Interdisciplinary study of human remains from the Early Iron Age cemetery at Zagorje ob Savi (Slovenia)

Interdisciplinarna študija človeških ostankov s starejšeželeznodobnega grobišča v Zagorju ob Savi

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Izvleček

Prispevek predstavlja dognanja interdisciplinarne raziskave človeških kostnih ostankov, odkritih leta 2011 na grobišču iz starejše železne dobe na Cesti Borisa Kidriča v Zagorju ob Savi. Študija je del obsežnejšega projekta osteoloških in izotopskih analiz kostnih ostankov iz bronaste in železne dobe (14–4. st. pr. n. št.) z območij Slovenije in Hrvaške.

Osteološka raziskava šestih oseb je pokazala, da gre za ostanke enega mlajšega odraslega moškega, enega zrelega odraslega moškega in dveh zrelih odraslih žensk ter dveh otrok nedoločljivega spola. Pri vseh šestih osebah so bile na kolagenu, pridobljenem iz kosti in/ali dentina, opravljene analize stabilnih izotopov ogljika in dušika. Na podlagi rezultatov lahko pri vseh osebah sklepamo na kopensko prehrano, ki vključuje živalske proteine (meso in/ali mlečne izdelke) in rastlinske sestavine tako iz rastlin C_3 kot C_4.

Ključne besede: Zagorje ob Savi; starejša železna doba; človeška osteologija; stabilni izotopi; interdisciplinarni pristop

Abstract

This paper presents the results of interdisciplinary investigations of human remains, discovered in 2011 at the Early Iron Age cemetery at Zagorje ob Savi (Cesta Borisa Kidriča) in Slovenia. The present study is a part of a larger isotopic and osteological investigation of Bronze/Iron Age (14^{th}–4^{th} centuries BC) skeletal assemblages from Croatia and Slovenia. The osteological analysis of the six individuals uncovered on this site indicates that they represent the remains of two adult males, two adult females and two infants of unknown sex. The results of carbon and nitrogen stable isotope analysis on the bone and dentine collagen extracted from these six individuals is strongly indicative of a terrestrial based diet, including animal-based protein (meat and/or dairy) and a mix of C_3 and C_4 plants.

Keywords: Zagorje ob Savi; Early Iron Age; human osteology; stable isotopes; interdisciplinary approach

INTRODUCTION

This paper presents a case study combining contextual, osteological and isotopic data derived from recently excavated inhumation graves from the Early Iron Age cemetery at Zagorje ob Savi (Cesta Borisa Kidriča) in Slovenia.

The cemetery is located at the foot of the hill, now known as Ocepkov hrib, where the contemporary settlement was probably located. The site has been known since the end of the 19^{th} century, when several graves were found during construction work. Some of these contained high status artefacts, including a belt plate featuring a

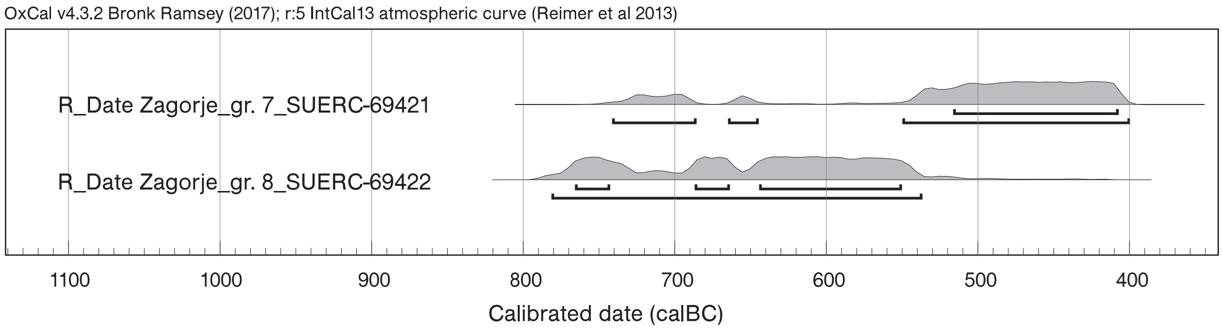

Fig. 1: OxCal plot of radiocarbon dates for graves from Zagorje ob Savi (68.2% and 95.4% probability).
Sl. 1: Prikaz radiokarbonskih datacij grobov iz Zagorja ob Savi v programu OxCal (68,2 % in 95,4 % verjetnost).

Sample	Laboratory code	BP	**Calibrated Age Range, 95.4% probability** (OxCal v.4.3.2.)
Zagorje, Grave 7	SUERC-69421 (GU42026)	2412 +/- 29	741–401 calBC
Zagorje, Grave 8	SUERC-69422 (GU42027)	2499 +/- 28	781–538 calBC

Fig. 2: Radiocarbon dates for graves from Zagorje ob Savi.
Sl. 2: Radiokarbonske datacije grobov iz Zagorja ob Savi.

hunting scene in the Situla art style. Contextual information on these burials, however, is scarce (Gabrovec 1966; Draksler 2007, 128–132, 149–152). Recent development-led excavations, taking place in 2011, provided the first opportunity to acquire high quality data from the site. The work revealed nine graves, six of which yielded human skeletal remains, comprising three distinct groups. The central group comprised the adults in Graves 4, 5 and 8, which accompanied two infant graves (Gr. 6 and 7), all positioned in very close proximity to each other. The graves are dated to the Late Hallstatt period, i. e. from the 6th to 4th centuries BC, based on typo-chronological analyses of the grave goods (see Murko, Draksler in this volume of Arheološki vestnik).

The date of the burials has been confirmed through subsequent radiocarbon analysis, undertaken as part of the ENTRANS project (*Figs. 1; 2*). However, these will be discussed elsewhere in connection with other radiocarbon dates acquired by the project and those previously obtained in the region (see Teržan, Črešnar 2014).

The preservation of the skeletal material from the site was generally poor. This was due mainly to the burial environment, but was also in part due to frequent disturbance and destruction by modern building work.

CARBON AND NITROGEN: STABLE ISOTOPE ANALYSIS OF COLLAGEN FOR DIETARY RECONSTRUCTION

Human bones and tooth dentine are made up of two fractions: approximately 70% (dry weight) is a hard, mineral bioapatite and the remainder is a flexible organic component, which is predominantly type I collagen. Collagen is a structural protein made up of long peptide chains. When extracting collagen from bone and dentine for light isotope analysis, it is the protein aspect of the diet that is under investigation, rather than the isotopic composition of the whole diet (Tykot 2004). The variation in mass between isotopes of the same element leads to a process known as isotopic fractionation. The results of this fractionation allow for the investigation of diet and health in the past (Tykot 2004; Hedges, Reynard 2007; Reynard, Tuross 2015).

Carbon isotope ratios

$\delta^{13}C$ values of collagen extracted from bone and tooth dentine have most frequently been used in the investigation of paleodiet (Harrison, Katzenberg

2003; Pearson et al. 2015). This is possible due to isotopic fractionation occurring during photosynthesis and diffusion, creating distinct ranges of values which can be related to constituents of diet (Tykot 2004).

Most plants – temperate grasses (wheat, barley etc.), fruits and vegetables – follow the C_3 photosynthesising pathway. In more arid locations, plants such as millet have adapted to follow the C_4 photosynthesising pathway, which results in higher $\delta^{13}C$ values (Tykot 2004; Tieszen 1991; Tafuri et al. 2009). This difference between pathways results in distinct ranges of $\delta^{13}C$ values, which indicate the consumption of either vegetation type (Tieszen 1991; Tafuri et al. 2009). If an individual was consuming a mix of C_3 and C_4 plants, this would be exhibited in the isotopic data as a $\delta^{13}C$ value in-between these two extremes (O'Leary 1981; Van den Merwe 1982; Lee-Thorp et al. 1989).

Nitrogen isotope ratios

Nitrogen isotope ratios from plants, humans and animals reflect their relative trophic level or position in the food chain (Ambrose 1991; Hedges, Reynard 2007). For example, in a terrestrial food chain, the highest $\delta^{15}N$ values are exhibited by organisms belonging to the highest trophic level, i.e. carnivores. This increase in $\delta^{15}N$ values occurs in a predictable manner known as a 'trophic level shift' and is an increase in $\delta^{15}N$ values of between 2 and 5‰ (Schoeninger et al. 1983; Schoeninger, DeNiro 1984; Hedges, Reynard 2007).

Although trophic shifts have been observed to be reasonably uniform, the $\delta^{15}N$ values themselves may still vary regionally based on local environments and ecosystems (Schoeninger, DeNiro 1984; O'Connell, Hedges 1999; Hedges, Reynard 2007; Ambrose 1991). Factors such as aridity, salinity and water availability can all play a role in the variation of $\delta^{15}N$ values (Heaton et al. 1986; Ambrose 1991). The manuring of land has been shown to increase $\delta^{15}N$ values by varying degrees (Bogaard et al. 2007; Fraser et al. 2011; Bogaard et al. 2013). Variable $\delta^{15}N$ values observed in plants grown in manured soil will influence $\delta^{15}N$ values further up the food chain, which could lead to the misinterpretation of human $\delta^{15}N$ values. Multiple communities may be consuming a largely similar diet, however, depending on their methods of cereal cultivation their $\delta^{15}N$ values could differ (Fraser et al. 2011). To support stable isotope interpretations, it is recommended that a population-specific baseline of carbon and nitrogen isotope values is created through the analysis of local and contemporary faunal and floral remains (Fraser et al. 2011).

The nitrogen isotope ratios of dentine and bone collagen have also been observed to reflect non-dietary influences, including metabolic stress and disease (Fuller et al. 2004; Fuller et al. 2005; Waters-Rist, Katzenberg 2010; Beaumont et al. 2015; Reynard, Tuross 2015). In the bones of adults, which have slow rates of turn-over, it is unlikely that short-lived shifts in nitrogen balance would be visible (Hedges et al. 2007; Waters-Rist, Katzenberg 2010). However, collagen from the actively forming bones and dentine of infants and children may produce values, which have been influenced by variables not directly linked to diet, such as growth or metabolic disease (Beaumont et al. 2013; Beaumont et al. 2015).

METHODS

Osteological analysis

Osteological analysis was undertaken on the six surviving human skeletons from the Zagorje ob Savi site through macroscopic observation and using a magnifying hand lens. Standard analysis and recording methods were used for biological sex assessment (pelvis: [Walker 2008; Phenice 1969; Klales et al. 2012], skull: [Buikstra, Ubelaker 1994; Walker 2008; İşcan, Steyn 2013] adult age estimation [Buckberry, Chamberlain 2002; Brooks, Suchey 1990; Brothwell 1981] and age estimation of the infants AlQahtani et al. [2010]). Supporting evidence for adult age was taken from late fusing epiphyses (Belcastro et al. 2008; Webb, Suchey 1985). Tooth wear (Brothwell 1981) was used with caution due to a lack of published, calibrated, population-specific standards for the study area and time period. As skeletal elements in the skull and pelvis become notably sexually dimorphic post puberty, the infant remains were not assessed for biological sex.

Due to the generally poor preservation of the skeletal material, broad ranges of young (20–35 years), middle (36–50 years) and mature (50+ years) adult were considered more appropriate than numerical ages (after Buikstra, Ubelaker, 1994). Standard protocols and guidelines were used for recording the appearance and location of pathological lesions (Buikstra, Ubelaker 1994; Aufderheide, Rodríguez-Martín 1998; Brickley, Ives 2008). Poor preservation can limit the nature of information obtained from osteological analysis (Bytheway, Ross 2010).

Carbon and nitrogen isotope analysis

Stable carbon and nitrogen isotope ratio analysis was carried out on rib (n=4), femur (n=3) and dentine (n=2) collagen from six individuals. The study has also included faunal material from three cattle, two pigs and a deer (*Fig. 3*). Animal bones were excavated from the grave fills and their immediate surroundings. These are, however, unlikely to represent grave goods, and are most probably remains from a settlement, immediately pre-dating the cemetery in this location. The settlement is dated, on the basis of associated pottery, to the final phase of the Urnfield Period and the Early Hallstatt period. As it directly predates the cemetery, however, this faunal assemblage can be regarded as providing an appropriate baseline of stable carbon and nitrogen isotope ratios for the site.

All collagen extractions were carried out following the modified Longin method (Longin 1971; Brown et al. 1988). Bulk dentine samples were removed from the apex (c. final 2mm) of tooth roots. Rib and femur fragments (c. 300mg) and dentine samples were demineralised in 0.5M HCl at 4°C, which took between two and four weeks for bone and 1 to 2 days for dentine. Once the production of CO_2 had ceased and the reaction was complete, all samples were rinsed three times with deionised water. Bone collagen was placed in an HCl solution of pH3 at 70°C for 48 hours, and dentine for 24 hours, to gelatinise. The solutions were filtered using Ezee filters, followed by centrifugal filtering using Millipore ultrafilters. The resulting liquid was then freeze-dried, weighed in duplicate and measured at the University of Bradford Stable Isotope Facility by combustion in a Thermo Flash EA 1112. Internal and external standards were run throughout, as well as separated N_2 and CO_2 references gases, using a Delta plus XL via a Conflo III interface. The analytical precision for both the $\delta^{13}C$ and $\delta^{15}N$ isotope analysis, based on instrumental error, is ± 0.2‰.

Dentine collagen samples reflect the average isotopic composition of protein ingested during tooth formation (i.e. childhood). Primary dentine does not turn over or regenerate and, subsequently, forms a concise record of dietary change across a uniform period of time, which can be accessed when sampling adult skeletons, as well as non-adult remains. Dentine collagen would have been influenced by short term periods of dietary change including breastfeeding, weaning and the cessation of breastfeeding.

Rib collagen is constantly remodelling (up to 7.7% a year for adults), and so will reflect a relatively short period of dietary consumption prior to death (Parfitt 2002). Conversely, the femur reflects a much longer average of up to 80 years of protein consumption (past the age of 20), providing a lifelong average of dietary protein consumption (Hedges et al. 2007).

RESULTS

The burial conditions within the current study area are predominantly detrimental to bone preservation, leading to severe cortical exfoliation, heavy fragmentation, and variable level of completeness (Nicholls 2017). The overall condition of the bone from this assemblage was generally poor. All of the adult skeletons were less than 50% complete. Diagnostic elements and surfaces (in the pelvis the auricular surface, pubic symphysis and greater sciatic notch, as well as the majority of the crania) routinely used for age and sex evaluations were severely impacted. The levels of fragmentation and the loss and/ or destruction of these elements and surfaces led to complications when estimating biological age and assessing sex. Nevertheless, the results of these investigations are presented in *Fig. 4*. Both of the infants were <1 year old at the time of death based on dental development.

The infant form Grave 7 exhibited marked abnormal porosity and new bone formation; the distribution and appearance of these pathological lesions suggested that this infant probably suffered from scurvy, i.e. vitamin C deficiency (see Nicholls et al. 2020 for an in-depth investigation of this individual). The middle aged adult female buried in Grave 8 exhibited diffuse porosity and compact, striated bone was also identified on surviving fragments of cranial and long bones. This suggests a non-specific inflammation response possibly due to infection or metabolic disease, however, further diagnosis was not possible due to the fragmented nature of the remains. No other palaeopathological lesions were observable on the other individuals.

Specimen	Element	Grave No.	Sex	δ¹³C ‰	δ¹⁵N ‰	C:N	Amt% N	Amt% C
Deer	metatarsal	9	N/A	-23.1	3.3	3.3	13.5	38.1
Cattle	scapula	5	N/A	-19.0	4.8	3.2	14.9	41.0
Cattle	metatarsal	1	N/A	-19.2	6.3	3.2	15.2	41.9
Cattle	metatarsal	5	N/A	-18.5	6.7	3.3	14.4	40.5
Pig	mandible	8	N/A	-21.0	6.3	3.2	14.4	40.1
Pig	scapula	8	N/A	-19.3	4.8	3.3	14.0	39.1

Fig. 3: Results of carbon and nitrogen isotope analysis of faunal skeletal remains from Zagorje ob Savi.
Sl. 3: Vrednosti stabilnih izotopov ogljika in dušika iz živalskih skeletnih ostankov iz Zagorja ob Savi.

			Human rib					**Human femur**					**Human dentine**					
Grave nr.	**Age**	**Sex**	**δ¹³C‰**	**δ¹⁵N‰**	**Amt%N**	**Amt%C**	**C/N**	**δ¹³C‰**	**δ¹⁵N‰**	**Amt%N**	**Amt%C**	**C/N**	**Tooth**	**δ¹³C‰**	**δ¹⁵N‰**	**Amt%N**	**Amt%C**	**C/N**
2	Middle adult	M	-14.8	8.6	16.7	46.0	3.2	/	/	/	/	/	Lower PM1	-14.7	9.4	14.8	41.0	3.2
5	Middle adult	F	-14.4	9.0	17.2	46.8	3.2	/	/	/	/	/	/	/	/	/	/	/
6	Infant	N/A	-11.9	11.8	15.3	41.3	3.2	/	/	/	/	/	/	/	/	/	/	/
7	Infant	N/A	/	/	/	/	/	-11.4	11.9	13.6	37.3	3.2	Upper I1	-12.1	12.0	3.2	15.9	43.2
8	Middle adult	F	-15.2	8.9	17.4	47.6	3.2	-15.2	8.4	13.6	37.3	3.2	Lower M1/2	-14.5	9.2	14.3	39.9	3.2
9	Young adult	M	/	/	/	/	/	-15.2	9.0	14.3	40.7	3.3	/	/	/	/	/	/
Av.			**-14.1**	**9.6**				**-13.9**	**9.8**					**-14.6**	**9.3**			

Fig. 4: Results of anthropological and carbon and nitrogen isotope analysis from human skeletal remains from Zagorje ob Savi.
Sl. 4: Rezultati antropoloških analiz in analiz izotopov ogljika in dušika iz človeških skeletnih ostankov iz Zagorja ob Savi.

However, the taphonomic damage to the skeletal remains was very severe, and the cortical surface of these remains was heavily impacted. There is likelihood that pathological lesions were destroyed in the burial environment.

The stable carbon and nitrogen isotope results have been presented in *Fig. 4* and *Fig. 5*. All samples fell within the accepted C:N ratio and >1 % collagen yield, indicating good collagen preservation (Van-Klinken 1999). When the human carbon and nitrogen isotope data is compared to the animal baseline, a trophic level shift in δ¹⁵N values of c. 2–5‰ between humans and most herbivores is present (Ambrose 1991; Hedges, Reynard 2007). The collagen extracted from the rib (Grave 6) and femur (Grave 7) collagen from the infant remains has considerably higher δ¹³C (+2.9‰) and δ¹⁵N (+3‰) values when compared to the adult values.

DISCUSSION AND CONCLUSION

The excavated area of the cemetery at Zagorje ob Savi contained the remains of two middle adult females, a middle adult male, a young adult male and two infants of unknown sex. The δ¹³C and δ¹⁵N values produced from their skeletal remains are strongly indicative of a terrestrial-based diet. δ¹³C values greater than -17‰ strongly suggest

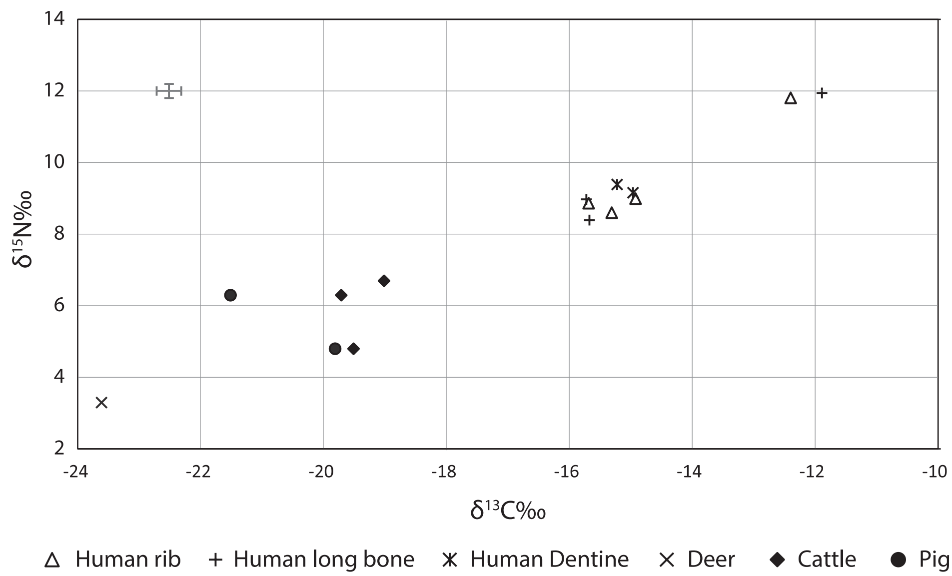

Fig. 5: Diagram of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values of human and animal skeletal remains from Zagorje ob Savi. Error bars represent analytical precision for both the $\delta^{13}C$ and $\delta^{15}N$ isotope analysis (± 0.2‰.) based on instrumental error.
Sl. 5: Diagram vrednosti stabilnih izotopov ogljika ($\delta^{13}C$) in dušika ($\delta^{15}N$) iz človeških in živalskih skeletnih ostankov iz Zagorja ob Savi. Prikaz intervala napake predstavlja natančnost merilnega procesa za izotopske analize tako $\delta^{13}C$ kot $\delta^{15}N$ glede na standardno napako instrumenta.

that all the individuals included in this study were ingesting a mix of C_3 and C_4 plants, with some consuming a significant amount of C_4 plants (Tieszen 1991; Richards 2003; Tykot 2004; Hedges, Reynard 2007; Lightfoot et al. 2013; Lightfoot et al. 2014). When the cemetery is placed within its wider archaeological context, taking into account evidence such as archaeobotanical studies, it is likely that this C_4 dietary contribution came from millet, which has been found in a number of Iron Age sites excavated in the region (Dular, Tecco Hvala 2007, 207–210).

When the human carbon and nitrogen isotope data are compared to the animal baseline, the predicted trophic level shift of c. 2–5‰ between humans and most domesticated herbivores is present (Ambrose 1991; Hedges, Reynard 2007). This supports the interpretation that humans were ingesting herbivorous animal protein, either dairy or meat. There is a clear distinction in isotope ratios between wild animal remains (deer), domesticated animal remains, and human remains, recovered from this site. The higher $\delta^{15}N$ values observed in the domesticated species relative to the wild is probably linked to penning and controlled feeding in domesticated animal populations, which can raise $\delta^{15}N$ values if animals are consuming vegetation grown in soil ^{15}N enriched by their faeces. Additionally, it can be linked to foddering, where the fodder had been grown on land ^{15}N enriched with manure (Bogaard et al. 2007; Fraser et al. 2011). If this fodder included C_4 plants (grain or crop waste), $\delta^{13}C$ values would also be increased relative to non-foddered animals, which would also account for the difference in $\delta^{13}C$ values between domesticated and wild animals (Tieszen 1991; Tafuri et al. 2009).

If the deer included in this study was living under heavily forested conditions, the $\delta^{13}C$ values produced from their bone collagen could be reflecting the 'canopy effect', where plants become depleted in ^{13}C because of either reduced light intensity or recycled CO_2 (van der Merwe, Medina 1991; Noe-Nygaard et al. 2005; Bonafini et al. 2013). If this were the case, the consumption of vegetation under forest conditions could mask the consumption of native C_4 species, and may have contributed to the disparity observed in the $\delta^{13}C$ values between wild and domesticated species.

The $\delta^{13}C$ and $\delta^{15}N$ values obtained from the bone collagen of the two infants is notably higher than that of those who survived into adulthood, which could be linked to the trophic shift associated with breastfeeding (Fuller et al. 2006; Jay et al. 2008; Millard 2000). Alternatively, unusually high $\delta^{15}N$ values can be linked to metabolic stress

(Fuller et al. 2005; Mekota et al. 2009; Beaumont et al. 2013; Beaumont et al. 2015). Unlike bone, tooth dentine grows incrementally. By sampling along the length of the tooth root at 1mm intervals it is possible to obtain a high resolution record of dietary and metabolic changes from pre-birth to around the time of death (Beaumont et al. 2013). The diet and nitrogen balance of the better-preserved infant (Grave 7) have been investigated by incremental dentine sampling and further stable carbon and nitrogen isotope analysis elsewhere. These isotopic investigations have been linked to palaeopathological observations, which have indicated this infant suffered from chronic malnutrition (Nicholls et al. 2020).

The consistency in adult stable isotope values between the different sources of bone collagen (dentine, femur and rib), indicates a continuity in diet from childhood and throughout adulthood, including a focus on the consumption of C_4 plants (millet). The socio-economic value of millet cultivation and consumption has been investigated in other studies across the wider region. Reed and Drnić (2016), for example, identified a store of both Broomcorn, but more specifically Foxtail, millet from an Iron Age structure at Sisak on the river Sava in central Croatia. Although they argued that this was an unusual deposit for the area, perhaps grown as a famine crop or for personal taste, millet is actually present more widely in the region and may even have been intensively cultivated as early as the Late Bronze Age (9th cent. BC) (Karavanić et al. 2017). Murray and Schroninger (1988) and Nicholls and Koon (2016) found that $\delta^{13}C$ values from Iron Age individuals buried at Magdalenska gora and across central and eastern Slovenia also reflected a sizable C_4 dietary component, suggesting the frequent consumption of millet. In coastal Croatia, Lightfoot et al. (2014) have noted that individuals buried in pits have a more pronounced C_4 signature than those buried in stone-lined graves, suggesting that millet may have been a low-status food (Lightfoot et al. 2014). Other examples of millet consumption in Bronze and Iron Age Europe have been presented in other stable isotope investigations (Lightfoot et al. 2012; Lightfoot et al. 2013; Tafuri et al. 2009). The individuals buried at Zagorje ob Savi, therefore, fit within a wider context of millet cultivation and consumption.

This case study has highlighted the benefits of a multidisciplinary approach to aid our understanding of prehistoric communities in this region. The inhumations of the Dolenjska Early Iron Age group are usually very poorly preserved, due to the natural soil conditions of the region, which means that any surviving human bone material excavated from the graves is very valuable. Thus, even basic osteological and palaeopathological analyses add considerably to our understanding of these Early Iron Age societies, while the application of stable isotope methods has further enhanced our knowledge and understanding of diet and agriculture in the area. The human remains from Zagorje ob Savi present an important dataset, which will hopefully be followed by other similar assemblages, adding an important new layer of information regarding the societies of the Dolenjska Early Iron Age group and beyond.

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ALQAHTANI, S. J. 2010, Brief Communication: The London Atlas of Human Tooth Development and Eruption. – *American Journal of Physical Anthropology* 142, 481–490.

AMBROSE, S. H. 1991, Effects of diet, climate and physiology on nitrogen isotope abundances in terrestrial foodwebs. – *Journal of Archaeological Science* 18/3, 293–317.

AUFDERHEIDE A. C., C. RODRÍGUEZ-MARTÍN 1998, *The Cambridge encyclopedia of human paleopathology.* – Cambridge.

BEAUMONT et al. 2013 = J. Beaumont, A. Gledhill, J. Lee-Thorp, J. Montgomery 2013, Childhood Diet: A Closer Examination of the Evidence from Dental Tissue Using Stable Isotope Analysis of Incremental Human Dentine. – *Archaeometry* 55/2, 277–295.

BEAUMONT et al. 2015 = J. Beaumont, J. Montgomery, J. Buckberry, M. Jay 2015, Infant mortality and isotopic complexity: New approaches to stress, maternal health, and weaning. – *American Journal of Physical Anthropology* 157/3, 441–457.

BELCASTRO et al. 2008 = M. G. Belcastro, E. Rastelli, V. Mariotti 2008, Variation of the degree of sacral vertebral body fusion in adulthood in two European modern skeletal collections. – *American Journal of Physical Anthropology* 135/2, 149–160.

BOGAARD et al. 2007 = A. Bogaard, T. H. E. Heaton, P. Poulton, I. Merbach 2007, The impact of manuring on nitrogen isotope ratios in cereals: archaeological implications for reconstruction of diet and crop management practices. – *Journal of Archaeological Science* 34/3, 335–343.

BOGAARD et al. 2013 = A. Bogaard, R. Fraser, T. H. E. Heaton, M. Wallace, P. Vaiglova, M. Charles, G. Jones, R. P. Evershed, A. K. Styring, N. H. Andersen, R.-M. Arbogast, L. Bartosiewicz, A. Gardeisen, M. Kanstrup, U. Maier, E. Marinova, L. Ninov, M. Schäfer, E. Stephan 2013, Crop manuring and intensive land management by Europe's first farmers. – *Proceedings of the National Academy of Sciences* 110/31, 12589–12594.

BONAFINI et al. 2013 = M. Bonafini, M. Pellegrini, P. Ditchfield, A. M. Pollard 2013, Investigation of the 'canopy effect' in the isotope ecology of temperate woodlands. – *Journal of Archaeological Science* 40/11, 3926–3935.

BRICKLEY, M., R. IVES 2008, *The bioarchaeology of metabolic bone disease.* – London.

BROOKS, S., J. M. SUCHEY 1990, Skeletal age determination based on the os pubis: A comparison of the Acsádi-Nemeskéri and Suchey-Brooks methods. – *Human Evolution* 5/3, 227–238.

BROWN et al. 1988 = T. A. Brown, D. E. Nelson, J. S. Vogal, J. R. Southon 1988, Improved collagen extraction by modified Longin method. – *Radiocarbon* 30, 171–177.

BROTHWELL, D. 1981[3], *Digging up Bones.* – Oxford.

BUCKBERRY, J. L., A. T. CHAMBERLAIN 2002, Age estimation from the auricular surface of the ilium: A revised method. – *American Journal of Physical Anthropology* 119/3, 231–239.

BUIKSTRA, J. E., D. H. UBELAKER 1994, *Standards for data collection from human skeletal remains.* – Arkansas Archaeological Survey Research Series 44.

BYTHEWAY, J. A., A. H. ROSS 2010, A Geometric Morphometric Approach to Sex Determination of the Human Adult Os Coxa. – *Journal of Forensic Sciences* 55/4, 859–864.

DRAKSLER, M. 2007, Območje Zagorja ob Savi v prazgodovini / Das Gebiet von Zagorje ob Savi in der Vorgeschichte. – *Arheološki vestnik* 58, 121–155.

DULAR, J., S. TECCO HVALA 2007, *South-Eastern Slovenia in the Early Iron Age. Settlement – economy – society / Jugovzhodna Slovenija v starejši železni dobi. Poselitev – gospodarstvo – družba.* – Opera Instituti Archaeologici Sloveniae 12.

FRASER et al. 2011 = R. A. Fraser, A. Bogaard, T. Heaton, M. Charles, G. Jones, B. T. Christensen, P. Halstead, I. Merbach, P. R. Poulton, D. Sparkes, A. K. Styring 2011, Manuring and stable nitrogen isotope ratios in cereals and pulses: towards a new archaeobotanical approach to the inference of land use and dietary practices. – *Journal of Archaeological Science* 38/10, 2790–2804.

FULLER et al. 2004 = B. T. Fuller, J. L. Fuller, N. E. Sage, D. A. Harris, T. C. O'Connell, R. E. M. Hedges 2004, Nitrogen balance and δ15N: why you're not what you eat during pregnancy. – *Rapid Communications in Mass Spectrometry* 18/23, 2889–2896.

FULLER et al. 2005 = B. T. Fuller, J. L. Fuller, N. E. Sage, D. A. Harris, T. C. O'Connell, R. E. M. Hedges 2005, Nitrogen balance and delta15N: why you're not what you eat during nutritional stress. – *Rapid Communications in Mass Spectrometry* 19/18, 2497–2506.

FULLER et al. 2006 = B. T. Fuller, J. L. Fuller, D. A. Harris, R. E. Hedges 2006, Detection of breastfeeding and weaning in modern human infants with carbon and nitrogen stable isotope ratios. – *American Journal of Physical Anthropology* 129/2, 279–293.

GABROVEC, S. 1966, Zagorje v prazgodovini / Zagorje in der Vorgeschichte. – *Arheološki vestnik* 17, 19–36.

HARRISON, R. G., M. A. KATZENBERG 2003, Paleodiet studies using stable carbon isotopes from bone apatite and collagen: examples from Southern Ontario and San Nicolas Island, California. – *Journal of Anthropological Archaeology* 22/3, 227–244.

HEATON et al. 1986 = T. H. E. Heaton, J. C. Vogal, G. V. L. Chevallerie, C. Gill 1986, Climatic influence on the isotopic composition of bone nitrogen. – *Nature* 322, 822–823.

HEDGES, R. E. M., L. REYNARD 2007, Nitrogen isotopes and the trophic level of humans in archaeology. – *Journal of Archaeological Science* 34/8, 1240–1251.

HEDGES et al. 2007 = R. E. M. Hedges, J. G. Clement, C. D. L. Thomas, T. C. O'Connell 2007, Collagen turnover in the adult femoral mid-shaft: Modeled from anthropogenic radiocarbon tracer measurements. – *American Journal of Physical Anthropology* 133/2, 808–816.

İŞCAN, M. Y., M. STEYN 2013, *The human skeleton in forensic medicine.* – Springfield, Illinois.

JAY et al. 2008 = M. Jay, B. T. Fuller, M. P. Richards, C. J. Knüsel, S. S. King 2008, Iron Age breastfeeding practices in Britain: isotopic evidence from Wetwang Slack, East Yorkshire. – *American Journal of Physical Anthropology* 136/3, 327–37.

KARAVANIĆ et al. 2017 = S. Karavanić, A. Kudelić, S. Essert, R. Šoštarić 2017, Archaeobotanical finds from the urned house at Kalnik-Igrišče site. – In / V: D. Ložnjak Dizdar, M. Dizdar (eds. / ur.), *The Late urnfield Culture between the Eastern Alps and the Danube. Zagreb, 2017. Proceedings of the International Conference in Zagreb, November 7–8, 2013,* Serta Instituti Archaeologici 9, 67–76.

KLALES et al. 2012 = A. R. Klales, S. D. Ousley, J. M. Vollner 2012, A revised method of sexing the human innominate using Phenice's nonmetric traits and statistical methods. – *American Journal of Physical Anthropology* 149/1, 104–114.

LEE-THORP et al. 1989 = J. A. Lee-Thorp, J. C. Sealy, N. J. Van Der Merwe 1989, Stable carbon isotope ratio differences between bone collagen and bone apatite, and their relationship to diet. – *Journal of Archaeological Science* 16/6, 585–599.

LIGHTFOOT et al. 2013 = E. Lightfoot, X. Liu, M. K. Jones 2013, Why move starchy cereals? A review of the isotopic evidence for prehistoric millet consumption across Eurasia. – *World Archaeology* 45/4, 574–623.

LIGHTFOOT et al. 2012 = E. Lightfoot, M. Šlaus, T. C. O'Connell 2012, Changing cultures, changing cuisines: Cultural transitions and dietary change in iron age, roman, and early medieval Croatia. – *American Journal of Physical Anthropology* 148/4, 543–556.

LIGHTFOOT et al. 2014 = E. Lightfoot, M. Šlaus, P. Šikanjić, T. O'Connell 2014, Metals and millets: Bronze and Iron Age diet in inland and coastal Croatia seen through stable isotope analysis. – *Archaeological and Anthropological Sciences* 7/3, 1–12.

LONGIN, R. 1971, New method of collagen extraction for radiocarbon dating. – *Nature* 230, 241–242.

MEKOTA et al. 2009 = A. M. Mekota, G. Grupe, S. Ufer, U. Cuntz 2009, Identifying starvation episodes using stable isotopes in hair. – *Rechtsmedizin* 19/6, 431–440.

MILLARD, A. R. 2000, A model for the effect of weaning on nitrogen isotope ratios in humans. – In / V: G. Goodfriend, M. Collins, M. Fogel, S. Macko, J. Wehmiller (eds. / ur.) *Perspectives in Amino Acid and Protein Geochemistry,* 51–59, Oxford.

MURRAY, M., M. SCHOENINGER 1988, Diet, status, and complex social structure in Iron Age Central Europe: some contributions of bone chemistry. – In / V: D. Gibson, M. Geselowitz (eds. / ur.) *Tribe and polity in Late Prehistoric Europe,* 155–176, London.

NICHOLLS, R. A. 2017, *More than bones. An investigation of life, death and diet in later prehistoric Slovenia and Croatia.* – Doctoral dissertation / doktorsko delo, University of Bradford, Bradford.

NICHOLLS, R. A., H. KOON 2016, The Use of Stable Light Isotopes as a Method of Exploring the Homogeneity and Heterogeneity of Diet in Late Bronze Age and Early Iron Age Temperate Europe: A Preliminary Study. – In / V: I. Armit, H. Potrebica, M. Črešnar, P. Mason, L. Büster (eds. / ur.), *Cultural Encounters in Iron Age Europe,* Archaeolingua. Series minor 38, 145–164.

NICHOLLS et al. 2020 = R. A. Nicholls, J. Buckberry, J. Beaumont, M. Črešnar, P. Mason, I. Armit, H. Koon 2020, A carbon and nitrogen isotopic investigation of a case of probable infantile scurvy (6th–4th centuries BC, Slovenia). – *Journal of Archaeological Science. Reports* 30 [doi.org/10.1016/j.jasrep.2020.102206].

NOE-NYGAARD et al. 2005 = N. Noe-Nygaard, T. D. Price, S. U. Hede 2005, Diet of aurochs and early cattle in southern Scandinavia: evidence from 15N and 13C stable isotopes. – *Journal of Archaeological Science* 32/6, 855–871.

O'CONNELL, T. C., R. E. M. HEDGES 1999, Investigations into the effect of diet on modern human hair isotopic values. – *American Journal of Physical Anthropology* 108/4, 409–425.

O'LEARY, M. H. 1981, Carbon isotope fractionation in plants. – *Phytochemistry* 20/4, 553–567.

PARFITT, A. M. 2002, Misconceptions (2): turnover is always higher in cancellous than in cortical bone. – *Bone* 30/6, 807–809.

PEARSON et al. 2015 = J. A. Pearson, A. Bogaard, M. Charles, S. W. Hillson, C. S. Larsen, N. Russell, K. Twiss 2015, Stable carbon and nitrogen isotope analysis at Neolithic Çatalhöyük: evidence for human and animal diet and their relationship to households. – *Journal of Archaeological Science* 57, 69–79.

PHENICE, T. W. 1969, A newly developed visual method of sexing the os pubis. – *American Journal of Physical Anthropology* 30/2, 297–301.

REED, K., I. DRNIĆ 2016, Iron Age Diet at Sisak, Croatia: Archaeobotanical Evidence of Foxtail Millet (*Setaria Italica* [L.] P.Beauv.). – *Oxford Journal of Archaeology* 35/4, 359–368.

REYNARD, L. M., N. TUROSS 2015, The known, the unknown and the unknowable: weaning times from archaeological bones using nitrogen isotope ratios. – *Journal of Archaeological Science* 53, 618–625.

RICHARDS, M. 2003, Sharp shift in diet at onset of Neolithic. – *Nature. Brief Communications* 425, 366.

SCHOENINGER, M. J., M. J. DENIRO 1984, Nitrogen and carbon isotopic composition of bone collagen from marine and terrestrial animals. – *Geochimica et Cosmochimica Acta* 48/4, 625–639.

SCHOENINGER et al. 1983 = M. J. Schoeninger, M. J. Deniro, H. Tauber 1983, Stable Nitrogen Isotope Ratios of Bone Collagen Reflect Marine and Terrestrial Components of Prehistoric Human Diet. – *Science* 220(4604), 1381–1383.

TAFURI et al. 2009 = M. A. Tafuri, O. E. Craig, A. Canci 2009, Stable isotope evidence for the consumption of millet and other plants in Bronze Age Italy. – *American Journal of Physical Anthropology* 139/2, 146–153.

TERŽAN B., M. ČREŠNAR 2014, *Absolutno datiranje bronaste in železne dobe na Slovenskem / Absolute dating of the Bronze and Iron Ages in Slovenia.* – Katalogi in monografije 40.

TIESZEN, L. L. 1991, Natural variations in the carbon isotope values of plants: Implications for archaeology, ecology, and paleoecology. – *Journal of Archaeological Science* 18/3, 227–248.

TYKOT, R. H. 2004, Stable isotopes and diet: You are what you eat. – In / V: M. Martini, M. Milazzo, M. Piacentini (eds. / ur.), *Physics Methods in Archaeometry* 154, 433–444.

VAN DER MERWE, N. J. 1982, Carbon Isotopes, Photosynthesis, and Archaeology: Different pathways of photosynthesis cause characteristic changes in carbon

isotope ratios that make possible the study of prehistoric human diets – *American Scientist* 70/6, 596–606.
VAN DER MERWE, N. J., E. MEDINA 1991, The canopy effect, carbon isotope ratios and foodwebs in Amazonia. – *Journal of Archaeological Science* 18/3, 249–259.
VAN-KLINKEN, G. 1999, Bone Quality Indicators for Paleodietary and Radiocarbon Measurements. – *Journal of Archaeological Science* 26, 687–695.
WALKER, P. L. 2008, Sexing skulls using discriminant function analysis of visually assessed traits. – *American Journal of Physical Anthropology* 136/1, 39–50.
WATERS-RIST, A. L., M. A. KATZENBERG 2010, The effect of growth on stable nitrogen isotope ratios in subadult bone collagen. – *International Journal of Osteoarchaeology* 20/2, 172–191.
WEBB, P. A. O., J. M. SUCHEY 1985, Epiphyseal union of the anterior iliac crest and medial clavicle in a modern multiracial sample of American males and females. – *American Journal of Physical Anthropology* 68/4, 457–466.

Interdisciplinarna študija človeških ostankov s starejšeželeznodobnega grobišča v Zagorju ob Savi

Povzetek

Prispevek predstavlja dognanja interdisciplinarne raziskave človeških kostnih ostankov, odkritih leta 2011 na grobišču iz starejše železne dobe na Cesti Borisa Kidriča v Zagorju ob Savi. Pri raziskavah je bilo odkritih devet grobov, razporejenih v tri skupine, od katerih jih je šest vsebovalo človeške skeletne ostanke. Osrednjo skupino predstavljajo grobovi treh odraslih oseb (gr. 4, 5 in 8), ob njih sta bila še dva grobova dojenčkov (gr. 6 in 7). Na podlagi študije grobnih pridatkov je grobišče datirano v pozno halštatsko obdobje, tj. od 6. do 4. stoletja pred našim štetjem (glej prispevek M. Murka in M. Drakslerja v tem Arheološkem vestniku).

Analiza stabilnih izotopov ogljika in dušika za rekonstrukcijo prehrane

Razmerja med izotopi ogljika in dušika v kolagenu, pridobljenem iz kosti in dentina, so pogosto uporabljena pri raziskavah prehrane v preteklosti (Harrison, Katzenberg 2003; Pearson et al. 2015). To je mogoče zaradi izotopske frakcionacije, ki se zgodi med fotosintezo, difuzijo in sintezo beljakovin (Ambrose 1991; Hedges, Reynard 2007; Tykot 2004).

Analiza razmerij stabilnih izotopov ogljika in dušika je bila izvedena na kolagenu iz reber (n = 4), stegnenic (n = 3) in dentina (n = 2) šestih posameznikov (*sl. 4*). Študija je vključevala tudi živalske kosti treh krav, dveh prašičev in jelena, ki so bile odkrite v polnilih grobov in v njihovi neposredni okolici (*sl. 3*).

Vzorci kolagena iz dentina odražajo povprečno izotopsko sestavo beljakovin, zaužitih med razvojem zob (tj. od zadnjega trimesečja nosečnosti do zgodnje odraslosti, a je odvisno od vzorčenega zoba). Ker se primarni dentin ne preoblikuje ali obnavlja, lahko iz zob tako otrok kot odraslih oseb pridobimo izotopske vrednosti iz otroštva. Na kolagen iz dentina vplivajo kratkoročne spremembe prehrane, vključno z dojenjem, prehodom na gosto hrano in prenehanjem dojenja. Kolagen iz večine kosti se, nasprotno, nenehno obnavlja. Tako velja, da se kolagen reber pri odraslih obnovi do 7,7 % na leto, zato odraža prehrano razmeroma kratkega obdobja pred smrtjo (Parfitt 2002). Po drugi strani stegnenica odraža povprečje zaužitih beljakovin mnogo daljšega – do 80 let dolgega – obdobja (po 20. letu starosti) in tako povprečje zaužitih prehranskih beljakovin celotnega odraslega življenja (Hedges et al. 2007).

Rezultati raziskave

Osteološka analiza

Kosti z grobišča na Cesti Borisa Kidriča so bile v splošnem slabo ohranjene. Celovitost skeletov odraslih je bila pod 50 %. Diagnostični elementi in površine (ušesna školjka, sramnična zrast in kolčni vozel medenice, pa tudi večina lobanje), ki se rutinsko uporabljajo za oceno starosti in spola, so bili močno poškodovani. Razdrobljenost, poškodovanost in/ali uničenost teh elementov so oteževale oceno bioloških starosti in spola, predstavljenih na *sliki 4*. Na podlagi razvitosti zob sta bila oba otroka v času smrti stara manj kot 1 leto.

Na izkopanem območju grobišča na Cesti Borisa Kidriča so bili odkriti posmrtni ostanki dveh zrelih odraslih žensk, zrelega odraslega moškega, mladega odraslega moškega in dveh dojenčkov nedoločljivega spola. Na kosteh dojenčka iz groba 7 so bile vidne neznačilna poroznost in tvorbe nove kosti. Glede na prizadete dele skeleta in lastnosti patoloških lezij je dojenček verjetno trpel zaradi skorbuta, tj. pomanjkanja vitamina C (za poglobljeno raziskavo tega posameznika glej Nicholls et al. 2020). Na kosteh zrele odrasle ženske, pokopane v grobu 8, so bile na ohranjenih odlomkih lobanjskih in dolgih kosti ugotovljene razpršena poroznost in tvorbe goste, progaste kosti. Gre za odziv kosti na nespecifično vnetje, morda zaradi okužbe ali presnovnih bolezni, vendar zaradi razdrobljenosti skeletnih ostankov natančnejša diagnoza ni bila mogoča. Pri drugih osebah ni bilo opaziti patoloških lezij.

Zaključek

Vrednosti razmerij stabilnih izotopov ogljika in dušika ($\delta^{13}C$ in $\delta^{15}N$), pridobljene iz skeletnih ostankov, lahko povezujemo s prevladujočo prehrano iz kopenskih virov. Ob tem vrednosti $\delta^{13}C$, višje od −17 ‰, kažejo, da so vsi analizirani posamezniki uživali mešanico rastlin C_3 in C_4, pri čemer so nekateri verjetno zaužili razmeroma velike količine rastlin C_4 (Tieszen 1991; Richards 2003; Tykot 2004; Hedges, Reynard 2007; Lightfoot et al. 2013; Lightfoot et al. 2014). Podobne vrednosti stabilnih izotopov pri odraslih, pridobljene iz različnih virov kolagena (dentin, stegnenica in rebro – *sl. 4*), ob tem dopuščajo sklep, da so analizirani posamezniki uživali enake vrste živil v otroštvu in odrasli dobi, vključno z uživanjem rastlin C_4.

Z umestitvijo najdišča v širše kulturno okolje in ob upoštevanju rezultatov arheobotaničnih študij je verjetno, da je prehranski prispevek rastlin C_4 prišel iz prosa, odkritega na številnih železnodobnih najdiščih v regiji (Dular, Tecco Hvala 2007, 207–210). Družbenoekonomski pomen gojenja in uporabe prosa je bil preučen v drugih raziskavah širše regije. Proso so tako intenzivno gojili že v pozni bronasti dobi, kar dokazuje odkritje pogorelega objekta na najdišču Kalnik na Hrvaškem (Karavanić et al. 2017). Murray in Schroninger (1988) ter Nicholls in Koon (2016) so ugotovili, da vrednosti $\delta^{13}C$ pri posameznikih iz železne dobe, pokopanih na Magdalenski gori ter drugje v osrednji in vzhodni Sloveniji, prav tako kažejo na pojav rastlin C_4 v prehrani. Na obalnem delu Hrvaške so Lightfoot et al. (2014) ugotovili, da imajo v preprostih grobnih jamah pokopani posamezniki izrazitejši C_4 odtis kot tisti, ki so bili pokopani v grobnih jamah, obdanih s kamni. Proso so v tej študiji opredelili kot živilo ljudi nižjega družbenega položaja (Lightfoot et al. 2014). Omeniti kaže, da sta Reed in Drnić (2016) v Sisku na Savi (Hrvaška) odkrila skladišče za bar oz. laški muhvič iz železne dobe, bar pa je prav tako opredeljen kot rastlina C_4. Čeprav menita, da gre za nenavadno odkritje na tem območju in da so rastlino morda gojili v obdobju pomanjkanja ali zaradi osebnega okusa. Ob tem je bilo v zadnjem času objavljenih še več primerov uporabe prosa v bronasti in železni dobi, kjer so bile v raziskavah izvedene tudi analize stabilnih izotopov (Lightfoot et al. 2012; Lightfoot et al. 2013; Tafuri et al. 2009).

V pričujoči študiji iz Zagorja je bila pri ljudeh in večini udomačenih rastlinojedih živali ugotovljena 2–5 ‰ velika sprememba trofičnega nivoja razmerij stabilnih izotopov dušika ($\delta^{15}N$) (*sl. 3; 4*). Iz tega sledi, da so ljudje uživali beljakovine rastlinojedih živali, bodisi v obliki mleka in mlečnih izdelkov bodisi mesa (Ambrose 1991; Hedges, Reynard 2007). Prepoznane so bile tudi jasne razlike med izotopskimi razmerji divjih (jelen) in domačih živali. Višje vrednosti $\delta^{15}N$ pri udomačenih vrstah v primerjavi z divjimi so lahko povezane s krmljenjem in nadzorovanim hranjenjem domačih živali, saj se vrednosti $\delta^{15}N$ zvišajo, če živali uživajo rastline, gojene na površinah, ki so zaradi živalskih iztrebkov (gnojenje?) obogatene z dušikom ^{15}N (Bogaard et al. 2007; Fraser et al. 2011; Bogaard et al. 2013).

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