to estimates that the cemetery started in *5370–5220 cal BC (95.4% probable)* or *5320–5230 cal BC (68.2% probable, Start Nitra)*. The end of activity at the Nitra cemetery is estimated to have occurred in *5210–4980 cal BC (95.4% probable)* or *5210–5090 cal BC (68.2% probable, End Nitra)*. The duration of burial at the site is therefore estimated to have lasted between *20–360 years (95.4% probable)* or *30–220 years (68.2% probable;* see Griffiths 2013 for full details). This is broadly in agreement with the chronology proposed from the pottery, but may be refined in the future by further radiocarbon dating. In total, almost all of the cemetery was sampled, with 61 individuals providing results for both the stable and strontium isotopes (*Tables 3, 4*).

In summary, therefore, the burials discussed in this paper are broadly contemporary, taking place either side of the transition from the initial LBK to its developed phase, currently placed in the 54th and 53rd centuries cal BC. It seems very probable, however, that although the beginning of burial at Nitra overlapped with the use of the Vedrovice cemetery, the Nitra cemetery continued to receive inhumations for longer (Griffiths 2013). We will therefore compare the burials from these two sites only in order to discuss change over time. The dating of the settlement burials is unfortunately less clear, but as for the Vedrovice cemetery, they appear to concentrate in phase Ib. While this provides a broad framework for contextualising the data discussed below, caution is

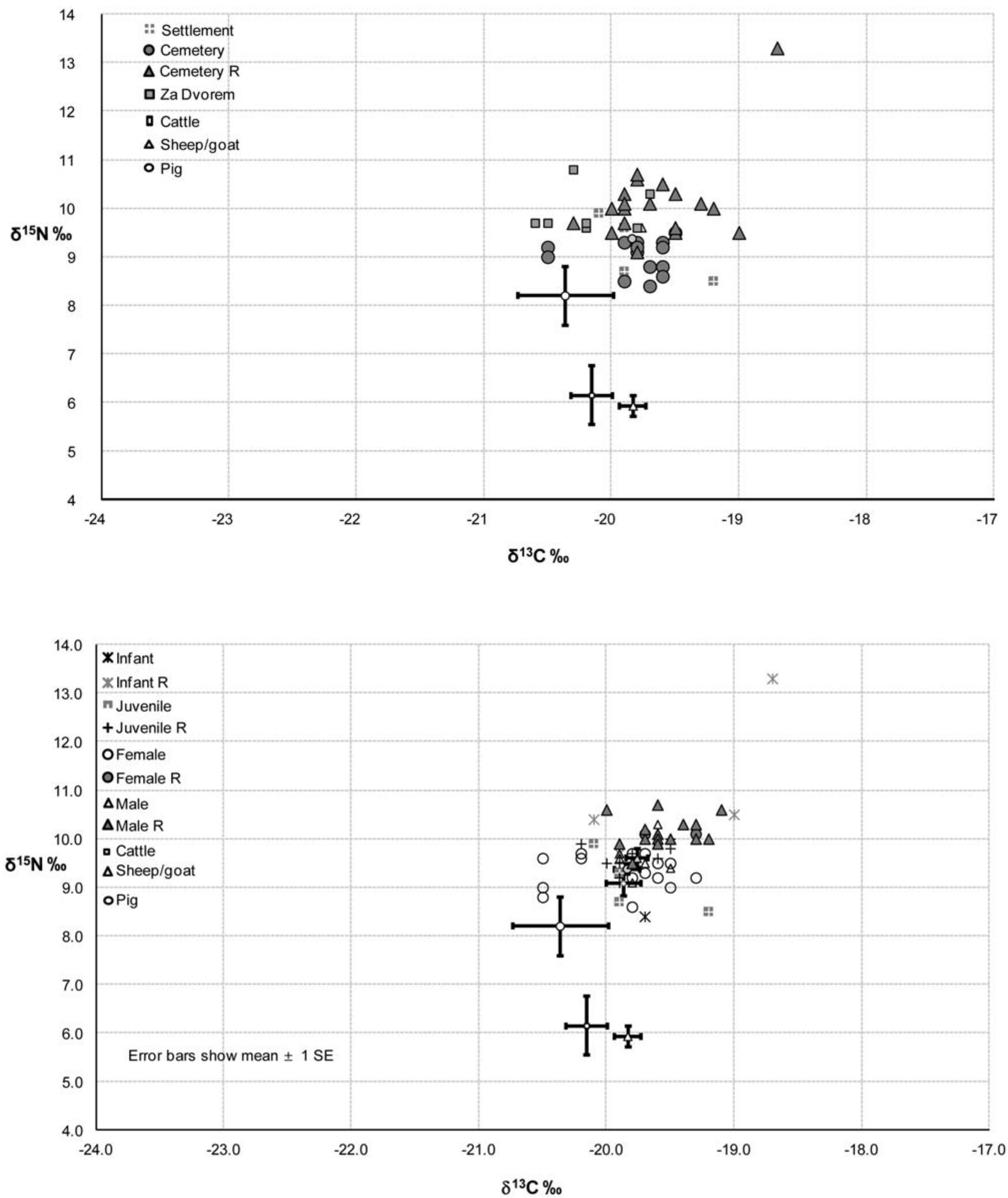

FIGURE 3. Vedrovice: carbon and nitrogen isotope ratios of humans shown by area (top) and by age and sex (bottom). Average ratios for animals are shown with SD. Data from Richards *et al.* (2008) is denoted by "R" in the graph legend.

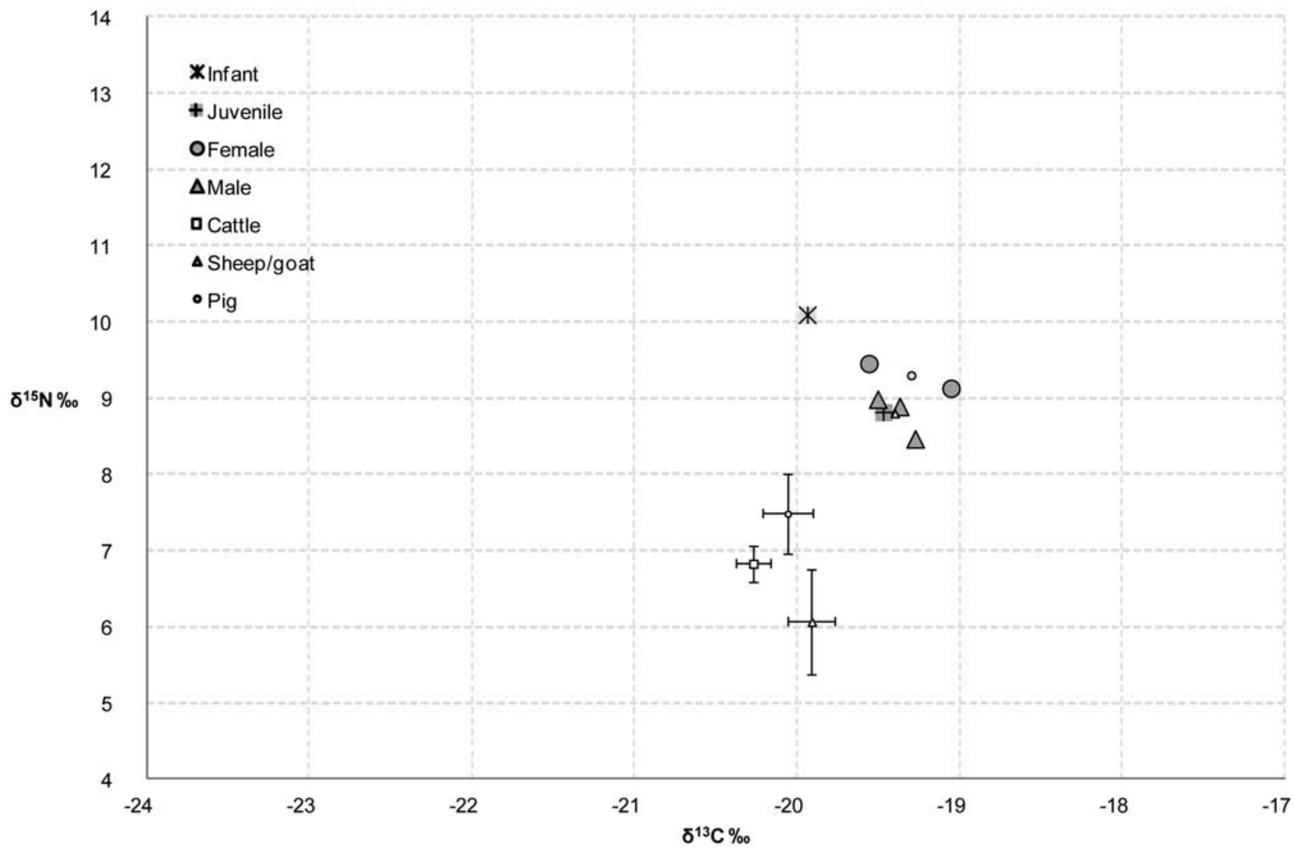

FIGURE 4. Těšetice-Kyjovice: carbon and nitrogen isotope ratios of humans and average ratios from animals, shown with SD.

urged and this sequence may be substantially refined in the future.

RESULTS

Carbon and nitrogen isotopes

Across the four sites of Brno, Těšetice, Vedrovice (all sites) and Nitra, 104 values were returned (averages reported by age and sex classes in *Tables 1–4*), to which a further 51 analyses from Richards *et al*. (2008) can be added, resulting in a total dataset of 161 values (see *Appendix 2*). Overall these data range from −21.0 to −18.0‰ for δ^{13}C and 13.1 to 8.4‰ for δ^{15}N, which fits well with a largely terrestrial diet proposed for the LBK. The higher end of the nitrogen value range will be due to the breastfeeding signal in infants. As a result of the potential impact of breastfeeding (rising values in infancy), it is more consistent to compare adult averages and ranges (represented by standard deviations). Nitra has the highest δ^{15}N average values with the largest standard deviation (10.2 ± 0.4‰; *Table 3*) (*Figure 9*), but other sites show a small deviation from these results (Brno, δ^{15}N = 10.1 ± 0.3‰; Těšetice, δ^{15}N = 9.0 ± 0.4‰; Vedrovice (cemetery), δ^{15}N = 9.7 ± 0.3‰; Vedrovice (Za dvorem), δ^{15}N = 9.2 ± 0.3‰; all reported in *Table 1*, *Figures 3–5*). For carbon, the highest δ^{13}C average values are found at Těšetice (−19.4 ± 0.2‰), but again there are only small variations between the sites (Nitra, δ^{13}C = −20.2 ± 0.3‰; Brno, average δ^{13}C = −19.7 ± 0.2‰; Vedrovice (cemetery), average δ^{13}C = −19.7 ± 0.2‰; Vedrovice (Za dvorem), average δ^{13}C = −20.2 ± 0.3‰ (*Tables 1, 3*, *Figures 3–5, 9*). The standard analytical errors on these values for both carbon and nitrogen are ± 0.2‰ (see *Appendix 1* below) (Hamilton *et al*. 2013: 32). Whereas no difference in carbon isotope ratios is observed between our average results and those reported in Richards *et al*. 2008 from the Vedrovice cemetery, a significant difference is attested for nitrogen values (*Table 1*) (Whittle *et al*. 2013: 122). However, this is most likely due to the different age and sex profiles of the two studies. The reduced numbers in our dataset of

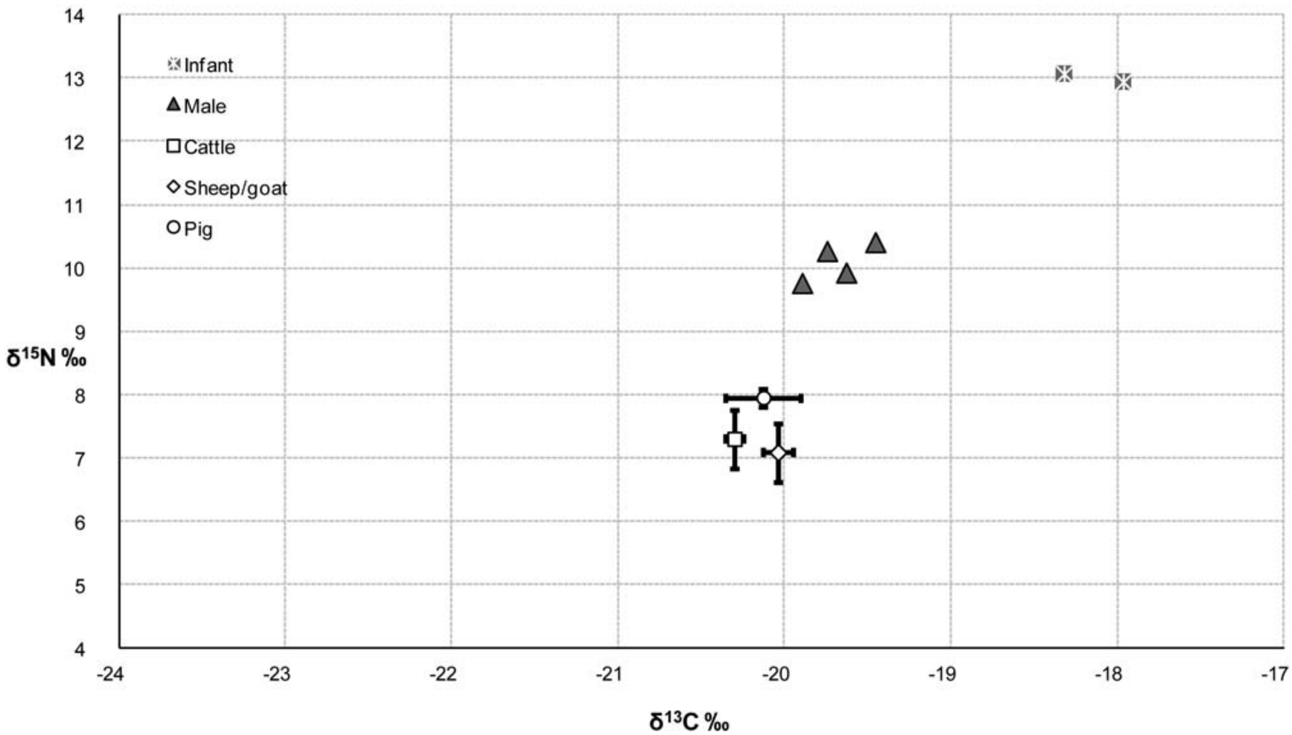

FIGURE 5. Brno-Starý Lískovec: carbon and nitrogen isotope ratios of humans and average ratios from animals, shown with SD.

adult males from the cemetery at Vedrovice (n = 3) strongly influence the overall mean, as males have higher average nitrogen values than females (see below; Whittle *et al*. 2013: 122).

Similarity in carbon and nitrogen values was also observed within the animals sampled. Three main domestic species, cattle, sheep/goat and pig, were analysed. Although the numbers of animals sampled were low, higher $\delta^{15}N$ mean values amongst pigs than for cattle and sheep/goat were found at each site (*Tables 1, 3*), reflecting a somewhat more omnivorous diet for pigs. The differences of $\delta^{13}C$ mean values between human and cattle are 0.5 ± 0.4‰ at Vedrovice (animals are from the settlement, compared to all humans including Richards *et al*. 2008), 0.9 ± 0.4‰ at Těšetice and 0.6 ± 0.2‰ at Brno (Nitra is discussed separately below), whereas the differences of $\delta^{15}N$ mean values are 3.5 ± 1.1‰ at Vedrovice (combined dataset), 2.2 ± 0.7‰ at Těšetice and 2.8 ± 1.3‰ at Brno. The difference in human-animal average $\delta^{15}N$ values is higher at Vedrovice than at the other sites in the region, while the largest difference in mean $\delta^{13}C$ is found at Těšetice.

The nearest animal bone assemblage available to compare to Nitra was the site of Blatné, which is about 30 km from Nitra. Again pig has the highest $\delta^{15}N$ mean value (8.5‰) when compared to the other animals. Sheep/goat from Blatné have significantly higher $\delta^{13}C$ values than the cattle (ANOVA with post hoc Bonferroni test, $P = 0.01$) (Whittle *et al*. 2013: 151) (*Figure 9*). Variation in carbon isotope values can be associated with degree of canopy openness (Balasse *et al*. 2012). This might explain the carbon values of sheep, indicating that these animals were being fed/grazed in more wooded areas than cattle. The difference between the mean human-animal values is 0.5 ± 0.51‰ for $\delta^{13}C$ and 2.5 ± 1.13‰ for $\delta^{15}N$ (*Table 1*). Due to their geographical and temporal proximity one may hypothesise that the animals in the Nitra diet had similar isotope ratios to those from Blatné. Based on this assumption, these data suggest that the LBK population were eating very similar proportions of meat and plants, but those from Vedrovice may have had a higher proportion of meat protein in their diet than others in the region (Hedges *et al*. 2013, Whittle *et al*. 2013).

However, from the Vedrovice area, it is interesting to note that burials from the settlement and Za dvorem have qualitatively different average $\delta^{13}C$ and $\delta^{15}N$ values to those individuals from the cemetery. Specifically the

TABLE 3. Carbon and nitrogen isotope ratios of humans from the Nitra cemetery and animals from Blatné, with means and standard deviations.

Species	Age/sex	Mean $\delta^{13}C$ (‰)	SD $\delta^{13}C$ (‰)	Mean $\delta^{15}N$ (‰)	SD $\delta^{15}N$ (‰)	*n*
Human	Infant	−19.4	0.30	12.6	0.39	5
Human	Juvenile	−20.2	0.20	10.1	0.57	15
Human	Female	−20.2	0.27	10.2	0.37	26
Human	Male	−20.1	0.24	10.5	0.39	14
Human	All adults[a]	−20.2	0.28	10.2	0.40	41
Cattle		−20.7	0.43	7.7	1.06	11
Sheep/goat		−20.1	0.30	7.3	1.64	6
Pig		−20.5	0.37	8.5	0.68	7

[a] Includes one unsexed adult. Infants and juveniles are not included in these values because of the potential influence of the breastfeeding signal.

individuals sampled from Za dvorem have higher $\delta^{15}N$ and lower $\delta^{13}C$ values when compared to the cemetery burials (*Figure 3*). Adults at Za dvorem exhibit average value of 0.5‰ higher for $\delta^{15}N$ and 0.5‰ lower for $\delta^{13}C$ than the adults from the cemetery and therefore 0.3‰ outside analytical error (see *Appendix 1*). Low sample numbers urge caution in performing statistical testing here. The one adult individual available for sampling from the settlement at Vedrovice produced similar results to those from Za dvorem. However, as only one of the Za dvorem burials was sexed as male, and this individual had a high $\delta^{15}N$ value (10.3‰), it is more consistent to compare the females from the cemetery and Za dvorem directly (Whittle *et al*. 2013). The female individuals at Za dvorem demonstrate a pattern of higher $\delta^{15}N$, but lower $\delta^{13}C$ average values compared to the cemetery (*Table 3, Figure 3*).

The low numbers of burials make further conclusions rather unreliable, but the results are consistent with those individuals buried in the Za dvorem location having a different average diet to those in the cemetery at Vedrovice. While it is difficult to reconstruct these differences in absolute terms for the diet, we can suggest that those buried at Za dvorem were eating more meat while sourcing more of their food from a wooded environment (as per the statement on how variation in the isotopes is interpreted; see methodology section above). Further conclusions about meat consumption are difficult as animal bone is, as is to be expected with funerary contexts, largely absent from the cemetery. Inclusion of a small amount of freshwater fish in the diet could also explain the higher average $\delta^{15}N$ value at Za dvorem when compared to the cemetery. Freshwater fish $\delta^{13}C$ values are variable and we would need samples of contemporary local fish to check this (Hedges, Reynard 2007). Overall, then, we argue that there were no important differences in plant and animal protein consumption between settlements and cemeteries in Moravia, but that those who were buried at Za dvorem may have eaten a diet sourced in a different location to the cemetery at Vedrovice (i.e. a more wooded environment), alongside a higher proportion of meat protein, or possibly freshwater fish.

The $\delta^{13}C$ values from Nitra, with an average $\delta^{13}C$ value of −20.2 ± 0.3‰ ($n = 23$), produce the lowest mean carbon isotope results reported in this paper (Hedges *et al*. 2013: 353). As we suggest that the varied canopy cover may be the best explanation for interpreting differences in the carbon isotope values on the scale we find, the low carbon values could suggest that the population at Nitra were sourcing their food from a more wooded environment than other sites sampled here, or perhaps the landscape in the region had denser forest. Other explanations for $\delta^{13}C$ variability include different rates in the consumption of freshwater fish, but in this case we would expect to see a difference in the nitrogen isotopes as well, which as for Za dvorem, is absent in this case. Differences in stable isotope averages between the sexes were found at both Nitra and Vedrovice (compare *Table 1* and *4*; the number of samples from other sites was too small to investigate once broken down by sex, falling well below the recommended five data points). While there were no significant differences in the average $\delta^{13}C$ values between males and females, at both sites men had higher $\delta^{15}N$ mean values, with the males being enriched in ^{15}N by 0.3–0.5‰ at both sites

(Hedges *et al*. 2013, Whittle *et al*. 2013). Previously, differences in male and female nitrogen isotope values have been interpreted in two ways, either as representative of physiological differences between the sexes (such as the stress placed on the body by pregnancy; tested by Nitsch *et al*. 2010) or varied amounts of animal protein in the diet. While this pattern was found at both the cemeteries of Vedrovice and Nitra, it was not seen more widely at other sites sampled for the *LBK Lifeways* project, suggesting that in this case the explanation of dietary differences seems more realistic (Hedges *et al*. 2013: 354). On this basis, we argue here that men had more meat protein in their diets than women. Stronger dietary differences between the sexes may, therefore, have been a practice found in both Moravia and western Slovakia, but further testing of large assemblages from the region is required. Overall, therefore, the stable isotopes suggest that the populations of Nitra and Vedrovice were eating similar rates of plant and animal protein and that at both sites the diets of men and women differed in similar ways.

Strontium isotopes

The average strontium isotope values from the three Moravian sites are reported in *Table 2* and *Figures 6–8*, and the values from Nitra are reported in *Table 4* and *Figure 10*. All of the sites discussed here are located on loess soils, but they are influenced differentially by the geologies around them. Erosion of the more radiogenic Precambrian geology of the Bohemian Massif has led to

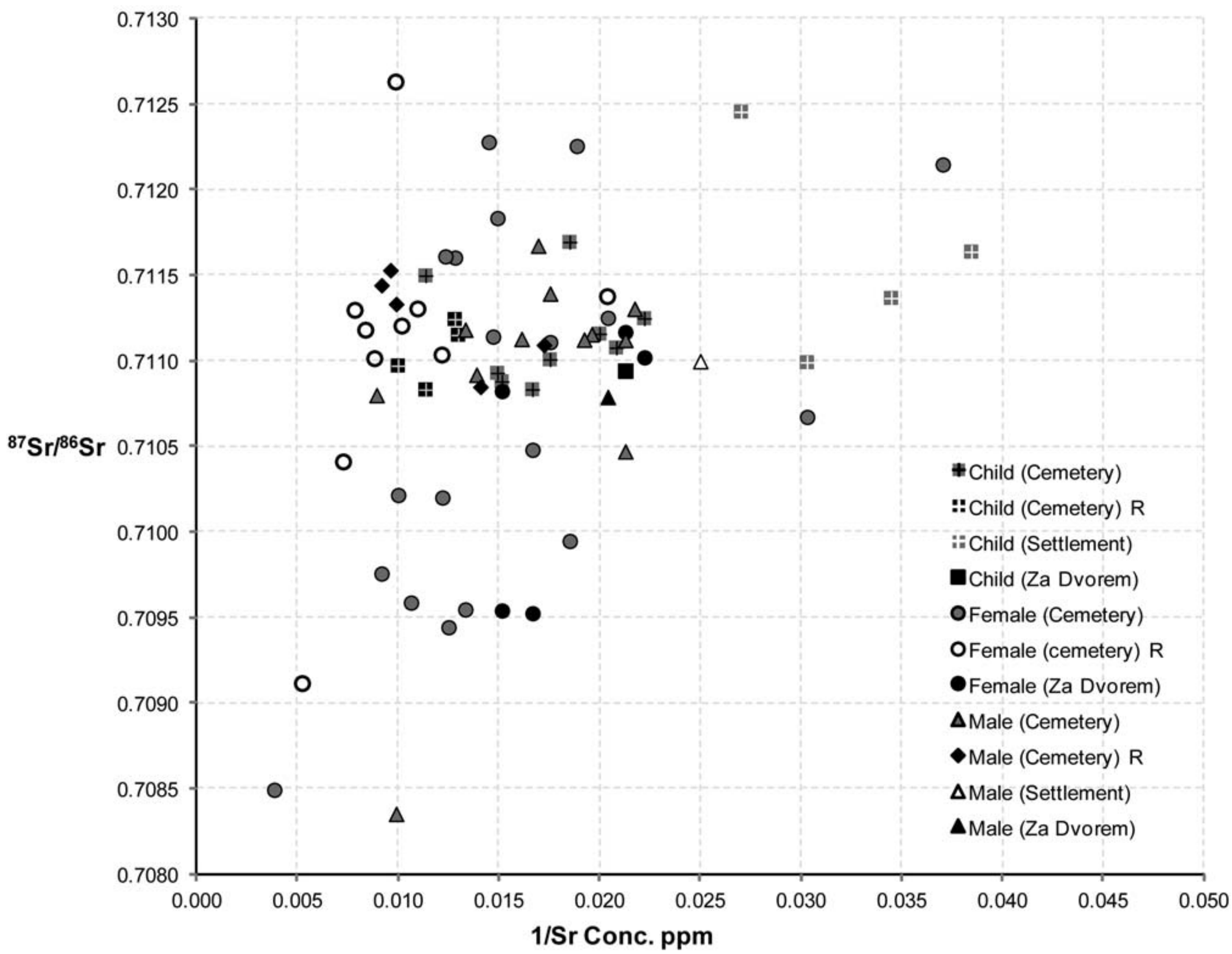

FIGURE 6. Vedrovice: strontium concentration (ppm) versus ratio ($^{87}Sr/^{86}Sr$). All areas of the site shown, data from Richards *et al.* (2008) are denoted by "R" in the graph legend.

the loess having a higher $^{87}Sr/^{86}Sr$ isotope ratio (0.7105–0.7108) in the areas of Vedrovice and Těšetice (Richards *et al*. 2008) than in the Brno and Nitra areas, where loess soils fall within the range found widely across the distribution of the LBK (0.7085–0.7105; Bentley 2006, 2013). Individuals whose strontium isotope ranges fall outside these ranges are likely to have sourced their food either from geologies further afield from the local settlement or moved into the area from outside during childhood (Bentley 2006, 2012). Overall, the range of strontium isotope ratios found at the Vedrovice cemetery is larger (0.70835–0.71263) than that found at the Vedrovice settlement (0.71099–0.71245), Těšetice--Kyjovice (0.71018–0.71184), Brno-Starý Lískovec/Nový Lískovec (0.70987–0.71075) or Nitra (0.70860–0.71046). The large Vedrovice range suggests that a population of more mixed origins was buried in this cemetery than in the settlement burials, though the limited number of settlement burials may well have an impact on these results.

However, given the clustering of results from Těšetice and Vedrovice in the range of 0.7105–0.7120 $^{87}Sr/^{86}Sr$, a larger range for the "local" population than that represented by the local loess is envisaged, as it is likely that early farming groups were sourcing food from varied geologies (e.g. for hunting or herding, Bentley 2013, Hamilton *et al*. 2013, Pollard 2011). Within our dataset, six individuals from Vedrovice stand out as having low strontium concentrations (high 1/Sr conc. values) in their molars, two females from the cemetery, three children from the settlement and one child from the cemetery. These values suggest that these individuals had a higher proportion of food types with lower strontium concentrations such as meat or milk in their diet at the time their teeth were forming than other burials in this location. In the case of all these burials the first molar was sampled, which may have partially formed while still breastfeeding, but the two females who died in early adulthood both had high $\delta^{15}N$ values when compared to the average for the females at the cemetery (both above

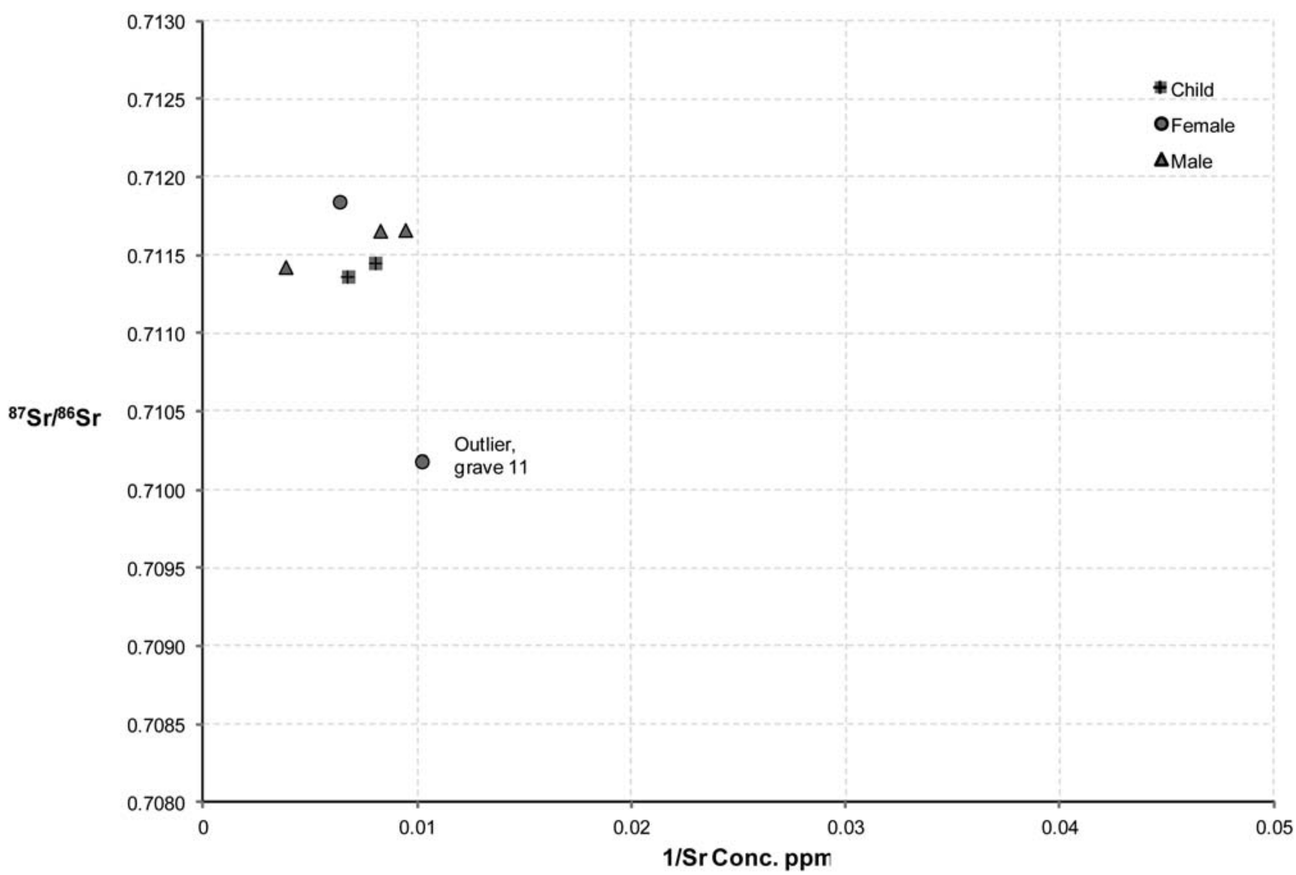

FIGURE 7. Těšetice-Kyjovice: strontium concentration (ppm) versus ratio ($^{87}Sr/^{86}Sr$).

10‰, Richards *et al*. 2008), suggesting that these were dietary differences which persisted throughout their lives (from early childhood to adulthood).

It is also noticeable that females had a significantly larger range of strontium isotope ratios than males buried in the cemetery (Bentley *et al*. 2012, Levene's test, $P = 0.015$; Whittle *et al*. 2013). While the smaller assemblage prevents such analysis at Těšetice-Kyjovice, it is interesting to note that the one burial with an outlying strontium isotope ratio is also female (Whittle *et al*. 2013) (*Figure 7*). This burial (grave 11) is situated on its own, away from the rest of the burials sampled by this project, which are clustered in one part of the settlement (Dočkalová, Čižmář 2008: 41). This older adult, who died between the ages of 45 and 55 (Dočkalová, Čižmář 2008), may well have moved into the settlement at some point during her life. However, we cannot exclude other reasons for the outlying value, such as chronology – perhaps the community made a change in where the majority of the diet was sourced – or that she belonged to a different dietary group at the settlement. That said, taken together with the wider range from strontium isotope values found for women at the Vedrovice cemetery, which (following the chronological discussion above) we can more confidently assign to a tight time period, the female population of the LBK demonstrates greater lifetime mobility (Bentley *et al*. 2012, Bickle *et al*. 2011, Hedges *et al*. 2013).

As discussed above, we would expect the average strontium ratios of Vedrovice and Nitra to differ because there are significant differences in the underlying values of the loess soils between the two sites. While we cannot therefore compare the absolute values from each cemetery, we can examine to a certain extent the degree of variability and compare any patterns found within the data. The strontium results from Nitra show a different pattern to those from Vedrovice, with a tightly clustered group falling within the range 0.7092–0.7097 and seven outliers (*Table 4, Figure 10*) (Whittle *et al*. 2013). This contrasts directly with the more even spread found at Vedrovice (*Figure 6*). While this could be explained by a more homogenous local geology in the immediate area of Nitra than at Vedrovice (*cf*. Knipper 2011), the cemetery falls very close to the crystalline uplands of the

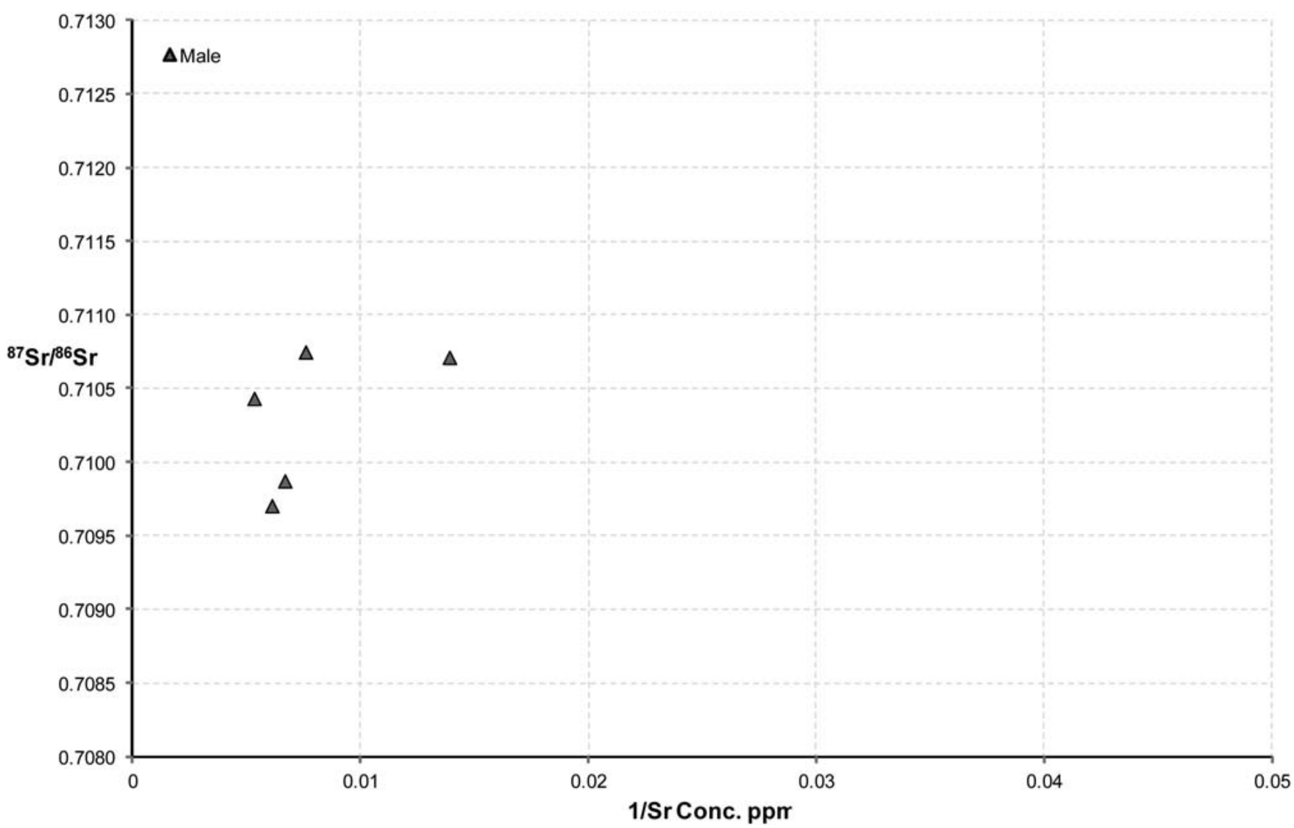

FIGURE 8. Brno-Starý Lískovec: strontium concentration (ppm) versus ratio ($^{87}Sr/^{86}Sr$). All points are males.

TABLE 4. Strontium isotope ratios and concentrations from the Nitra cemetery.

Age/sex	Mean $^{87}Sr/^{86}Sr$	SD $^{87}Sr/^{86}Sr$	Mean Sr. conc.	SD Sr. conc.	*n*
Juvenile	0.70948	0.00009	42	13	15
Male	0.70944	0.00013	74	59	15
Female	0.70952	0.00039	100	106	25
All[a]	0.70948	0.00025	72	74	61

[a] Includes one unsexed adult.

Tribeč mountains and their expected higher radiogenic strontium ratios. This suggests that the population buried at Nitra were themselves much more homogenous than at Vedrovice. Elsewhere, Bentley (2007) has suggested that mobility levels decreased over the life of the LBK (see also Knipper 2011) and we suggest that the different strontium isotope ratios between Vedrovice and Nitra may also be explained by chronological differences between the two cemeteries. If, as Zvelebil and Pettitt (2008) suggest, Vedrovice was founded early in the expansion of the LBK and attracted a variety of different individuals, then perhaps we can suggest that over time there was a reduction in the different kinds of lifeways that were followed as the culture became more established.

However, despite the overall differences in the strontium isotope ratios, there were some shared patterns between the two sites. At both sites, the strontium isotope ratios of women were more variable than those of males (as noted above for Vedrovice; Whittle *et al*. 2013). Following previous work (Bentley 2007, 2013, Bentley *et al*. 2012, Bickle *et al*. 2011), we argue that this represents practices of patrilocality in the LBK, with women moving on marriage and men largely staying in the communities into which they were born (as previously suggested by Eisenhauer 2003a, b). As this pattern is identifiable at Vedrovice, we can suggest that these practices were established fairly early in the history of the LBK.

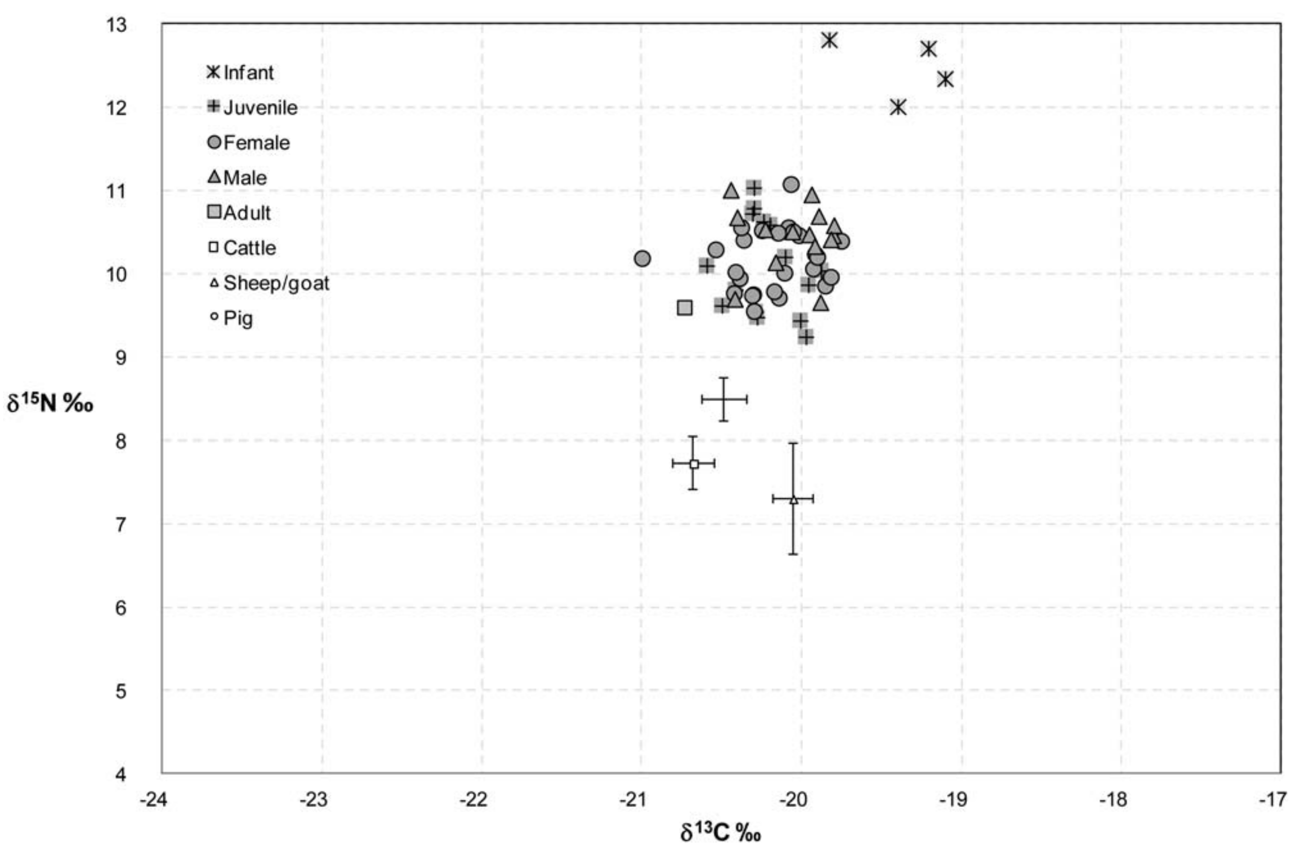

FIGURE 9. Nitra: carbon and nitrogen isotope ratios of humans and average ratios from animals, shown with SD.

SETTLEMENT AND CEMETERY BURIALS IN MORAVIA

The stable and strontium isotope ratios together suggest that individuals buried at settlements and cemeteries in Moravia during the LBK were sharing many of the same lifeways. In terms of overall diet, it seems that most of the LBK population in Moravia were consuming similar rates of animal and plant protein, suggesting shared access to foodstuffs such as meat and cereals (Hedges *et al*. 2013). However, the individuals interred at Vedrovice, and more specifically, Za dvorem did stand out in dietary terms. Given that these burials are thought to be roughly contemporary with the Vedrovice cemetery burials on our best current estimate, this could suggest that two different groups were using the Vedrovice area to bury their dead. In this light the rare find of marble beads in the graves at Za dvorem (Podborský 2002) is interesting. While overall the grave good assemblages present familiar LBK practices of including ornamentation in the grave, the unusual material may speak to varied exchange networks or resource use correlating with different diets.

The strontium results from the cemetery at Vedrovice suggest a population drawn from a wider geographical area, confirming the results of Richards *et al*. (2008) and Zvelebil and Pettitt (2008). The settlement burials, however, seem to fall within narrow ranges and to have a lower proportion of incomers. While the relative size of available samples from the two contexts perhaps exaggerates the variability at Vedrovice, we may suggest that the population buried in cemeteries represents

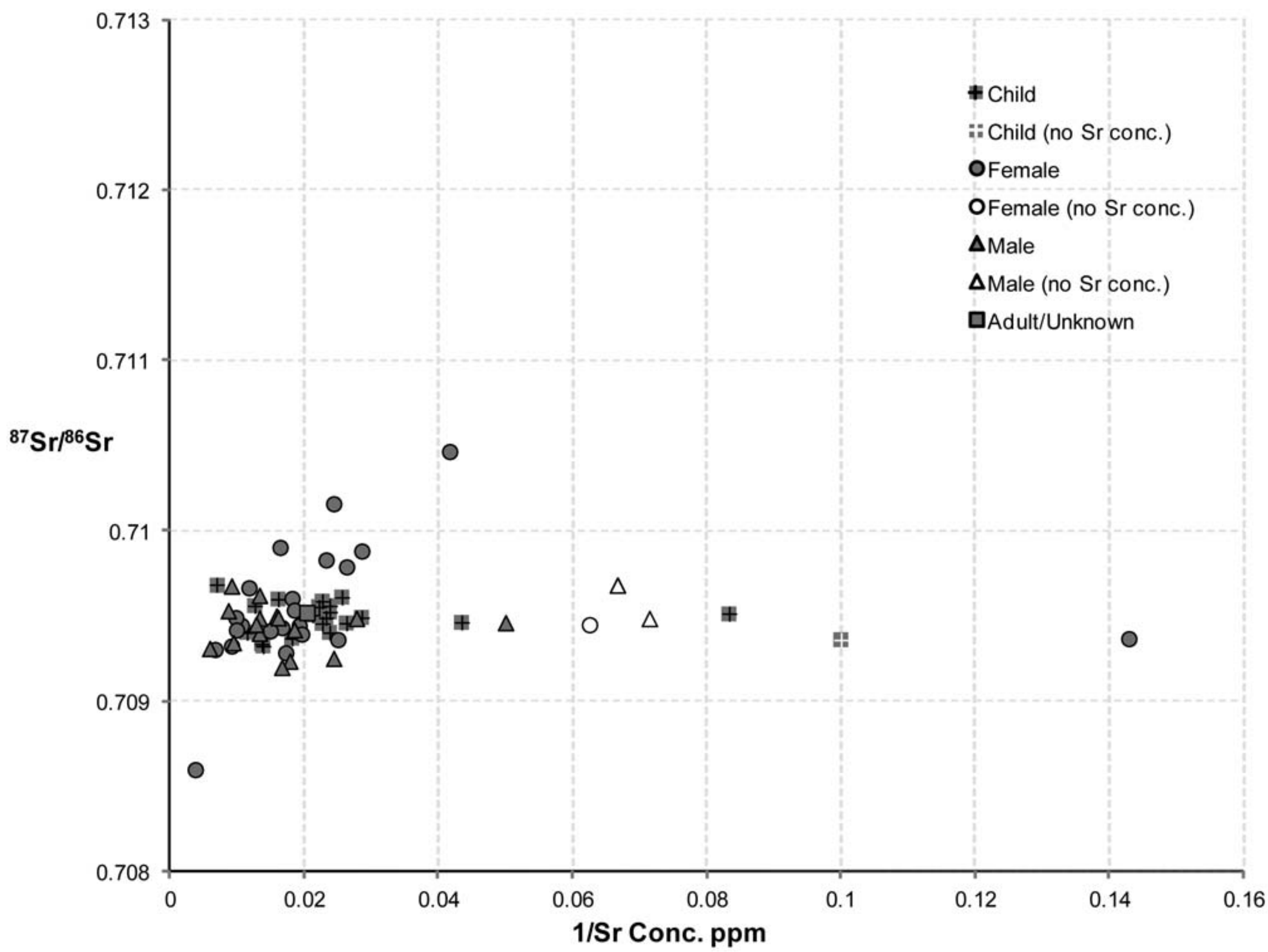

FIGURE 10. Nitra: strontium concentration (ppm, expressed 1/Sr conc.) versus ratio ($^{87}Sr/^{86}Sr$). In the case of samples where strontium concentration data could not be produced, the data are reported here as no Sr. conc. and their position on the x-axis is arbitrary.

a more heterogeneous population than that at settlements. Viewed in light of the higher rates of grave goods found at cemeteries more broadly across the LBK, we may also suggest that greater diversity in communities using cemeteries resulted in more dynamic and complex demonstrations of identity and status, represented in higher rates of furnished graves. In contrast, overall in the LBK more diverse body positions and grave orientations are found amongst settlement rather than cemetery burials (Hedges *et al*. 2013). That said, the context of burial is rarely an arena for the straightforward presentation of the deceased in life, and the frequency of grave goods or unusual body positions and orientations may have also been determined by what was deemed culturally appropriate for the context of burial. Overall, the dataset shows that against a background of widely practised and shared experiences of diet, different rates of lifetime mobility may have impacted on the communities of Moravia and on the lifeways of men and women.

THE LIFEWAYS OF VEDROVICE AND NITRA

The isotope results from Vedrovice and Nitra demonstrate both similarity in dietary practices and differences in the mobility strategies pursued. Importantly, they suggest that the degree of variation within burial communities could itself vary between sites during the LBK. The stable isotope results suggest that dietary protein consumption was broadly similar at both sites, with differences in the diets of males and females also repeated at both cemeteries. While the difference in carbon isotope results from Vedrovice and Nitra do suggest that some changes in diet may have taken place over time (as burial at Nitra continued after it had been abandoned at Vedrovice), through lower than average $\delta^{13}C$ values found amongst the population, we suggest that as this deviation is not repeated in the nitrogen results such differences represent varied landscape cover in the Nitra area. Broadly then, dietary practices appear to have been widely shared across the Moravian and western Slovakian areas of the LBK. However, the strontium results suggested distinct differences in lifetime mobility or the locations from which food was sourced; while the Vedrovice cemetery fell across a broad range of strontium isotope ratios, the population from Nitra formed a much tighter cluster. This chimes well with previous suggestions that mobility reduced over the duration of the LBK (Bentley 2007).

CONCLUSIONS

The aim of this paper was to consider the extent of variability within the isotope datasets from the sites of Vedrovice, Nitra, Těšetice-Kyjovice and Brno-Starý Lískovec/Nový Lískovec and its potential implications for variability in lifeways during the LBK. While the large assemblages of Nitra and Vedrovice suggested that different degrees of mobility were present at each site, potentially related to changes over the duration of the LBK, they also shared dietary practices related to protein consumption which were widespread across the LBK, though perhaps also indicating a regionally specific variation in diet by sex (Hedges *et al*. 2013, Whittle *et al*. 2013). The smaller assemblages from Těšetice-Kyjovice and Brno-Starý Lískovec/Nový Lískovec contributed to the overall picture of variability, suggesting that although there may have been a higher tendency for those who had been born and lived locally to be buried in a settlement context, this was by no means exclusive and those buried at settlements and in cemeteries are likely to have shared many of the same experiences of diet and mobility. This is in contrast to the results from Vedrovice, where there was a correlation between the area of the site where an individual was buried and their diet in the last years of their life. However, no distinct "indigenous" versus "incomer" or "farmer" versus "hunter-gatherer" isotope signatures could be identified and we follow Zvelebil and Pettitt (2008) in arguing for a more complex admixture of different groups and dietary practices. Where we did find distinct differences in the lifeways of these early Neolithic communities was in the comparison of males and females. Not only do they seem to have eaten a different diet in the Moravian and western Slovakian areas, females across the LBK appear to have experienced higher rates of mobility. We interpret this pattern as representing practices of patrilocality, where women moved during life (e.g. at marriage) from the settlements of their childhood to those of their husbands (Bentley 2007, 2013, Bentley *et al*. 2012, Bickle *et al*. 2011). This seems to have been a fairly widespread practice across the LBK and has even been suggested as one of the mechanisms by which it spread (Price *et al*. 2001, Mateiciucová 2008, 160), echoing Zvelebil's (Zvelebil, Dolukhanov 1991) availability model for the Mesolithic-Neolithic transition. While we should be very wary of explaining all these data in terms of the transition from hunting and gathering to farming (Bickle, Hofmann 2007), it is certainly interesting to speculate on whether an aspect of social organisation that possibly helped the

LBK to spread later became embedded in the forms of lifeways experienced and the networks of communities that practised the LBK culture in the centuries that followed.

ACKNOWLEDGEMENTS

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APPENDIX 1. Methodology for analysing the carbon, nitrogen and strontium isotopes.

Carbon and nitrogen. The methodology for analysing the carbon and nitrogen isotopes is summarised as detailed in Hamilton *et al*. (2013). Collagen was extracted from up to 1g of bone per sample using a modified Longin method according to a standard protocol (e.g. O'Connell, Hedges 1999). The bone was cleaned by shot-blasting, then samples were demineralised in 0.5 M HCl at 4°C, rinsed with distilled water, and gelatinised in a pH 3 solution for 48 hours at 75°C. The solution was filtered, frozen and freeze-dried. Between 2.0 and 2.5 mg of dried collagen were loaded into a tin capsule for continuous flow combustion and isotopic analysis. Samples were isotopically analysed using an automated Carlo Erba carbon and nitrogen elemental analyser coupled with a continuous flow isotope ratio monitoring mass spectrometer (PDZ Europa Geo 20/20 mass spectrometer). Each sample was measured in at least duplicate and where necessary triplicate runs, using internal secondary standards (bovine liver standard, bone standard, nylon, and alanine), giving an analytical error of ± 0.2‰ for both isotopes. Results are reported in unit per mil (‰) and $\delta^{13}C$ and $\delta^{15}N$ values were measured relative to the VPDB and AIR standards respectively (Gonfiantini *et al.* 1990, Mariotti 1983). Samples with C:N ratios outside the range 3.0–3.5 or with less than 1% collagen yield (weight % of whole bone) were rejected; a few accepted samples with slightly less than 1% collagen yield had an acceptable weight % of nitrogen and carbon in their collagen as well as acceptable C:N ratios (Ambrose 1990, DeNiro 1985).

Strontium. The methodology for analysing the strontium isotope ratios and concentrations is summarised as detailed in Hamilton *et al*. (2013). For this project, all Sr isotope analyses were conducted in the Department of Earth Sciences, Durham University. Using an established procedure, about 5 mg of tooth enamel from each individual was mechanically cleaned and dentine removed with a surgical steel scalpel, and soaked for one hour in weak (5%) acetic acid. Each sample was then dissolved in 3-N HNO_3, purified by extraction chromatography in polyethelyne columns with Sr-spec resin. With the purified Sr in 3% HNO_3 acid, $^{86}Sr/^{87}Sr$ analyses were carried out on a Thermo Electron Neptune Multi Collector Mass Spectrometer. Over all the separate analytical sessions, the average composition and reproducibility of the 212 analyses of NBS 987 Sr isotope reference material (0.71024) had a value of 0.710262 ± 0.000001 (the ± expresses one standard error, which in the sixth digit is much smaller than the variation of the samples). Blanks were typically below 10 pg Sr and always below 30 pg Sr for all runs.

APPENDIX 2. The human isotope, osteological and archaeological data.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Brno-Starý Lískovec	2601/801	M2		M?	44–45	0.71043	188							NE-SW	LC	n.d.
Brno-Starý Lískovec	2565/802	M1	Long bone	M?	40–65	0.71071	72	−19.6	9.9	38.2	13.8	3.20	8.3			n.d.
Brno-Starý Lískovec	5817/803	M3	Rib	M	20–21	0.71075	132	−19.7	10.3	34.0	12.5	3.20	3.3		RC	n.d.
Brno-Starý Lískovec	7714/805	M2	Rib	M	14–19	0.70970	164	−19.9	9.8	30.1	10.7	3.30	1.8	E-W	LC	F.Cer.(1)
Brno-Starý Lískovec	7727/806	M1	Rib	M	50–60	0.70987	150	−19.5	10.4	44.9	16.4	3.20	10.5	N-S	P	n.d.
Brno-Starý Lískovec	5575/534/800		Rib		6 mon.			−18.3	13.1	40.8	14.9	3.20	9.2	SE-NW	LC	Shd.,Grd.(2)
Brno-Starý Lískovec	658/410/800		Rib		4–5 mon.			−18.0	12.9	37.3	13.5	3.20	6.8			
Nitra	1/64	M1	Rib	F	YA > 20	0.70943	60	−20.2	9.7	35.1	12.6	3.26	3.6	S-N	LC	Cer.(1)
Nitra	2/64	M1		M	OMA	0.70946	20							SE-NW	CF	Pol.(1), Cer.(1), Spon.(1 bead, V buckle)
Nitra	3/64	M2	Rib		Adol.	n.d.	n.d.	−20.0	9.3	32.0	11.5	3.25	3.5	E-W	LC	Cer.(1)
Nitra	4/64		Rib		Adol.			−19.8	10.4	38.3	13.7	3.26	4.2			Cer.(2), Lit.(4), Bon.(1)
Nitra	4/64	M3	Rib	F	YMA	0.70944	52	−19.9	10.3	42.4	15.3	3.24	11.6			n.d
Nitra	4/64	M2	Rib	M	Mid-ad.	0.70953	115	−20.0	9.5	36.9	12.8	3.37	2.4			n.d.
Nitra	5/64	M2	Mc		Adol.	0.70940	87	−20.0	9.9	36.5	13.1	3.26	4.2	SE-NW	LC	Och., Graphite pieces
Nitra	6/64	M3?	Rib	F	Mature ad.	0.70933	109	−20.1	10.5	38.5	13.8	3.26	5.1	SE-NW	LC	Cer.(1), Spon.(6 beads)
Nitra	7/64	M3		M?	Adult	0.70968	109									Cer.(1), Och.
Nitra	8/64	M1	Rib	M	Mature ad.	0.70934	106	−19.9	11.0	36.7	13.0	3.28	3.2	E-W	LC	Pol.(1), Cer.(1), Spon.(1 bead)
Nitra	9/64		Long bone	M?	Mid-ad.	0.70945	78	−20.4	9.7	20.0	7.2	3.26	1.6	SE-NW	LC?	F.Cer.(1)

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Nitra	14/64	M1	Rib	F	Adult	0.70937	7	−20.4	9.8	23.5	8.4	3.29	1.3	SE-NW	LC	Lit.(3), Bon.(2)
Nitra	15/65		Rib	F?	Adult < 20			−21.0	10.2	39.2	14.0	3.26	5.2	SE-NW		F.Shd.(?)
Nitra	15/65	M2 dec.	Rib		1–1.5	0.70961	39	−19.7	13	37.0	12.9	3.35	3.5			As above
Nitra	16/65		Rib		Adult			−20.7	9.6	31.1	11.1	3.26	4.5			U.
Nitra	17/65	M2	Rib	M	Mature ad.	0.70949		−19.9	10.3	38.2	13.5	3.29	3.4	SE-NW	LC	Cer.(2)
Nitra	18/65	M2	Rib	F	Mid-ad.	0.70931	149	−20.4	10.4	24.1	8.4	3.37	1.6	SE-NW	LC	U.
Nitra	19/65	M2	Rib	M	OMA	0.70940	75	−19.9	10.7	40.7	14.7	3.23	7.0	SE-NW	LC	Tee.(7, human and animal)
Nitra	20/65	M1	Rib	F	YMA/ < 30	0.70988	35	−19.9	9.9	39.9	14.3	3.24	8.2	S-N	LC	U.
Nitra	21/65	PM		M	Older ad.	0.70931	169							SE-NW	LC	Pol.(1), Cer.(1), Spon.(1 bead)
Nitra	22/65	M2	Rib	F	Mature ad.	0.70860	266	−20.4	10.0	33.9	11.9	3.32	7.8	S-N	LC	F.Shd.(?)
Nitra	23/65	M1	Rib		11–12	0.70960	62	−20.3	9.6	43.9	15.5	3.30	8.3	SE-NW	LC	F.Shd.(?)
Nitra	24/65	M2	Rib	F	YMA	0.70945	94	−20.3	10.5	42.1	14.8	3.33	8.7	S-N	LC	Cer.(1)
Nitra	25/65		Rib	M	Mature ad.			−20.2	10.5	36.3	12.7	3.33	5.3	SE-NW	LC	Pol.(1), Cer.(1), Spon.(1 bead)
Nitra	26/65	M2	Rib	M	Mid-ad. > 30	0.70962	75	−20.1	10.5	37.2	13.0	3.33	7.1	SE-NW	LC	Pol.(1), Shd.(?)
Nitra	27/65	M3	Rib	F	Older/ mature ad.	0.70967	85	−20.4	10.0	39.0	13.6	3.35	6.9	E-W	LC	Pol.(1), Cer.(1)
Nitra	28/65		Skull		≤ 6 mon.			−19.2	12.7	41.0	14.2	3.38	6.8			Cer.(1)
Nitra	29/65	M2	Rib		10–12	0.70949	35	−20.5	9.6	27.9	9.3	3.50	2.2	SE-NW	LC	U.
Nitra	30/65	M1	Rib		6–7	0.70937	55	−19.9	10.1	38.0	13.5	3.28	12.4	S-N		Cer.(1)
Nitra	31/65	M1	Rib		1.5–2	0.70951	47	−19.8	12.8	38.7	13.2	3.42	7.8	SE-NW	LC	Grd.(1)
Nitra	32/65	M1	Rib	F	YA	0.70929	58	−20.5	10.3	39.9	14.1	3.31	5.3	E-W	LC	Cer.(1)
Nitra	33/65	M2	Rib	F?	YMA	0.70954	54	−20.3	9.8	43.1	15.3	3.28	12.9	E-W	LC	U.

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Nitra	34/65	M1 M3	Rib	M	Mid-ad.	0.70950 0.70925	63	−19.8	10.5	37.4	13.3	3.27	5.5	S-N	LC	Pol.(1), Cer.(1), Spon. (frags., unworked)
Nitra	35/65	M2	Rib	F?	Older ad.	0.70941	67	−19.9	10.1	36.1	12.7	3.32	8.0	E-W	LC	Cer.(1), Spon.(1 bead)
Nitra	36/65	M2	Rib	F	Mature ad.	0.70949	102	−20.2	10.5	33.3	11.8	3.29	10.0	SE-NW	CF	Cer.(1), Och.
Nitra	37/56	M2	Rib	F	YMA	0.70942	101	−20.3	9.8	27.4	9.3	3.42	4.2	SE-NW	CB	U.
Nitra	38/65	M1	Rib		6–7	0.70934	73	−20.6	10.1	18.7	6.4	3.41	2.5	S-N	LC	U.
Nitra	39/65	M2	Rib	F?	OMA	0.71016	41	−19.8	10.0	33.7	11.7	3.36	4.7	S-N	LC	Shd.(?), Spon.(1 bead)
Nitra	40/65	M1			c. 3	0.70952	42							SE-NW	LC	Pol.(1), Cer.(1)
Nitra	41/65	M2	Rib		Early adol.	0.70940	42	−20.1	10.2	33.4	11.8	3.31	5.9	S-N	CB	Pol.(flake), Cer.(1), Lit.(1)
Nitra	42/65	M1			5–7	0.70932	72							SE-NW	LC	Cer.(1)
Nitra	43/65				Adult									SE-NW	RC	Shd.(?)
Nitra	44/65	M2	Rib	F	Mid-ad.	0.70979	38	−20.4	10.6	38.3	12.8	3.50	2.6	SE-NW	LC	Cer.(1)
Nitra	45/65	M1			Mid-ad.	0.70952	49							S-N	LC	U.
Nitra	46/65				Adult or adol.										C	U.
Nitra	47/65	M1	Skull		1–1.5	0.70968	141	−19.4	12.0	29.4	10.5	3.27	1.7	SE-NW	LC	Cer.(1)
Nitra	48/65	M1	Rib	F	YA	0.70983	43	−20.3	9.6	39.0	13.1	3.48	2.5	E-W	LC	U.
Nitra	49/65	M1	Rib Skull		5–6	0.70956	42	−20.3 −20.3	11.0 9.5	38.9 28.0	13.7 10.1	3.31 3.22	4.4 2.4	E-W	LC	U.
Nitra	50/65	M1	Skull		4–5	0.70959	44	−20.2	10.6	32.9	12.0	3.20	2.3	E-W	LC	U.
Nitra	52/65		Rib	F?	Mid-ad.			−20.2	9.8	31.0	10.5	3.42	2.5	S-N	LC	F.Cer.(1)
Nitra	53/65		Rib	F	YA			−20.1	10.6	42.0	14.7	3.34	5.6	SW-NE	LC	Cer.(1)
Nitra	54/65	M1	Rib		6–7	0.70946	38	−20.3	10.7	42.8	14.8	3.38	5.3	E-W	LC	U.
Nitra	55/65				3–6 mon.									S-N	LC	U.
Nitra	56/65	M2	Rib	M	Mature ad.	0.70949	62	−19.9	9.7	41.3	14.7	3.27	3.7	SE-NW	LC	Cer.(1)
Nitra	57/65	M2	Rib	F	YA	0.70960	55	−20.1	11.1	43.2	15.3	3.29	7.1	SE-NW	LC	Shd.(?)
Nitra	58/65	M2	Rib	M	Mid-ad.	0.70923	56	−19.8	10.6	42.0	14.7	3.34	4.6	S-N	LC?	Pol.(1), Cer.(1), Spon.(2 beads), Lit.(1), Bon.(1)

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Nitra	59/65	M2			Adol.	0.70946	44							E-W	LC	Cer.(1)
Nitra	60/65	M2 dec.			c. 1	0.70955	45									U.
Nitra	61/65	M2	Rib	F	Mature ad.	0.70945		−19.9	10.2	41.2	14.7	3.28	5.9	SE-NW	LC	Cer.(1)
Nitra	62/65	M3	Rib	M?	YMA	0.70942	54	−20.2	10.2	41.1	14.5	3.31	10.1	SE-NW	LC	U.
Nitra	63/65	M2		M?	Adult > 20	n.d.								SE-NW	LC	U.
Nitra	64/65	M1	Rib	F	OMA	0.71046	24	−20.3	9.8	39.5	13.9	3.32	6.2	SE-NW	LC	Cer.(1), Och.
Nitra	65/65	M1	Rib	F	Older ad. > 40	0.70940	51	−20.0	10.5	36.9	13.0	3.32	8.8	SE-NW	CB	Cer.(1), Och.
Nitra	66/65		Long bone	F	Older ad.			−20.1	10.0	28.2	10.4	3.16	2.4	S-N	LC	Cer.(1)
Nitra	67/65	M1	Rib		1.5	0.70956	79	−19.1	12.4	39.0	13.8	3.29	13.7	S-N	LC	U.
Nitra	68/65	M1	Skull		8–9	0.70946	23	−20.4	9.8	21.5	7.4	3.40	1.0			Cer.(1)
Nitra	69/65	M1 M3	Rib	M	YA	0.70949 0.70949	75 36	−20.0	10.5	37.5	13.3	3.30	6.9	E-W	CF?	Cer.(1)
Nitra	70/65	M2	Rib	F	YMA	0.70990	61	−19.8	10.4	39.1	13.7	3.32	5.6	E-W	CF	Cer.(1), Spon.(3 beads)
Nitra	71/65	M1	Rib		5–6	0.70936		−20.2	10.6	43.5	15.4	3.31	8.5	S-N	RC	Cer.(1)
Nitra	72/65	M2	Rib	M	YA	0.70968		−20.4	10.7	41.6	14.5	3.34	10.4	S-N	CB	U.
Nitra	73/65				6–9 mon.									S-N	LC	U.
Nitra	74/65	M2	Rib		2–3	0.70951	12	−20.3	10.8	32.6	11.1	3.43	3.9	S-N	LC	Cer.(1)
Nitra	75/65	M2			Early adol.	0.70949	43							S-N	LC	U.
Nitra	76/65	M2		F?	Mid-ad.	0.70936	40							SE-NW	LC	Pol.(1), Cer.(1), Lit.(2)
Nitra	77/65	M2	Long bone	M?	Mid-ad.	0.70920	60	−20.5	11.0	27.2	9.6	3.30	2.2			n.d.
Těšetice-Kyjovice	11/86	M1	Rib	F	45–55	0.71018	98	−19.6	9.5	42.4	15.3	3.23	8.3	NW-SE	LC	Cer.(2), Grd.(1)
Těšetice-Kyjovice	15/91	M1	Rib		Inf. II	0.71145	124	−19.9	10.1	28.0	9.8	3.34	0.9	E-W	LC	U.

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Těšetice-Kyjovice	17/91	M1	Long bone		9–10	0.71136	147	−19.5	8.8	36.9	13.4	3.20	4.5	E-W	LC	n.d.
Těšetice-Kyjovice	18/92	M2	Rib	F	20–25	0.71184	157	−19.1	9.1	41.1	15.0	3.20	9.5	E-W	LC	Cer.(1), Och. on skull
Těšetice-Kyjovice	19/92	M3	Rib	M	16–18	0.71143	260	−19.4	8.9	34.8	12.5	3.24	2.6	S-N	RC	F.Cer.(3?)
Těšetice-Kyjovice	20/92	M3	Rib	M	17–19	0.71166	106	−19.3	8.5	36.7	13.4	3.21	3.6	S-N	LC	Cer.(3?)
Těšetice-Kyjovice	21/92	M1	Rib	M	20–22	0.71166	121	−19.5	9.0	32.9	11.8	3.27	1.3			n.d.
Těšetice-Kyjovice	21/92				8–10											n.d.
Těšetice-Kyjovice	22/92				2–2.5									E-W		n.d.
Těšetice-Kyjovice	23/92				6									W-E	LC	n.d./Cer.(1)
Vedrovice-Sídliště	1/63				6–9 mon.											n.d.
Vedrovice-Sídliště	2/63	M1			5	0.71099	33							NW-SE	RC	n.d.
Vedrovice-Sídliště	3/66	M1	Rib		9	0.71245	37	−19.9	8.7	30.9	10.9	3.30	1.9	W-E	LC	U.
Vedrovice-Sídliště	4/69	M1	Rib		8	0.71137	29	−20.1	9.9	32.4	11.6	3.26	2.1			U.
Vedrovice-Sídliště	5/71	M1	Rib		6–7	0.71164	26	−19.2	8.5	31.3	11.1	3.29	2.0			n.d.
Vedrovice-Sídliště	6/72				3											n.d.
Vedrovice-Sídliště	7/72				Neonate											n.d.
Vedrovice-Sídliště	8/74				Neonate											n.d.
Vedrovice-Sídliště	9/74			F	50–60											n.d.

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Vedrovice-Sídliště	10/74	M1	Rib	M	40–49	0.71080	40	−19.9	9.6	32.4	11.6	3.26	2.1			n.d.
Vedrovice-Sídliště	11/74			M	45–55											n.d.
Vedrovice-Široká u lesa	12/74		Long bone		Adult			−19.6	9.3	35.2	12.5	3.28	1.7	SE-NW		Pol.(2), Cer.(2), Bon.(1)
Vedrovice-Široká u lesa	13/75	M2		F	Adult	0.71114	68	−19.7[c]	10.1[c]					SE-NW	LC	Och.
Vedrovice-Široká u lesa	14/75			F	35–40			−19.3[c]	10.1[c]					NW-SE	LC	Shd.(1), Spon.(1 bead), Och., Lit.(1)
Vedrovice-Široká u lesa	15/75			M	35–40	0.71085	71	−19.2[c]	10.0[c]					NW-SE	LC	Pol.(1), Cer.(1), Spon.(19 beads), Lit.(1), Grd.(1)
Vedrovice-Široká u lesa	16/75	M1			3–4	0.71115	77	−19.9[c]	9.7[c]					SE-NW	LC	F.Shd.(1)
Vedrovice-Široká u lesa	17/75	M1			c. 1			−18.7[c]	13.3[c]					SE-NW	RC	F.Shd.(2)
Vedrovice-Široká u lesa	18/75	M1			6–7	0.71108	48							SE-NW	LC	Pol.(1), Cer.(1), Bon.(1)
Vedrovice-Široká u lesa	19/75	M3		M	25–35	0.7108	112							NW-SE	LC	Pol.(1), Cer.(1), Spon.(24 beads), Och., Silicate pebble
Vedrovice-Široká u lesa	20/75	M2dec.	Rib		3–4	0.71125	45	−19.7	8.4	40.2	14.5	3.24	4.4	SE-NW	LC	U.
Vedrovice-Široká u lesa	21/75	M3	Long bone	F	30–40	0.71160	78	−19.6	9.2	30.9	10.8	3.32	1.4	SE-NW	LC	Cer.(1), Lit.(1)
Vedrovice-Široká u lesa	22/75	M2		F	35–45	0.70976	109	−19.8[c]	9.5[c]					SE-NW	LC	U.
Vedrovice-Široká u lesa	23/75	M3		M	17–20	0.71139	57	−20.0[c]	10.6[c]					SE-NW	LC	F.Cer.(1), Lit.(1)
Vedrovice-Široká u lesa	24/75				5–7			−19.9[c]	9.2[c]							Cer.(1), Snail shells
Vedrovice-Široká u lesa	25/75			M	Adult			−19.5[c]	10.0[c]							U.

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Vedrovice-Široká u lesa	27/76		Rib	F	> 20			−20.5	9.2	34.9	12.1	3.37	2.3	SENW		Cer.(1)
Vedrovice-Široká u lesa	28/76	M1			4–5	0.71093	67	−19.9[c]	10.0[c]					SE-NW	LC	U.
Vedrovice-Široká u lesa	29/76	M3	Rib	F	18–20	0.70849	260	−20.5	9.0	42.4	15.0	3.31	4.5	SE-NW	LC	F.Shd.(1)
Vedrovice-Široká u lesa	30/76	M1			10–12	0.71083	88	−19.5[c]	9.5[c]					E-W	LC	Pol.(1), Cer.(1), Och., Grd.(1),
Vedrovice-Široká u lesa	31/76			F	Adult			−20.0[c]	10.3[c]							Pol.(1)
Vedrovice-Široká u lesa	32/76	M1	Rib		12–14	0.71101	57	−19.9	8.5	36.3	12.9	3.28	2.1	S-N	LC	Pol.(1), Cer.(1)
Vedrovice-Široká u lesa	35/76		Long bone		Adult			−19.9	9.3	42.4	15.3	3.24	4.8			U.
Vedrovice-Široká u lesa	36/76	M1	Rib	F	45–50	0.71183	67	−19.7	8.8	37.8	13.3	3.33	2.0	NW-SE	LC	Pol.(1), Cer.(2), Spon.(3 beads), Grd.(1)
Vedrovice-Široká u lesa	37/76	M2			11–12			−19.6[c]	9.6[c]					S-N	LC	Pol.(1), Lit.(1)
Vedrovice-Široká u lesa	38/76	M3		F	30–35	0.71041	137	−20.3[c]	9.5[c]					E-W	RC	U.
Vedrovice-Široká u lesa	39/76	M1			3–4	0.71088	66	−19.0[c]	10.5[c]					S-N	I	Cer.(1), Spon.(11 beads), Lit.(8)
Vedrovice-Široká u lesa	40/76	M2	Long bone		8–10	0.71083	60	−19.6	8.8	40.0	14.3	3.28	2.5	NW-SE	LC	Lit.(1)
Vedrovice-Široká u lesa	42/77	M3		F	20–30	0.71101	113	−19.5[c]	9.8[c]					NW-SE	CB	Spon.(2 beads)
Vedrovice-Široká u lesa	43/77	M1			14	0.71124	78	−20.0[c]	9.7[c]					W-E	LC	Lit.(1)
Vedrovice-Široká u lesa	44/77	M1			10–14	0.71169	54	−19.9[c]	9.5[c]							F.Shd.(1)
Vedrovice-Široká u lesa	45/77	M3		F	35–45	0.71048	60							SE-NW	LC	Cer.(1)

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Vedrovice-Široká u lesa	46/77	M3	Rib	M	20–35	0.71115	51	−19.8	9.1	39.6	14.0	3.30	3.5	SE-NW	LC	Pol.(1), Cer.(2), Spon.(2 beads), Lit.(15)
Vedrovice-Široká u lesa	48/77	M3		F	18–25	0.71103	82	−19.8[c]	10.3[c]					E-W	LC	F.Shd.(4), Och.
Vedrovice-Široká u lesa	50/77			M	Adult			−19.8[c]	9.5[c]					NW-SE	LC	Cer.(1)
Vedrovice-Široká u lesa	51/77	M1		F	45–55	0.70911	190	−20.7[c]	9.5[c]					SE-NW		Cer.(2)
Vedrovice-Široká u lesa	54/78	M3		M	20–25	0.71109	58	−19.6[c]	10.1[c]					SE-NW	LC	Pol.(1), Cer.(1), Spon.(2 beads), Lit.(1)
Vedrovice-Široká u lesa	56/78				4–5			−19.8[c]	9.1[c]							U.
Vedrovice-Široká u lesa	57/78	M3		M	40–50	0.71092	72	−19.6[c]	10.7[c]					NW-SE	LC	Pol.(2), Lit.(7)
Vedrovice-Široká u lesa	59/78	M2		M	25–30	0.71144	109	−19.4[c]	10.3[c]					E-W	RC	Pol.(1), Cer.(1), Lit.(2)
Vedrovice-Široká u lesa	61/78	M1	Rib	F	40–50	0.71161	81	−19.8	9.3	38.7	13.9	3.25	3.1	E-W	LC	Cer.(1), Och.
Vedrovice-Široká u lesa	62/78	M1		F	30–40	0.71129	127	−19.9[c]	9.4[c]					SE-NW	LC	Cer.(1), Spon.(1 bead), Lit.(1)
Vedrovice-Široká u lesa	63/78	M2		M	40–45	0.71167	59	−19.9[c]	10.0[c]					SE-NW	LC	U.
Vedrovice-Široká u lesa	64/78	M3	Rib	F	18–25	0.71111	57	−19.8	9.2	39.1	13.8	3.30	2.3	E-W	LC	U.
Vedrovice-Široká u lesa	66/78	M3		M	30–35	0.71153	104	−19.7[c]	9.9[c]					E-W	LC	Cer.(2), Lit.(2)
Vedrovice-Široká u lesa	67/78	M2	Rib	F	35–45	0.71226	53	−19.6	8.6	39.4	13.9	3.31	2.4	SE-NW	LC	U.
Vedrovice-Široká u lesa	68/78	M2	Rib	F	> 50	0.70959	94	−19.5	9.5	41.8	15.1	3.23	4.0	NW-SE	LC	U.
Vedrovice-Široká u lesa	69/78			M	20–30									NW-SE	LC	Pol.(1), Cer.(5), Spon.(18 beads), Bon.(1), Grd.(1), Unworked pebble

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Vedrovice-Široká u lesa	70/79	M3	Rib	F	45–50	0.70995	54	−19.5	9.5	37.1	12.9	3.36	2.3	SE-NW	LC	Cer.(1), Spon.(20 beads)
Vedrovice-Široká u lesa	71/79	M3		M	35–45	0.71112	47	−19.3[c]	10.3[c]					E-W	LC	Pol.(1), Cer.(1), Worked antler(1)
Vedrovice-Široká u lesa	72/79	M2		F	30–40	0.71228	69	−19.5[c]	9.3[c]					E-W	LC	Cer.(2), She.(2), Och.
Vedrovice-Široká u lesa	73/79	M2		M	20–25	0.71047	47	−19.7[c]	10.2[c]					SE-NW	LC	Lit.(1)
Vedrovice-Široká u lesa	74/79	M2	Rib	F	> 50			−19.3	9.5	37.7	13.4	3.27	1.7	SE-NW	LC	Och.
Vedrovice-Široká u lesa	75/79	M2		F	25–35	0.71118	119	−19.5[c]	9.3[c]					SE-NW	LC	Spon.(1 bead)
Vedrovice-Široká u lesa	76/79	M2	Rib	M	30–35	0.71130	46	−19.5	9.4	43.2	15.5	3.25	7.3	E-W	LC	Pol.(1), Lit.(1), Worked antler(1)
Vedrovice-Široká u lesa	77/79	M2		M	40–50	0.71113	62	−19.3[c]	10.0[c]					SE-NW	LC	Pol.(1), Cer.(1), Worked antler(1)
Vedrovice-Široká u lesa	78/79	M2	Rib		7–8	0.71150	88	−19.5	9.1	40.1	14.2	3.30	5.4	SE-NW	LC	Spon.(1 bead), She.(1)
Vedrovice-Široká u lesa	79/79	M1		M	25–35	0.71112	52	−19.6[c]	10.0[c]					SE-NW	LC	Pol.(1), Cer.(1), Spon.(1 bead), Lit.(8), Bon.(1)
Vedrovice-Široká u lesa	80/79	M1	Rib	F	35–45			−19.6	9.2	42.0	14.9	3.28	6.2	SE-NW	LC	Lit.(1)
Vedrovice-Široká u lesa	81a/79			F	20–30									SE-NW	LC	Cer.(2), Lit.(2), Spon.(1 bead), Unworked pebble
Vedrovice-Široká u lesa	81b/79				Neonate			−20.1[c]	10.4[c]							U.
Vedrovice-Široká u lesa	82/79	M2		M	> 50	0.71133	101	−19.1[c]	10.6[c]					SE-NW	LC	U.
Vedrovice-Široká u lesa	83/80		Rib	F	> 60			−19.5	9.2	36.4	12.8	3.32	1.8	E-W	LC	Cer.(1), Spon.(4 beads), Worked pebbles (2)
Vedrovice-Široká u lesa	84/80	M1			9	0.71097	100	−20.2[c]	9.9[c]					E-W	LC	Marble medallion (imitation *Spondylus*?)

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Vedrovice-Široká u lesa	86/80	M3		F	25–30	0.70955	75	−19.9[c]	9.8[c]					E-W	LC	Cer.(1), Spon.(2 beads), Lit.(1), She.(1)
Vedrovice-Široká u lesa	87/80			F	Adult			−19.5[c]	9.7[c]					SE-NW	LC	U.
Vedrovice-Široká u lesa	88/80	M1	Rib	M	20–30	0.71118	75	−19.9	9.7	35.5	12.2	3.39	1.7	SE-NW	LC	Pol.(1), Worked antler (1)
Vedrovice-Široká u lesa	89/80			F	Adult			−20.0[c]	9.3[c]					E-W	LC	U.
Vedrovice-Široká u lesa	90/80			F	Adult			−19.7[c]	9.5[c]							Shd.(1), Spon.(1 beads), Lit.(2), Pebble with traces of ochre
Vedrovice-Široká u lesa	91/80	M3		F	18–20	0.71022	100	−19.4[c]	9.8[c]					E-W	LC	Cer.(2), Spon.(2 beads), Lit.(3)
Vedrovice-Široká u lesa	93a/80	M1?		F	18–25	0.71215	27	−19.8[c]	10.2[c]					SE-NW	LC	Spon.(1 bead)
Vedrovice-Široká u lesa	93b/80				Neonate											U.
Vedrovice-Široká u lesa	94/80	M2	Rib	F	18–25	0.71125	49	−19.7	9.0	40.5	14.4	3.29	6.8	SE-NW	LC	Unworked flint nodule (1)
Vedrovice-Široká u lesa	95/80			M	50–60			−19.6[c]	9.7[c]							Spon.(1 bead)
Vedrovice-Široká u lesa	96/80	M1			3–5	0.71116	50	−19.5[c]	9.8[c]					SE-NW	RC	Spon.(1 bead)
Vedrovice-Široká u lesa	97/80	M3		F	30–40	0.71020	82	−19.7[c]	9.5[c]					SE-NW	LC	Shd.(2)
Vedrovice-Široká u lesa	98/81				Adult											Cer.(1)
Vedrovice-Široká u lesa	99/81	M3		M	30	0.70835	101	−20.1[c]	9.5[c]					E-W	LC	Cer.(1)
Vedrovice-Široká u lesa	100/81	M1		F	20–30	0.71067	33	−19.7[c]	10.0[c]					NW-SE	LC	Cer. 1), Shd.(1), Spon.(1 bead)
Vedrovice-Široká u lesa	101/81	M3		F	45–55	0.70944	80	−19.7[c]	9.9[c]					SE-NW	LC	Grd.(1), Worked pebble (1)

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Vedrovice-Široká u lesa	102/81	M2		F	40–45	0.71263	101	−20.0[c]	9.2[c]					E-W	RC	Spon.(1 bead)
Vedrovice-Široká u lesa	103/81			F	50–60									E-W	LC	U.
Vedrovice-Široká u lesa	104/81			F	> 50	0.71120	98	−19.9[c]	9.8[c]					NW-SE	LC	Cer.(1), Worked flint nodule(1)
Vedrovice-Široká u lesa	105/81	M3		F	16–18	0.71130	91	−19.7[c]	9.0[c]					E-W	RC	U.
Vedrovice-Široká u lesa	106/82			F	16–18			−19.5[c]	8.9[c]					SE-NW	LC	Cer.(1)
Vedrovice-Široká u lesa	107/82	M1		F	18–20	0.71137	49	−19.3[c]	8.9[c]					W-E	LC	Cer.(2)
Vedrovice-Široká u lesa	108/84			M	Adult-senile			−19.6[c]	9.9[c]							Pol.(1)
Vedrovice-Za dvorem	1/85	M1	Rib	F	20–25	0.71102	45	−20.5	9.7	21.2	7.3	3.39	1.1			U.
Vedrovice-Za dvorem	2/85	M2	Rib	M	25–30	0.71079	49	−19.7	10.3	38.0	13.3	3.34	6.4	SE-NW	LC	Pol.(1), Spon.(12 beads), Bon.(1)
Vedrovice-Za dvorem	3/86				1.5–2											U.
Vedrovice-Za dvorem	5/88				3									SE-NW	LC	Spon.(2 beads)
Vedrovice-Za dvorem	6/88	M2	Rib	F	> 50	0.70956	60	−20.2	9.6	27.4	9.6	3.32	1.1	SE-NW	LC	U.
Vedrovice-Za dvorem	7/88	M1	Rib	F	35–45	0.71117	47	−19.8	9.6	38.6	13.7	3.28	3.7	SE-NW	LC	Shd.(1), Bon.(1)
Vedrovice-Za dvorem	8/88	M1	Rib		13–15	0.71094	47	−20.3	10.8	44.0	15.4	3.33	10.1	SE-NW	LC	Pol.(1), Bon.(1), Spon.(1 beads), Marble beads(68)

APPENDIX 2. Continued.

Site	Burial	Tooth	Bone	Sex	Age	$^{87}Sr/^{86}Sr$	1/Sr ppm	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C:N	%Coll.	Orien-tation	Body pos.[a]	Grave goods[b]
Vedrovice-Za dvorem	9/88	M2	Rib	F	18	0.71082	66	−20.2	9.7	20.7	7.0	3.45	1.2	SE-NW	LC	Spon.(30 beads), Marble beads(c. 506), She.(300)
Vedrovice-Za dvorem	10/89	M1	Rib	F	20–25	0.70954	66	−20.6	9.7	42.5	15.2	3.25	13.2	SE-NW	LC	Pol.(1), She.(2)

[a] Key for body position: LC, Left-crouched; RC, Right-crouched; C, Crouched, direction unknown; CB, Crouched on back; CF, Crouched on front; S, Supine; P, Prone; I, Irregular.
[b] Key for grave goods (number of items in brackets): U., Unfurnished; F., Fill only (all items listed after an F. were in the fill of the grave rather than at the level of the skeleton); Pol., Polished stone; Cer., Ceramics; Shd., Sherds; Spon., Spondylus; She., Other shell; Och., Ochre; Lit., Chipped stone; Bon, Worked bone; Grd., Grinding stone: Tee, animal teeth; n.d., no data.
[c] Sampled values from Richards *et al.* (2008).

APPENDIX 3. The animal isotope data.

Site	Sample No.	Species	Bone	δ13C (‰)	δ15N (‰)	%C	%N	C:N	%Coll.
Blatné	Bla-001	Pig	Long bone	−20.6	8.4	35.3	12.6	3.30	8.3
Blatné	Bla-002	Sheep/goat	Long bone	−19.6	9.7	34.7	12.4	3.30	9.3
Blatné	Bla-003	Cattle	Bone	−21.0	6.9	35.4	12.6	3.30	10.0
Blatné	Bla-005	Pig	Scapula	−20.0	8.6	43.0	15.8	3.20	5.4
Blatné	Bla-008	Cattle	Rib	−20.6	7.4	35.8	12.8	3.30	2.9
Blatné	Bla-009	Pig	Skull	−21.1	8.9	30.1	10.6	3.30	3.4
Blatné	Bla-011	Cattle	Rib	−20.6	5.5	34.6	12.6	3.20	9.5
Blatné	Bla-013	Cattle	Phalanx	−21.5	8.4	35.6	12.4	3.30	7.0
Blatné	Bla-014	Cattle	Rib	−20.5	8.2	28.3	9.8	3.40	1.0
Blatné	Bla-015	Sheep/goat	Scapula	−20.1	5.8	38.7	14.0	3.20	10.6
Blatné	Bla-017	Sheep/goat	Long bone	−20.1	8.3	39.0	13.9	3.30	10.7
Blatné	Bla-018	Pig	Long bone	−20.6	8.5	36.6	13.1	3.30	10.8
Blatné	Bla-019	Pig	Scapula	−20.2	9.0	28.9	10.0	3.40	3.9
Blatné	Bla-021	Cattle	Rib	−20.6	9.0	28.3	9.8	3.40	2.3
Blatné	Bla-022	Cattle	Long bone	−20.7	8.1	30.8	10.7	3.40	4.3
Blatné	Bla-023	Pig	Long bone	−20.5	7.1	33.3	11.7	3.30	5.7
Blatné	Bla-024	Cattle	Scapula	−20.0	9.2	30.1	10.5	3.40	3.0
Blatné	Bla-025	Cattle	Phalanx?	−20.6	7.5	24.4	8.3	3.40	3.2
Blatné	Bla-026	Pig	Long bone	−20.4	9.0	35.0	12.3	3.30	8.0
Blatné	Bla-027	Cattle	Long bone	−21.2	7.9	26.1	8.8	3.50	3.1
Blatné	Bla-029	Sheep/goat	Long bone	−19.8	7.8	36.2	13.0	3.30	8.5
Blatné	Bla-030	Sheep/goat	Bone	−20.4	7.1	27.6	9.4	3.40	4.3
Blatné	Bla-031	Sheep/goat	Long bone	−20.3	5.2	32.0	11.5	3.30	7.1
Blatné	Bla-033	Cattle	Long bone	−20.2	6.9	27.9	9.7	3.40	4.7
Brno-Starý Lískovec	Brn-100	Sheep/goat	Long bone	−20.1	6.7	38.7	13.7	3.30	12.1
Brno-Starý Lískovec	Brn-101	Pig	Long bone	−20.4	8.1	40.5	14.7	3.20	9.5
Brno-Starý Lískovec	Brn-102	Cattle	Long bone	−20.4	6.4	35.7	12.7	3.30	5.6
Brno-Starý Lískovec	Brn-105	Cattle	Long bone	−20.3	5.9	38.3	13.8	3.20	6.4
Brno-Starý Lískovec	Brn-106	Cattle	Rib	−20.2	6.8	36.1	12.8	3.30	4.2
Brno-Starý Lískovec	Brn-108	Cattle	Long bone	−20.1	8.7	36.3	13.2	3.20	5.6
Brno-Starý Lískovec	Brn-110	Sheep/goat	Long bone	−19.7	8.1	37.6	13.6	3.20	5.2
Brno-Starý Lískovec	Brn-113	Cattle	Long bone	−20.4	6.9	40.9	15.0	3.20	5.5
Brno-Starý Lískovec	Brn-116	Sheep/goat	Long bone	−20.0	8.2	42.1	15.3	3.20	7.9
Brno-Starý Lískovec	Brn-118	Cattle	Long bone	−20.5	7.4	35.5	12.6	3.30	2.5
Brno-Starý Lískovec	Brn-119	Sheep/goat	Long bone	−20.2	5.7	37.7	13.4	3.30	4.4
Brno-Starý Lískovec	Brn-121	Sheep/goat	Long bone	−20.1	6.8	35.8	13.0	3.20	7.2
Brno-Starý Lískovec	Brn-123	Cattle	Long bone	−20.2	9.2	40.9	14.8	3.20	4.7
Brno-Starý Lískovec	Brn-125	Pig	Long bone	−19.9	7.8	42.1	15.4	3.20	5.6

APPENDIX 3. Continued.

Site	Sample No.	Species	Bone	δ13C (‰)	δ15N (‰)	%C	%N	C:N	%Coll.
Těšetice-Kyjovice	Tes-100	Pig	Long bone	−19.8	8.3	41.4	15.2	3.18	8.6
Těšetice-Kyjovice	Tes-103	Sheep/goat	Long bone	−19.6	5.8	39.0	14.2	3.20	5.0
Těšetice-Kyjovice	Tes-104	Sheep/goat	Long bone	−20.0	5.5	38.2	13.8	3.25	4.9
Těšetice-Kyjovice	Tes-105	Sheep/goat	Long bone	−19.7	4.9	37.1	13.4	3.22	5.1
Těšetice-Kyjovice	Tes-106	Cattle	Long bone	−20.2	6.1	39.7	14.0	3.31	4.9
Těšetice-Kyjovice	Tes-108	Sheep/goat	Long bone	−20.3	8.1	41.2	15.2	3.17	4.6
Těšetice-Kyjovice	Tes-109	Cattle	Metacarpal	−20.9	6.8	40.0	14.4	3.24	6.4
Těšetice-Kyjovice	Tes-111	Pig	Humerus	−20.0	7.3	37.6	13.6	3.23	4.3
Těšetice-Kyjovice	Tes-113	Cattle	Long bone	−20.3	7.0	40.4	14.7	3.20	6.5
Těšetice-Kyjovice	Tes-115	Cattle	Long bone	−20.2	6.7	40.1	14.3	3.27	5.2
Těšetice-Kyjovice	Tes-116	Cattle	Long bone	−20.1	8.3	38.4	13.6	3.30	3.8
Těšetice-Kyjovice	Tes-117	Cattle	Long bone	−20.2	6.3	38.6	13.8	3.27	5.7
Těšetice-Kyjovice	Tes-119	Pig	Humerus	−20.0	6.1	39.1	14.0	3.26	9.1
Těšetice-Kyjovice	Tes-120	Pig	Ulna	−20.5	8.3	41.2	14.9	3.23	4.6
Těšetice-Kyjovice	Tes-121	Cattle	Tibia	−20.3	6.6	38.2	13.9	3.22	6.1
Těšetice-Kyjovice	Tes-123	Cattle	Metapodium	−19.9	6.9	34.3	12.0	3.34	3.4
Vedrovice-Sídliště	Ved-101	Cattle	Tibia	−19.8	6.5	29.0	9.6	3.51	4.3
Vedrovice-Sídliště	Ved-103	Sheep/goat	Long bone	−19.8	6.1	36.7	12.7	3.36	7.9
Vedrovice-Sídliště	Ved-104	Cattle	Rib	−20.3	7.0	34.7	12.6	3.20	7.7
Vedrovice-Sídliště	Ved-105	Pig	Long bone	−20.0	7.6	39.3	14.2	3.23	11.8
Vedrovice-Sídliště	Ved-107	Sheep/goat	Long bone	−20.0	5.5	39.6	14.4	3.21	11.4
Vedrovice-Sídliště	Ved-109	Sheep/goat	Long bone	−19.7	6.2	37.3	13.2	3.30	10.2
Vedrovice-Sídliště	Ved-111	Pig	Long bone	−20.7	8.8	34.7	12.0	3.39	7.3
Vedrovice-Sídliště	Ved-113	Cattle	Long bone	−20.3	5.0	36.7	13.1	3.27	10.9

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