

# Buried at home? Stable isotope analysis of the late hunter-gatherer cemetery population at Tamula, SE Estonia

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Received 19 December 2022, accepted 29 March 2023, available online 23 November 2023

## ABSTRACT

The function of European Stone Age forager sites with several burials has been debated for decades. One little-known site of this kind is the 4th–3rd millennium cal BC Tamula I (hereinafter Tamula) in south-eastern Estonia. Bringing together the results of archaeological and archaeoanatomical analyses and departing from stable isotope based dietary reconstructions together with the idea of ‘you are what you eat’ as a basis for forming a group identity, we discuss the function of Stone Age forager sites with more than one interment. Should these be considered cemeteries, meeting places or ordinary settlements? Bulk stable carbon ( $\delta^{13}\text{C}$ ) and nitrogen isotope ( $\delta^{15}\text{N}$ ) analysis of human skeletal remains from Tamula and a spatio-temporally close multiple burial at Veibri (5th millennium cal BC) demonstrate a significant consumption of freshwater resources. However, the stable isotope values from these two sites differ significantly, allowing a clear distinction between the two populations. Regarding these values not merely as a reflection of peoples’ dietary preferences, but also as a reflection of their primary identities and an indication of local ecologies, we argue that the stable isotope data together with the fact that the late foragers were sedentary provides additional insights into the discussion on the structure of buried populations. These new isotope data together with archaeological records from Tamula, Veibri and the Stone Age complex Zvejnieki in Latvia suggest that at least three different types of burial places existed among the hunter-gatherer communities in the eastern Baltic region during the Stone Age. In the future, these preliminary results about the people forming a burial community could be further consolidated by the establishment of local baseline information and the application of stable isotope analysis of single amino acids.

## KEYWORDS

bulk stable carbon and nitrogen isotope analysis, hunter-gatherer burials, site characteristics, Stone Age, Estonia.

## Introduction

The emergence of forager cemeteries is a notable cultural change in prehistory. There is no unambiguous answer to the question of why these formal burial areas appear and become visible in archaeological material, their function and meaning in European prehistory have been frequently debated. The motivations (why?) behind the clustering of forager burials are thought to be related to increased sedentism and revolve around two focal ideas: i) tight economic and demographic conditions that are manifested through ancestral claims to one's territory (Clark & Neeley 1987; Zvelebil & Dolukhanov 1991; Larsson 1993; Rowley-Conwy 1998; Halinen 1999; Kriiska 2003; Zvelebil 2003; 2010; Grünberg 2016), and ii) the general understanding of forager worldview, where different worlds are materially enacted in the cultural landscape and burial sites are regarded as liminal places (Nilsson Stutz 2006; Jonuks 2009; Zvelebil 2010; Conneller 2013). Irrespective of the motivations, researchers distinguish between i) proper cemeteries designated for a single community (e.g., Grünberg 2016, 13), ii) meeting places of several hunter-gatherer groups to perform different kinds of rituals, incl. burials (e.g., Jonuks 2009; Schulting et al. 2022), and/or iii) settlement sites where amongst daily activities death was also handled (e.g., Brück 1999; Nilsson Stutz 2014; Gummesson & Molin 2016; Törv 2018). Thus, all the answers about the function and meaning of hunter-gatherer burials sites are in one way or another related to the people buried in a designated burial area, i.e., the **burial community**. Generally, interpretations of the burial community derive from the analysis of burial assemblages, i.e., the nature and function of grave goods (e.g., Zagorskis 1987; Jonuks 2009), (post-)depositional body positions (e.g., Nilsson Stutz 2003; Peyroteo-Stjerna 2016), and/or other aspects of material culture (e.g., Zagorskis 1987; Kriiska 2003; Nilsson Stutz et al. 2013).

In this article we aim to demonstrate that **food** – a silent witness to one's identity – could be a **reasonable medium in dividing and connecting regional hunter-gatherer populations**. We will explore whether and to what extent dietary stable isotope analysis aids in determining a burial community. Through the application of bulk stable isotope analysis we will explore the primary identities of the buried individuals to improve our knowledge about the structure of the burial community. By assuming that the differences in human isotope values correspond to differences in food consumption and/or to isotope baseline values related to local environments, but not to changes in human metabolism, we argue that food preferences enable to capture regional patterns. This further allows us to observe whether different hunter-gatherer burial places were used by a single or multiple groups (a family, a residential forager group or a larger group formed by several extended families), providing new insights into the discussion on the use and meaning of forager burial sites.

Food is 'utterly essential for human existence' (Mintz & Du Bois 2002, 99), being so much more than simply providing one with necessary nutrients. Food choices are not only dependent on the availability of edible fauna and flora, but

are a matter of the economic situation, cultural background (incl. family history), psychological and physiological factors (Hastorf 2017, 21). Food as a culturally defined substance is and has been used, among other aspects of life, to create and maintain social relationships (Mintz & Du Bois 2002, 109; Hastorf 2017, 224–225). One of the most prominent examples of food being a cultural entity in defining social belonging is the study by the British anthropologist Mary Douglas (1921–2007). In her famous book *Purity and Danger: an Analysis of the Concepts of Pollution and Taboo* (1966) she demonstrated that the categories along the ‘edible-inedible’ axis within a society are tightly bound to other cultural rules creating social and kin boundaries. Although in modern Europe bread is a staple food, ‘it is also the locus of cultural distinctiveness’ (Hastorf 2017, 234) since the grain types used and ways of bread preparation vary considerably across the continent. The importance of bread has been documented since the Middle Ages, when to live meant to eat one’s own bread (Pölttsam-Jürjo 2013, 63). From prehistory, the most notable food-related yet cultural distinction between the two groups is the subsistence-based divide between Mesolithic foragers and Neolithic farmers. To put it very simply, it has been argued that during the Mesolithic–Neolithic transition hunter-gatherers turned their back on marine resources and, together with the introduction of farming and cultivation, adapted to terrestrial mode of subsistence (e.g., Tauber 1981; Bonsall et al. 1997; Richards et al. 2003; Milner et al. 2004; Richards & Schulting 2006). These temporally and spatially variable studies demonstrate vividly that food – its preferences, ways of preparation and rules for serving and sharing – reflect cultural affiliation(s), be it ethnic, class/rank variation, gender, religious, national or other.

**Food creates a commonality within a group, setting us apart from others.**

Since the 1980s we have witnessed a considerable growth in food studies – both theoretical and empirical – in different social and cultural disciplines (Warde 2016; Becuț & Puerto 2017), incl. archaeology (Graff 2018; Roberts et al. 2018; Twiss 2019). Among more traditional studies based on material culture (e.g., vessels, hunting/fishing gear, food processing tools), zooarchaeological materials (e.g., Lõugas 2017) and ancient plant macro-remains, stable isotope analysis of human tissues, faunal and plant remains has been used to study past diets since the late 1970s (Roberts et al. 2018). The number of these studies has increased considerably since the mid-1990s (Roberts et al. 2018) and has reached the point where stable isotope analysis of ancient tissues is conducted routinely today. Stable isotope analysis was first applied to test the Neolithization hypothesis, i.e., the grand subsistence change in prehistory (see above; Tauber 1981), and is yet to be studied to put the details in the right place (e.g., Richards et al. 2003; Katzenberg 2008). In addition to studying subsistence strategies, other topics such as preparing and consuming food in relation to gender (e.g., Kjellström et al. 2009; Graff 2018), socially constrained food choices (e.g., Lee-Thorp 2008; Makarewicz & Sealey 2015; Pearson et al. 2015) and distinctions between daily and ritual foodways (e.g., Barrett & Richards 2004; Oras et al. 2018; Curto et al. 2019) have arisen more recently. In the eastern Baltic and Estonia, however, stable isotope analysis is not a standard procedure

yet, but we are witnessing a peak (e.g., Tõrv & Meadows 2015; Piličiauskas et al. 2017a; 2017b; Meadows et al. 2018; Oras et al. 2018; Tõrv 2018; Agurauja-Lätti & Lõugas 2019; Vasks et al. 2021).

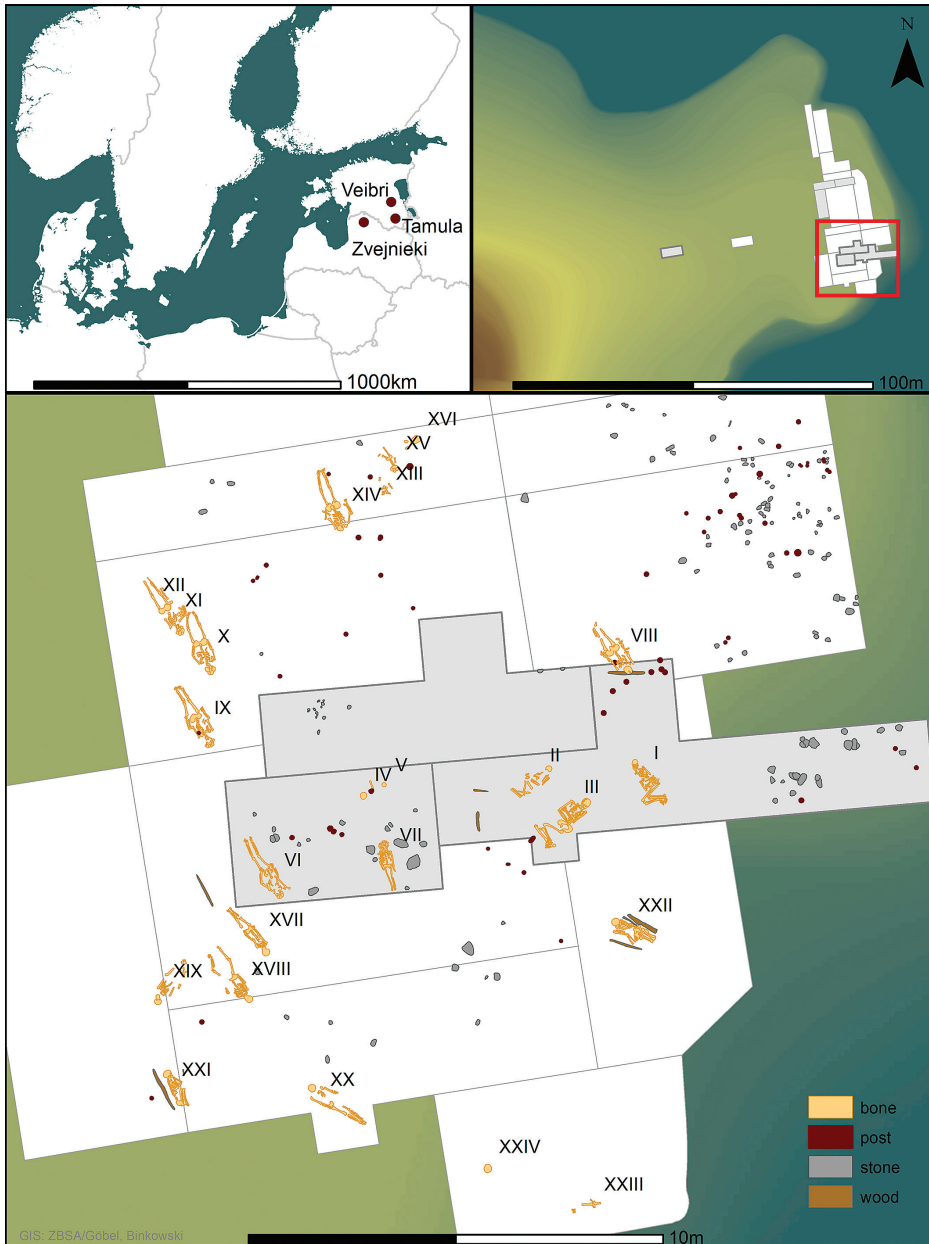
Drawing on anthropological research and social theories about identity creation and manifestation, we argue that the dietary differences reflected in stable isotope values are the locus of cultural distinctiveness, i.e., ‘you are what you eat’. Thus, by studying the stable isotope composition and employing an intra- and inter-site comparison, we can make sophisticated guesses about individuals’ group belonging. In a homogeneous group (i.e., a family or residential group), the variability of stable isotope values of its members is negligible, in a heterogeneous group(s), such as locals vs foreigners and/or sedentary populations vs mobile groups, clear differences in individual values are reported. Following this line of reasoning, we aim to test two scenarios for the use of the forager burial sites: i) homogeneous stable isotope values from a single burial site represent a site (cemetery or settlement) used by a single forager group, and ii) heterogeneous stable isotope values indicate a site used by different groups, and thus could be labelled as an occasional meeting place. These scenarios rely on a further assumption that the differences in human isotope values correspond to differences in food consumption and/or to isotope baseline values related to local environments, but not to changes in human metabolism.

We will explore the question of burial community through the application of bulk carbon and nitrogen isotope analysis of human bones and dentine collagen. As a case study, we will explore the Tamula hunter-gatherer site with the aim of discussing whether it should be regarded as a purpose-built cemetery, a meeting place, or a residential settlement site. By the characterization of the food preferences of the individuals interred at the site, we will reconstruct their primary identities and compare these at a regional scale. Two sites temporally and geographically similar to Tamula will be used for comparison: Zvejnieki (Eriksson 2006; Zagorska 2006b) and Veibri (Kriiska et al. 2007; Lõhmus et al. 2011; Tõrv 2018). By bringing together the lines of evidence from archaeological records (Indreko 1945; Jaanits 1957; 1984; Lõhmus 2005), osteological and archaeothanatological analysis (Tõrv 2018) and bulk stable isotope, we identify the patterns in the use of forager burial sites in the eastern Baltic during the Stone Age by determining the burial communities based on their dietary identities. Our paper further contributes to the broader discussions on the function and meaning of European hunter-gatherer cemeteries.

### Archaeological background: Tamula, Veibri and Zvejnieki

Tamula is the most researched forager burial site in Estonia. Discovered in 1938, the area of 657 m<sup>2</sup> was investigated during the field seasons in 1942–1943 (Indreko 1942; 1943), 1946 (Moora 1946), 1955–1956, 1961, 1968, and finally in 1988–1989 (Jaanits 1957; 1984). The site is located in south-eastern Estonia, between Lake Vagula and Lake Tamula, where the River Vahejõgi flows into Lake Tamula (Fig. 1).

The palaeogeography has not been formally studied, although it seems likely that the water level in Lake Tamula was lower during the Stone Age habitation (Indreko 1945, 41; Jaanits 1984, 183).



**FIG. 1.** Map of the Baltic region with the location of Tamula, Veibri and Zvejnieki (top left). General plan of the extension of the excavation at Tamula, with the present waterfront (top right). Excavation plot of the Tamula burial place (bottom). Drawings after the Archaeology Research Collection of Tallinn University by Karin Göbel, Nina Binkowski and Mari Tõrv.

The most obvious structures at Tamula are the 25 inhumation burials, dug down into the cultural layer. The cultural layer is characterized as sand mixed with peat, being rich in artefacts and entailing other features reflecting everyday activities. These include wooden poles and hearths (Jaanits 1984, 184). However, despite the abundance of the wooden poles that are claimed to be part of the dwellings (Jaanits 1957; Jaanits et al. 1982, 82; Jaanits 1984, 184), the outlines of houses have not been determined. The archaeological material is abundant (Fig. 2), with preservation conditions conducive to the survival of organic materials, incl. numerous bone artefacts (e.g., arrowheads, harpoons, and fishhooks) (Jaanits 1984, 186–187, figs 4–5). Lithics include pieces of flint and stone adzes of various raw materials (Jaanits 1984, 196). The quantity of debris is relatively sparse but may have been biased by imprecise excavation techniques (Jaanits 1984, 185). Many anthropomorphic and zoomorphic bone and amber figurines were recovered, mostly from graves (Jaanits 1957, 83, 87, figs 3–4; 1984, 189, fig. 7; Ots 2006). Ceramics – Late Combed Ware and Corded Ware – are poorly represented (Jaanits 1984, 190–192). Daily life is also represented by the abundance of faunal remains, incl. elk and beaver, less frequently wild boar, aurochs, marten, otter, bear, red deer, roe deer, badger and hare; and fishes (primarily pike and perch; Paaver 1965, 439–440; Jaanits 1991, 27).

This is a forager site with 25 inhumations and features loose human bones within an associated settlement layer dating to the beginning of 4th and mid-3rd millennium cal BC (Tõrv 2018). There is no consensus about the function of the Tamula site. First, the abundance and representation of faunal remains has enabled to interpret Tamula as a residential settlement used annually (Indreko 1945; Jaanits 1957; 1984). Second, according to the classification of settlement patterns in the eastern Baltic (Zvelebil 2010, 32–35), Tamula belongs to a group of inland sites that are marked by direct rather than logistic procurement, greater residential mobility, and focuses on terrestrial resources, compared to coastal settlement sites. Alternatively, Tõnno Jonuks (2009) has argued that Tamula should not be viewed as a residential site used repeatedly by a single community, but rather as a meeting place or aggregation site for regional groups to perform various rituals, with a focus on mortuary practices (Jonuks 2009, 128).

The graves at Tamula mainly represent primary inhumations, where the initial body position varies (see <https://datadoi.ee/handle/33/587>). It is only tentatively possible to argue that some of the disarticulated human bone assemblages represent different kinds of mortuary practices (Tõrv 2018). The outlines of the shallow graves were not observable and lacked permanent above-ground markers. Wood and perishable materials surrounding the body have been observed in several graves along with a variety of grave goods (Jaanits 1957; Lõhmus 2005; Tõrv 2015; 2018).

Based on the characteristics of the material culture, Lembit Jaanits inferred that the occupation at Tamula was short-lived compared with other regional sites, occurring over a period of only several centuries (Jaanits & Liiva 1973, 159; Jaanits 1984, 192). Recent radiocarbon dating of grave contexts (14 on human collagen

and three wooden samples) indicates, however, that the site was used over a longer time period, ca 3900–2600 cal BC (Tõrv 2018).



**FIG. 2.** The most characteristic grave goods from the Tamula burial place: bone figurines (1–5: AI 4118: 576, 575, 269, 1238, 556), tooth pendants (6: AI 4118: 1245), bird bone pendants (7: AI 4118: 833), and amber figurines (11–14: AI 4118: 1739, 266; 3960: 265; 4118: 1751), stone adzes (8–10: AI 3960: 281; 4118: 832, 792), bone arrowheads (15–19: AI 4118: 559, 836, 2990, 2338, 3044), and unworked animal bones (20, 21: AI 4118: 568, 572). All finds are stored in the Archaeological Research Collection of Tallinn University. Photos by Jaana Ratas and Marko Usler.

Two similar hunter-gatherer burial sites within a radius of ca 100 km from Tamula are the Veibri quadruple grave in Estonia and the Zvejnieki burial place in Latvia (Fig. 1). Similarities in environmental, ecological and cultural settings provide a good comparison with Tamula (Table 1). All three sites are situated on the shores of shallow freshwater bodies in the interior of the eastern Baltic region (Mäemets 1977; Eberhards 2006). Dominated by the East European Plain, this flat landscape features bedrock formed of Devonian sandstone and siltstone overlain by various glacial and meltwater deposits, as well as Holocene deposits (Sandgren et al. 1997; Eberhards 2006). Changes in the climate and the different stages of the Baltic Sea during the Holocene affected the ecology at all these sites in the same manner.

All three sites are good representatives of the hunter-gatherer mortuary repertoire in the eastern Baltic region (Table 1). The archaeothanatological analysis reveals that Veibri quadruple grave represents a single burial event that predates Tamula (Kriiska et al. 2007; Tõrv 2018). Unlike Tamula and Zvejnieki, no spatio-temporally overlying or adjacent occupation layer could be associated with it (Lõhmus et al. 2011).

**TABLE 1.** Comparison of the characteristics of Tamula, Zvejnieki and Veibri

Characteristics		Tamula	Zvejnieki	Veibri
Date		3900–2600 cal BC	7310–7050 to 2890–2630 cal BC	4550–4370 cal BC
Environmental background	Geological background	Devonian sand- and siltstone		
	Waterbody	Lake Tamula	Lake Burtnieks	River Suur-Emajõgi
	Chronozone (after Walker et al. 2012)	Middle Holocene	Early to Late Holocene	Middle Holocene
Cultural background	Archaeological period	Neolithic	Middle Mesolithic to Neolithic	Late Mesolithic
	Associated occupation layer	Yes	No	No
	Number of burials	25	Over 300	1
	MNI*	31	Over 300	4
	Grave goods	Yes	Yes	Yes
	Other archaeological structures	Hearths	No	No
	Archaeological material	Bone and stone tools, amber and bone figurines, ceramics, faunal material	Bone and stone tools, amber, bone figurines, ceramics, faunal material	Ceramics
	Types of ceramics	Late Combed Ware, Corded Ware	Narva Ware, Combed Ware	Narva Ware
Human stable isotope data		In this paper	Eriksson 2006	In this paper

\* minimum number of individuals



The Zvejnieki complex is quite different with its large number of burials (over 300) and long continuous use (ca 7000–3000 cal BC) (Zagorska 2006a; Nilsson Stutz et al. 2013). Radiocarbon dates from Tamula and Zvejnieki (Meadows et al. 2016; 2018) together with similarities in material culture clearly indicate that these sites were used for mortuary rituals partly at the same time and thus provide a good comparison.

## Material and methods

Bulk stable isotope analysis of the collagen extracted from ancient bone and dentine was applied for dietary reconstructions. The  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of collagen provide dietary information, primarily indicating protein intake (Ambrose & Norr 1993; Jim et al. 2006). The  $\delta^{13}\text{C}$  value distinguishes between marine and terrestrial  $\text{C}_3$  plant producers and consumers (as there were no  $\text{C}_4$  plants in Stone Age Northern Europe). The  $\delta^{15}\text{N}$  value increases with trophic level, identifying different classes of organisms (Minagawa & Wada 1984; Schoeninger & DeNiro 1984). Since bone tissue is constantly remodelled, stable isotope values of human bone collagen give us the protein intake of a person up to 20 years prior to death (Ambrose & Norr 1993; Hedges et al. 2007); the chemical composition of dentine collagen is inert and reflects the formation time of permanent molars (Hillson 2005; Table 2). This enables to trace intra-individual variances, i.e., to reveal a person's dietary biography (e.g., Sealey et al. 1995; Eriksson 2003; Eriksson & Lidén 2013).

**TABLE 2.** Estimates of the time of formation of the dentine samples, derived from Smith 1991. The samples were taken directly from below the crown, at the cervix

Bone element	Time of formation	Age category
M1	4 ± 1 year	Young child
M2	8.5 ± 1 year	Older child
M3	14 ± 1 year	Adolescent

A total of 48 samples of human bone and dentine powder were obtained from 19 individuals by means of a dentist's drill, and the surface layer of both bone and teeth was discarded to avoid contamination. Care was taken not to impede potential future osteological studies. Dentine samples were drilled directly from below the crown of the teeth, at the cervix, and where possible, the three permanent molars (M1, M2 and M3) and bones of each individual were analysed, reflecting different times of formation and thus different stages of the individual's life (Table 2). To provide an isotopic baseline, 13 faunal samples from the graves were initially included.

Most samples were processed in 2011 at Stockholm University, but some supplementary samples were processed in 2014 at two different laboratories. The pre-treatment protocols and the analysis instrumentation are summarized in Table 3. In general, collagen extraction was carried out following a modified Longin method

(Brown et al. 1988), but slight differences occurred: the 14CHRONO Centre used an additional acid step (NaOH), while ZBSA (Centre for Baltic and Scandinavian Archaeology) was the only laboratory that did not use ultrafiltration. Approximately 0.5 mg of the lyophilized sample was weighed into a tin capsule, combusted and measured in an EA-IRMS (Elemental Analyser - Isotope Ratio Mass Spectrometer) system run in continuous flow. Laboratory and international standards were interspersed throughout each analytical run. The results are expressed using the delta notation in parts per thousand (per mil or ‰) relative to the international marine limestone VPDB standard for carbon and AIR standard for nitrogen. The error of the carbon and nitrogen isotope ratio measurements, determined from repeated measurement of international and laboratory standards, was up to  $\pm 0.2\%$ .

**TABLE 3.** Overview of the three extraction protocols and subsequent EA-IRMS analysis of bulk collagen samples

<b>Pre-treatment</b>	Laboratory	Archaeological Research Laboratory, Stockholm University	Centre for Baltic and Scandinavian Archaeology (ZBSA)	14CHRONO Centre, Queen's University Belfast
	Sample material	Bone powder	Bone powder	Crushed bone
	Demineralization	0.25 M HCl for ca 48 h	0.5 M HCl for ca 24 h	2% HCl and 0.1 M NaOH for ca 19 h
	Gelatinization	0.01 M HCl, at 58 °C for ca 16 h	0.02 M HCl, at 58–70 °C for ca 16 h	pH2–pH3 solution at 70 °C for 15 h
	Ultrafiltration	Yes (30kD ultrafilter)	No	Yes (>30kD ultrafilter)
	Reference	Brown et al. 1988	Törv and Meadows 2015	Reimer et al. 2015
<b>Analysis</b>	EA-IRMS analysis	Stable Isotope Laboratory (SIL), Department of Geological Sciences, Stockholm University	School of Life Sciences, University of Bradford	14CHRONO Centre, Queen's University Belfast
	Instrumentation	Carlo Erba NC2500 elemental analyser, Finnigan MAT Delta+ isotope ratio mass spectrometer	Thermo Flash 1112 elemental analyser, Thermo Delta plus XL mass spectrometer	Thermo Delta V elemental analyser - isotope ratio mass spectrometer
	Measurement error ( $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ )	$\pm 0.15\%$	$\pm 0.2\%$	$\pm 0.1\%$
Laboratory codes of samples		TAM/VEI	KIA	UBA
No. of samples measured at Tamula		13	1	5
$\delta^{13}\text{C}$	Mean $\pm$ s.d.*	$-24.1 \pm 0.5$	$-24.4$	$-25.1 \pm 0.5$
$\delta^{15}\text{N}$	Mean $\pm$ s.d.	$13.3 \pm 0.7$	13.5	$13.8 \pm 0.7$
No. of samples measured at Veibri		10	1	1
$\delta^{13}\text{C}$	Mean $\pm$ s.d.	$-23.3 \pm 0.3$	$-22.9$	$-23.3$
$\delta^{15}\text{N}$	Mean $\pm$ s.d.	$15.1 \pm 0.6$	15.8	15.0

\* standard deviation

Recently, it has been demonstrated that, similarly to different diagenetic factors, the different pre-treatment protocols used (as is the case here) may influence stable isotope values (Vaiglova et al. 2014; Roberts et al. 2018). An experimental study (Pestle et al. 2014) showed statistically significant differences between the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of bulk bone collagen from different laboratories ( $n=21$ ) that implemented different collagen extraction protocols. This variability could be attributed in roughly equal parts to differences in sample preparation (collagen extraction protocol) and analysis (instrumentation, working standards, and data calibration). Moreover, in the sample preparation phase, neither the choice of demineralizing agent nor the potential removal of humic acids engendered any significant differences in the resulting isotopic signatures (Rumpelmayr 2012; Pestle et al. 2014). The average pairwise difference between any two laboratories was reported to be only 0.2‰ for  $\delta^{13}\text{C}$  and 0.4‰ for  $\delta^{15}\text{N}$  (Pestle et al. 2014). These values are relatively small and thus confirm that collagen isotope results obtained from different laboratories can be meaningfully compared.

## Results

The results of the stable carbon and nitrogen analyses are given in Table 4. The success rate of the Tamula material was only 32%, with poor collagen preservation in both bone and tooth samples. Of the 48 human samples, 23 yielded insufficient collagen for analysis, in five cases the C/N ratios were outside the accepted range, and one sample had to be excluded due to machine failure. The remaining 19 samples, from 11 individuals, all complied with accepted quality criteria regarding collagen yield (0.5 to 7.3 mg), C:N ratio falling within the accepted range (2.9–3.6), and carbon and nitrogen percentage inclusion (DeNiro 1985; Ambrose 1990; van Klinken 1999). Three individuals from Tamula (graves III, VIII, and XXII) yielded data for multiple elements (both teeth and bones), while the remaining individuals only produced a single sample each. These samples provide insights into multiple temporal sequences of the site, including different mortuary practices and a cross-section of the mortuary population (see <https://datadoi.ee/handle/33/587>), and enable the reconstruction of the dietary life histories.

Since the best practice in interpreting human stable isotope values is to juxtapose these to local faunal and floral values representing ecologies spatially and temporarily close to humans (Eriksson 2003; Hedges & Reynard 2007; Casey & Post 2011; Zangrando et al. 2014), we sampled animal remains from 13 individuals from Tamula (species included: elk, wild boar, beaver, brown bear, badger, marten, birds (incl. western capercaillie) and dog. However, only one (AI 4118: 833: a seal tooth from grave IX) yielded sufficient collagen for analysis, preventing us from using here a local stable isotope baseline (i.e., from the same site and time period). To overcome this interpretative limitation, we have employed the published data from Zvejnieki and neighbouring Rīņukalna in the Lake Burtnieks region of Latvia (Eriksson 2006; Bērziņš et al. 2014; Schmölcke et al. 2015; Meadows et al. 2018; Brinker et al.

2020), Lithuania (Antanaitis-Jacobs et al. 2009; Heron et al. 2015; Piličiauskas et al. 2017a; 2017b; Robson et al. 2019) and Sweden (Eriksson 2006) to allow an intelligible comparison with temporally and spatially close faunal references reflecting similar ecological backgrounds to Tamula and Veibri to interpret human isotope values.

**TABLE 4.** Stable isotope data of samples from Tamula and Veibri that fulfilled the quality criteria. The sex of the individuals was determined on dimorphic traits on skeletons (Törv 2018, table 16), in some cases sex was determined by aDNA analysis (indicated by\*) (Mittnik et al. 2018). M – male, F – female

Grave No.	Age/Sex	Lab No.	Element	Collagen (mg)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	C:N	%C	%N
Tamula III	Middle adult, M?	TAM26	M1	2.3	-24.2	14.0	3.2	39.4	14.6
Tamula III	Middle adult, M?	TAM25	M2	1.4	-24.2	13.6	3.5	40.8	13.6
Tamula III	Middle adult, M?	TAM08	Mandible	1.6	-24.7	13.5	3.5	39.4	13.3
Tamula VII	Older child, F*	TAM12	M1	1.4	-24.0	14.0	3.4	39.8	13.7
Tamula VIII	Middle adult, F	TAM17	M1	0.7	-23.1	13.5	3.3	37.3	13.2
Tamula VIII	Middle adult, F	TAM15	M2	1.7	-23.9	12.7	3.2	39.3	14.3
Tamula VIII	Middle adult, F	TAM16	M3	1.0	-23.8	12.2	3.2	39.2	14.2
Tamula IX	Middle adult, M?	KIA48838	Humerus	n/a	-24.4	13.5	3.3	51.3	18.4
Tamula X	Middle adult, F?/F*	UBA27362	Femur	3.1	-25.1	12.7	3.3	n/a	n/a
Tamula XIV	Non-adult	UBA27361	M2	7.3	-25.5	14.5	3.2	n/a	n/a
Tamula XVII	Middle adult, F	TAM24	M2	0.5	-23.5	14.1	3.6	n/a	n/a
Tamula XVIII	Older adult, F?	UBA27359	Humerus	4.4	-24.3	14.1	3.3	n/a	n/a
Tamula XXI	Middle adult, M?	UBA25994	Humerus	n/a	-25.3	13.4	3.4	n/a	n/a
Tamula XXII	Older adult, M?	TAM22	M1	1.3	-24.5	14.4	2.9	2.4	0.9
Tamula XXII	Older adult, M?	TAM20 <sup>1</sup>	M2	1.3	-24.8	13.1	3.3	38.8	13.6
Tamula XXII	Older adult, M?	TAM34	M2	2.8	-24.7	13.0	3.2	40.1	14.7
Tamula XXII	Older adult, M?	TAM21	M3	2.2	-23.9	12.4	3.4	40.2	13.9

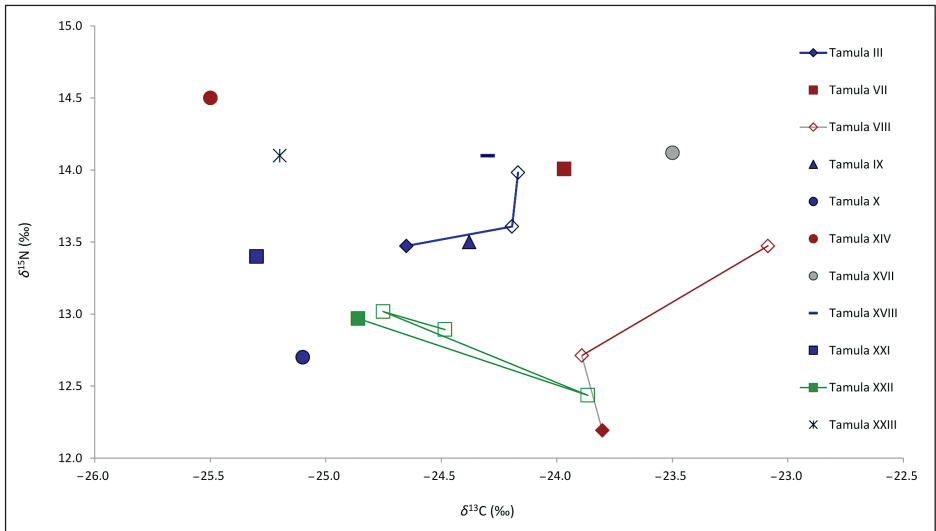
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- 1 In the case of the individual XXII, the mean of samples TAM20 and TAM34 is used in statistical analysis, as this is a duplicate sample derived from the left M2, except that for TAM34 the tooth was cleaned with acetone.

TABLE 4. Continued

Grave No.	Age/Sex	Lab No.	Element	Collagen (mg)	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)	C:N	%C	%N
Tamula XXII	Older adult, M?	TAM01	Mandible	4.4	-24.9	13.0	3.5	42.6	14.1
Tamula XXIII	Adult	UBA25995	Tibia	n/a	-25.2	14.1	3.2	n/a	n/a
Veibri I/I	Adolescent, F*	VEI09	M1	0.8	-23.2	15.4	3.3	37.8	13.6
Veibri I/I	Adolescent, F*	VEI10	M2	1.5	-22.7	14.6	3.4	39.4	13.4
Veibri I/I	Adolescent, F*	VEI07	M2	1.9	-22.6	15.0	3.2	39.7	14.3
Veibri I/I	Adolescent, F*	VEI01	Mandible	4.8	-23.5	15.1	3.5	41.8	14.1
Veibri I/I	Adolescent, F	UBA27355	Mandible	5.6	-23.3	15.0	3.2	n/a	n/a
Veibri I/II	Middle adult, F?/M*	VEI06	M2	0.5	-23.1	15.0	3.3	38.2	13.4
Veibri I/II	Middle adult, F?/M*	VEI11	M3	1.4	-23.2	14.4	3.2	39.4	14.3
Veibri I/II	Middle adult, F?/M*	VEI02	Mandible	1.9	-23.5	14.4	3.4	39.9	13.6
Veibri I/III	Young child	VEI05	M1	1.8	-23.0	15.2	3.2	40.1	14.5
Veibri I/III	Young child	VEI03	Mandible	2.9	-23.5	16.1	3.3	40.2	14.0
Veibri I/IV	Young child, F*	VEI04	Mandible	3.2	-23.3	15.9	3.5	40.7	13.8
Veibri I/IV	Young child, F*	KIA48843	Femur	n/a	-22.9	15.8	3.2	42.0	15.2

The isotope values from Tamula suggest an isotopically homogeneous diet, with  $\delta^{13}\text{C}$  ranging from -25.5‰ to -23.1‰ and  $\delta^{15}\text{N}$  from 12.2‰ to 14.5‰. Mean and standard deviations of the human values are  $-24.4 \pm 0.6$ ‰ for  $\delta^{13}\text{C}$  and  $13.5 \pm 0.7$ ‰ for  $\delta^{15}\text{N}$ . The lowest  $\delta^{13}\text{C}$  values are derived from the bones of the probable males in graves X, XXI and XXIII, and from the non-adult in grave XIV. The latter also displays the highest  $\delta^{15}\text{N}$  value. The other samples showing elevated  $\delta^{15}\text{N}$  values mostly represent childhood samples (III, VII, XVII and XXII), only two of them are from adults (XVIII and XXIII). Limited or moderate intra-individual dietary changes are observed in individuals III, VIII and XXII (Fig. 3); in all three cases, the  $\delta^{15}\text{N}$  values in M1 are consistently higher than in other molars or bone tissue (Table 5). This probably indicates a nursing effect, which is a trophic level difference between a nursing infant and its mother (Fogel et al. 1989). As the formation of the crown of the first molar is completed by the time the child is several years old, weaning must have commenced, and one should therefore not expect a full trophic level shift of 3–4‰ (Minagawa & Wada 1984; Schoeninger & DeNiro 1984; Bocherens & Drucker 2003).



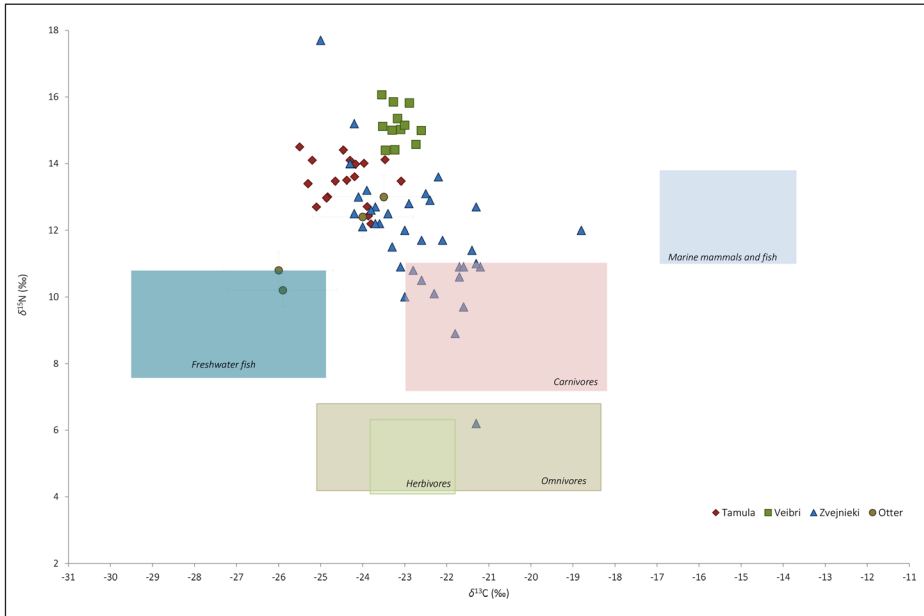
**FIG. 3.** Stable carbon and nitrogen isotope data of Tamula humans with intra-individual values connected by a line, in order of collagen formation (last value plotted with a filled symbol). Colour codes indicate the date range for each grave: red – 3900–3500 cal BC, blue – 3500–3000 cal BC, green – 3000–2600 cal BC, grey – no date.

The Veibri material contains multiple samples from four individuals – one adult and three children (Table 4). In contrast to Tamula, the collagen preservation at Veibri was exceptional with a 100% success rate. The stable isotope values of the Veibri individuals are also indicative of an isotopically homogeneous diet, but with elevated values compared with Tamula, with  $\delta^{13}\text{C}$  ranging from  $-23.5\text{‰}$  to  $-22.7\text{‰}$  and  $\delta^{15}\text{N}$  from  $14.4\text{‰}$  to  $16.1\text{‰}$ . Mean and standard deviations of the human data are  $-23.2 \pm 0.3\text{‰}$  for  $\delta^{13}\text{C}$  and  $15.1 \pm 0.5\text{‰}$  for  $\delta^{15}\text{N}$ . The elevated  $\delta^{15}\text{N}$  values among these individuals are most probably an outcome of a nursing effect, as these derive from the dentine samples. The lowest  $\delta^{15}\text{N}$  value represents the average diet over several years prior to the adult's death. There is no evidence of significant intra-individual dietary change at Veibri. Variability in the data is constrained to  $0.2\text{--}0.5\text{‰}$  for both  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ , which is indistinguishable from the analytical error.

## Discussion

### THE DIET OF PEOPLE AT TAMULA

Freshwater fish played an important role in the protein intake at Tamula, as the low  $\delta^{13}\text{C}$  and high  $\delta^{15}\text{N}$  values demonstrate (Fig. 4), contributing to the inhabitants' inland identities. The high  $\delta^{15}\text{N}$  values further suggest that carnivorous fishes (e.g., pike, perch and pikeperch) must have comprised a substantial portion of the protein intake of these people, corroborated by the faunal remains at the site (Jaanimäe 1991). Carnivorous pike and perch constituted more than 60% of the fish bones at Tamula, followed by the bottom-feeding bream (also catfish, roach, tench, ide, and rudd



**FIG. 4.** Human  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  data for Tamula, Veibri (this study) and Zvejnieki (Eriksson 2006). The shaded areas indicate predicted ranges for humans who consume exclusively protein from each faunal group (with a trophic level offset relative to fauna of +1‰ for  $\delta^{13}\text{C}$  and +3‰ for  $\delta^{15}\text{N}$ ), based on faunal data from Tamula (Estonia, Latvia (Eriksson 2006; Bērziņš et al. 2014; Schmölcke et al. 2015; Meadows et al. 2016; Brinker et al. 2020), Lithuania (Antanaitis-Jacobs et al. 2009; Heron et al. 2015; Piličiauskas et al. 2017a; 2017b; Robson et al. 2019) and Sweden (Eriksson 2006); otter values derive from Zvejnieki (Eriksson 2006). Data are presented at <https://datadotui.ee/handle/33/586>.

were caught). Terrestrial and/or marine species do not appear to have contributed significantly to the diet of these individuals. The Tamula sample is comparable to Zvejnieki, where several individuals cluster around two otter samples, suggesting a similarly fish-intensive diet (Eriksson 2006, 191; Meadows et al. 2018). Similarly to the Stone Age hunter-gatherers in the eastern Baltic, otters (*Lutra lutra*) inhabit river- and lakesides. Their diet consists of various fish in 30–90%, further supplemented by frogs, smaller terrestrial mammals (e.g., hare, rat, and mouse) and waterfowl (e.g., duck) (Laanetu 2007; Moks et al. 2015, 223). Smaller mammals and waterfowl must also have contributed to the diets of hunter-gatherers, and thus the similarity in their dietary stable isotope values should not come as a surprise.

Moreover, material culture from Tamula – abundant fish bones compared to other Stone Age sites in Estonia (e.g., Pulli, Kunda, Kääpa, and Loona) and fishing gear including fishhooks ( $n = 26$ ), fish spears and harpoons ( $n = 40$ ), fishhook sinkers ( $n = 5$ ) and net sinkers/floats ( $n = 4$ ) (Fig. 5; Jaanits 1991, 27; Ööbik 2014, 50–55, appendix 1) – is also in accordance with the stable isotope values indicating a fish-rich diet. It may be argued that these sites are not comparable, since the soil conditions that differ from site to site most probably affected the preservation of small bones (see e.g., Ritchie 2010 and references therein). However, the comparison between

Kääpa and Tamula is most telling, as these sites have similar soil conditions and fishing tools in the archaeological assemblage (Ööbik 2014), but fish remains at Kääpa are much less frequent than at Tamula.

We observe an age-related difference in the stable isotope values. The mean  $\delta^{13}\text{C}$  values of adults (adult bone,  $-24.8 \pm 0.4\text{‰}$ , mean  $\pm$  s.d.,  $n = 7$ ) and non-adults (dentine and non-adult bone,  $-24.1 \pm 0.6\text{‰}$ ,  $n = 11$ ) from Tamula are significantly different (Table 5: Student's t-test,  $p = 0.018$ ). This suggests a proportional difference in the intake of freshwater fish protein between these two age groups, showing that adults must have consumed slightly more freshwater fish than non-adults. The variations in  $\delta^{15}\text{N}$  values are not statistically significant; however, the larger standard deviation within the non-adult group could be due to both tissue differences (dentine



**FIG. 5.** Fishing gear from Tamula: fishhooks (1–4: unnumbered, AI 4118: 3930; 3932: 35), fishhook sinkers (5–8: AI 4118: 2349, 31, 3031, 127), harpoons (9–11: AI 4118: 3558, 2603, 3539), a net sinker (12: AI 4118: 3276), and a float (13: AI 4118: 3644). Photos by Jaana Ratas.



vs bone) and differences in collagen turnover rates between adult and non-adult bone (O’Connell et al. 2001; Hedges et al. 2007). The latter could also indicate that the non-adult values represent seasonal patterns, with fish being more frequent in the diet during certain times of the year. The seasonality aspect, however, remains a hypothesis at the present state of the research. This could be further tested by the application of compound-specific (e.g., Webb et al. 2018) and incremental tooth stable isotope analysis (e.g., Beaumont et al. 2013), coupled with a detailed investigation of local freshwater ecosystems (incl. Lake Tamula, River Vöhandu; Guiry 2019).

**TABLE 5.** P-values of Student’s t-test for independent samples, while detecting differences in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  for different characteristics in graves at Tamula. Bold values are significant differences at the  $p < 0.05$  level. Comparison of different mortuary practices includes only the values closest to death. The mean values of the compared characteristics are separated from other pairs by lines

	Compared characteristics	n samples	mean (‰) $\pm$ s.d.* ( $\sigma$ )	p-value
$\delta^{13}\text{C}$	Female	4	$-24.7 \pm 0.4$	0.755
	Male	2	$-24.8 \pm 0.3$	
	Adult	7	$-24.8 \pm 0.4$	<b>0.018</b>
	Non-adult	11	$-24.1 \pm 0.6$	
	Burials with additional structures	8	$-24.6 \pm 0.7$	0.723
	Burials without additional structures	3	$-24.7 \pm 0.4$	
	Initial body position: supine	7	$-24.4 \pm 0.7$	0.211
	Initial body position: flexed	3	$-25.0 \pm 0.3$	
	Burials with grave goods	7	$-24.4 \pm 0.7$	0.249
	Burials without grave goods	4	$-25.0 \pm 0.4$	
$\delta^{15}\text{N}$	Female	4	$13.3 \pm 0.2$	0.919
	Male	2	$13.4 \pm 0.7$	
	Adult	7	$13.5 \pm 0.5$	0.956
	Non-adult	11	$13.5 \pm 0.8$	
	Burials with additional structures	8	$13.4 \pm 0.7$	0.342
	Burials without additional structures	3	$13.9 \pm 0.3$	
	Initial body position: supine	7	$13.6 \pm 0.8$	0.591
	Initial body position: flexed	3	$13.3 \pm 0.2$	
	Burials with grave goods	7	$13.5 \pm 0.8$	0.751
	Burials without grave goods	4	$13.7 \pm 0.5$	

\* standard deviation

We observe no statistically significant differences in diet between male and female nor between individuals who received different mortuary treatment. Intra-individual variation at Tamula is negligible, as demonstrated by the standard deviations of 0.2–0.8‰ for both  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values. The low intra-individual variability suggests that these people obtained their protein from the same ecological setting throughout their lifetimes, further indicating a relatively sedentary way of life (for general trends, see e.g., Nordqvist & Kriiska 2015; Oras et al. 2018). The overall homogeneity in dietary identities further allows us to draw the conclusion that other aspects of one's personhood must have influenced the decision-making about proper mortuary practices at Tamula.

### The eastern Baltic perspective: inland fisher-hunter-gatherers

At a regional level the binding food-related factor in the identity of the people buried in these three burials sites is fish. All the individuals at Tamula, Veibri and Zvejnieki were inland fisher-hunter-gatherers, for whom freshwater resources were a substantial source of protein. At Tamula the most common catch might have been pike, perch and pikeperch (see above), in Zvejnieki (similarly to Rīņņukalns) they have been shown to catch cyprinids, pike, perch, eel and zander (Eriksson 2006; Schmölcke et al. 2015). For Veibri we do not have any reference material to argue in favour of a specific fish taxon, but we see that the catch must have had rather similar stable isotope values as at Tamula. However, despite this commonality, the isotopic values of these sites are statistically different from one another (Table 6; Fig. 4). The stable isotope values of Tamula and Veibri display low intra-site variability. Although we lack the local baseline data, the statistically significant inter-site differences between these two allow us to imply that the freshwater fish of these two populations might have derived from different ecosystems (e.g., Lake Tamula vs River Emajõgi). Considering the stable isotope values together with the material culture and zooarchaeological finds (Jaaniits 1957; Paaever 1965; Jaaniits 1984; 1991) further suggests a rather sedentary lifeway of these two forager groups. The stable isotope values from Zvejnieki are more varied (Table 6), representing a combination of terrestrial and freshwater diets and a single individual subsisting primarily on marine resources (Eriksson 2006, 191–192; Meadows et al. 2016; 2018). What could be the reasons behind the differences in the stable isotope values of these three sites?

First, we argue that the differences in the stable isotope values at Tamula, Veibri, and Zvejnieki could be due to the temporal differences in the use of these sites. Zvejnieki was exploited as a burial ground over four millennia, ca 7300–2600 cal BC (Zagorska 2006a, 93; Nilsson Stutz & Larsson 2016), while the maximum time range for Tamula as a burial ground for 1.3 millennia (ca 3900–2600 cal BC) was brief in comparison (Törv 2018, 137ff.), and Veibri represents a single burial event. It is possible that the ecological baseline in the area of Zvejnieki changed

due to the transition from Atlantic to Sub-Boreal chronozone around 3000 cal BC, which engendered a shift from warm and wet conditions towards a more continental climate, bringing about changes in the local flora and fauna (Lõugas 1997; Poska et al. 2004; Kriiska 2009; Reitalu et al. 2013). The longer use time provided greater variability within the Zvejnieki population's stable isotope values and enables to observe changes in dietary preferences, such as the shifts observed during the transition from Mesolithic to Neolithic in Western Europe (e.g., Tauber 1981; Bonsall et al. 1997; Richards et al. 2003; Milner et al. 2004). Meadows et al. (2018, 1004) have shown that there has been a considerable dietary change from the Narva phase to the Pitted Ware phase at Zvejnieki, which is the addition of shellfish to Middle Neolithic diets. This kind of temporal changes are negligible at Tamula and Veibri. However, if we look at these two sites separately and compare their isotope values with the dietary shifts demonstrated at Zvejnieki, we observe similar temporal trends in Estonia. The Veibri results correspond chronologically to the Narva phase and the Tamula data to the Pitted Ware phase at Zvejnieki. Both the  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$  values at Tamula are slightly lower compared to Veibri, which might reflect a trophic-level shift (e.g., the addition of shellfish to Middle Neolithic diets) or is due to local environmental differences. The latter could be resolved in the future with the inclusion of local faunal isotope values.

**TABLE 6.** P-values of Student's t-test for independent samples of all the analysed individuals, while detecting inter-site differences in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ . Bold values indicate statistically significant differences at the  $p < 0.05$  level. The data for Zvejnieki derive from Eriksson 2006

		n samples	MNI*	mean (‰) $\pm$ s.d.** ( $\sigma$ )	Tamula	Veibri	Zvejnieki
$\delta^{13}\text{C}$	Tamula	18	11	$-24.4 \pm 0.6$	–		
	Veibri	12	4	$-23.2 \pm 0.3$	<b>&lt;0.001</b>	–	
	Zvejnieki	37	32	$-22.6 \pm 7.6$	<b>0.025</b>	<b>&lt;0.001</b>	–
$\delta^{15}\text{N}$	Tamula	18	11	$13.5 \pm 0.7$	–		
	Veibri	12	4	$15.1 \pm 0.5$	<b>&lt;0.001</b>	–	
	Zvejnieki	37	32	$12.0 \pm 1.8$	<b>&lt;0.001</b>	<b>&lt;0.001</b>	–

\* minimum number of individuals

\*\* standard deviation

Considering that food as a culturally defined substance is and has been one of the key elements in creating and maintaining social relationships, we propose here that the inter-site differences between Tamula, Veibri and Zvejnieki could equally well reflect the differences in groups using these sites (i.e., burial communities and their identities). Moreover, users determine the further function of these sites. Archaeological material demonstrates that the number of individuals buried at Tamula, Veibri and Zvejnieki varies considerably (Table 1). Tamula and Zvejnieki with many inhumations, the latter being an exceptional site in the European context

with over 300 interments, could be considered more or less proper burial sites, whereas Veibri with its four individuals within a single burial is a solitary grave (Tõrv 2018). Regarding the temporal span, number of interments, varying burial practices (Zagorskis 1987; Nilsson Stutz et al. 2013; Nilsson Stutz & Larsson 2016) and stable isotope ranges at Zvejnieki, we suggest considering it as a formal burial place. This means that the site forming part of a complex of Mesolithic and Neolithic deposits, where both burials and adjacent settlement sites have been found (Zagorska 2006b, 12, 15, fig. 9), was a burial area designated solely for the dead and could thus be regarded as a proper cemetery of long-term use. Unlike Tamula, settlement deposits and burials do not overlap at Zvejnieki (excl. single graves from the Mesolithic settlement layer; Nilsson Stutz et al. 2013, 1018). The significance of Zvejnieki as a designated place for mortuary rituals is also demonstrated by the disturbances of older burials (Nilsson Stutz et al. 2013, 1026–1027; Nilsson Stutz & Larsson 2016). The varying stable isotope ranges of the individuals buried there do not only have to reflect temporal differences, but could further indicate that different communities placed their dead in the Zvejnieki cemetery.

Although we stated that Tamula could be regarded as a more or less proper burial place, it still represents a different pattern than Zvejnieki. At Tamula the burials and settlement layer overlap, which is a characteristic shared with other Estonian and Latvian hunter-gatherer burial places (Tõrv 2018; Macāne & Nordqvist 2021). The daily objects and faunal remains suggest that Tamula was a residential village. It was a place where death was part of natural cycles of life and was handled rapidly, as in other hunter-gatherer burial places around the Baltic Sea (see Nilsson Stutz 2003; Tõrv 2018; Ahola 2019). The low intra-site variability of the dietary stable isotopes suggests that a single community used this site for both living and shorter-term depositing of its dead. This hypothesis is also supported by the recent mitochondrial DNA studies that demonstrate that at least two individuals – Tamula I and XXII – are related to each other through maternal lineages (U5a1d2b; Mittnik et al. 2018). Thus, we may conclude that no sharp distinction was made between life and death at Tamula (see also Jaanits 1961; Jordan 2001; Jonuks 2009; Zvelebil 2010, 52).

Despite the similarities in the range of the isotopic signatures between Tamula and Veibri, the latter represents an example of its own. The low intra-site variability within this sample is restricted by the common temporal background of these four individuals. Their western hunter-gatherer ancestry has been proved by aDNA studies; furthermore, at least individuals II and IV have an identical mitochondrial haplotype (U5b1), being regarded as relatives (Mittnik et al. 2018). The archaeoanthatological analysis demonstrated that these four individuals were buried simultaneously during a single event. Due to the unusual location of this burial – apart from a simultaneous settlement (Lõhmus et al. 2011) – it has been interpreted as a solitary grave, which was constructed because of the sudden death of these people while moving about in the landscape (Tõrv 2018).

The variations observed in the food identities of the individuals buried at Tamula, Veibri and Zvejnieki imply that different groups were using these burial sites. The

homogeneity of stable isotope values among Tamula and Veibri groups, together with the inter-site variability, aDNA results, temporal span of the sites, commonality of mortuary practices, allows us to propose that these sites were used by a residential forager group and a single family, respectively. Zvejnieki, on the other hand, must have been used by a much larger group of inland fisher-hunter-gatherers representing several residential groups. These results suggest that a threefold pattern with respect to hunter-gatherer burial places existed in the eastern Baltic region. We argue that the commonly accepted concept of the hunter-gatherer world view, which does not make a sharp distinction between daily and ritual life (incl. life and death), and the fact that death must have been handled rapidly (Nilsson Stutz et al. 2013; Nilsson Stutz & Larsson 2016; Tõrv 2018) allowed the eastern Baltic foragers to bury their deceased in different locales of their landscape. The high intra-site variability observed at Zvejnieki, together with its long temporal duration and no overlap with a simultaneous occupation layer, implies that different forager groups might have interred their dead there. Thus, it seems that the long-lived site fulfils the requirements of a proper cemetery. The low intra-site variability, together with the limited changes of individual diets, indicates that the mortuary population at Tamula was homogeneous and relatively sedentary. The same can be said about Veibri. The archaeological material, together with the stable isotope data from Tamula, further suggest that the site was probably a quotidian settlement (i.e., residential village), where life and death were not strictly separated from one another. Therefore, everyday activities carried out in villages such as Tamula also included mortuary rituals that were held in honour of the dead members of these communities. The location of the Veibri quadruple grave suggests that also need-based solitary burials were established next to seasonal migration paths.

## Conclusions

We hope to have demonstrated that stable isotope analysis is an excellent tool for reconstructing past food identities. With this we have added a mundane identity marker to the row of material culture elements to distinguish forager groups from one another. By analysing the stable isotope values of the Tamula, Veibri and Zvejnieki burial sites within a cultural context of the region, it became clear that without a solid analysis one cannot label all the sites with the common denominator ‘cemetery’. Thus, when discussing the function of the sites of hunter-gatherer burials, these group affiliations (here: food-based) could be used to make a more unambiguous and meaningful distinction between them. To sum it up, in the context of eastern Baltic, different kinds of sites were associated with death and mortuary rituals within hunter-gatherer societies: proper cemeteries, residential villages and need-based solitary graves were used for burying the dead.

## ACKNOWLEDGEMENTS

This research was undertaken within the framework of the strategic research theme ‘Man and Society’ of the Centre for Baltic and Scandinavian Archaeology, Germany, and supported by the European Union through the European Regional Development Fund (Center of Excellence of Cultural Theory, CECT), Estonian Research Council personal research grant PSG492, the European Union HORIZON Coordination and Support Actions under grant agreement No. 101079396, Innovate UK grant No. 10063975 and the Estonian Ministry of Education and Research through the national programme ‘Estonian Language and Culture in the Digital Age 2019–2027’ (EKKD12). We are thankful to Jan Storå who determined the animal bones from Tamula. We are grateful to the anonymous reviewer and Fredrik Hallgren for their constructive critique that helped to improve the quality of the paper. We would also like to extend our gratitude to Dr Ester Oras for constructive criticism, Dr Kenneth Ritchie and Dr Ian Scharlotta for language revision of the first version of this article, and Silvia-Kristiin Kask for editing the references and the Estonian summary. The publication costs of this article were partially covered by the Estonian Academy of Sciences.

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## *Koju maetud? Tamula kalmistu küttide-korilaste kogukond stabiilsete isotoopide analüüsi valguses*

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### RESÜMEE

Euroopa kiviaegsete küttide-korilaste matmispaikade funktsiooni ja tähenduse üle on arutletud aastakümneid. Seni puudub uurijatel üksmeel arheoloogiliselt nähtavate matuserituaalide tekkepõhjuste ja motiivide suhtes. Valdavalt arvatakse, et matused muutusid kultuuris nähtavaks majandusliku ja demograafilise surve tulemusel, mis tingis rühma territooriumi markeerimise esivanemate matusega. Samuti on arvatud, et matuste ilmumine on seotud küttide-korilaste maailmavaatega, kus eri maailmad markeeriti maastikul materiaalse kultuuri elementidega: matused tähistasid elavate ja surnute valduste piire.

Funktsionaalselt on kiviaegseid inimsäilmeid sisaldavad paigad jagatud kolmeks: 1) ühe kogukonna kalmistud, 2) asulad, kus muu elutegevuse kõrval korraldati ka

matuserituaale ning 3) mitme rühma kogunemiskohad, kus teiste rituaalide seas toimusid ka matused. Näeme, et kõik need tõlgendused on ühel või teisel moel seotud matjate ja maetutega (kogukond). Valdavalt on kogukonna määratlemisel kasutatud materiaalse kultuuri elemente nagu surnute kehaasend, matmisviis ja hauapanused. Selles uuringus pakume maetute kogukonna piiritlemiseks uue meediumi, milleks on toit. Ühtlasi lähtume ideest, et oled see, mida sööd. Toit on üks kultuuri element, mis aitab luua ja säilitada sotsiaalseid sidemeid, loob rühmas ühistunde ning võimaldab eristada omasid teistest.

Arutleme, keda maeti ja milliseid matmispaiku võisid Baltikumi kütid-korilased rajada. Selleks rekonstrueerisime stabiilse süsiniku ja lämmastiku isotoopide analüüsi abil Tamulas (Kagu-Eesti) paikneva kalmistu kogukonna identiteedid ning määratlesime rühma kuuluvuse. 4.–3. aastatuhande keskpaigani e.m.a kasutusel olnud Tamula (joonis 1 ja 2) on oma 25 matusega suurim matmispaik Eestis (MNI = 31) (tabel 1). Lisaks matustele on samas ka tüse kultuurkiht, mis viitab igapäevaeluga seotud tegevustele. Paiga tähenduse ja funktsiooni osas puudub üksmeel: seda on peetud aastaringseks külaks, aga ka eri gruppide kogunemiskohaks. Tamulale tausta loomiseks kõrvutasime saadud isotoopväärtusi ajalisel ja ruumiliselt lähedaste Veibri ja Zvejnieki matmispaikadega (tabel 1).

Tamulasse maetud indiviididelt võeti valdavalt üks proov; võimalusel rekonstrueeriti indiviidi toitumisalane elulugu, määrates  $\delta^{13}\text{C}$  ja  $\delta^{15}\text{N}$  väärtused ka purihammade dentiinist, mis kajastavad lapsepõlve toitumist (tabel 2). Analüüsid tehti kolmes eri laboris ning rakendatud meetodid on esitatud tabelis 3. Vaid 1/3 proovidest õnnestus kaasata edasisse analüüsi ( $n_{\text{proov}} = 19$ ,  $n_{\text{indiviid}} = 11$ ).  $\delta^{15}\text{N}$  (12,2‰ kuni 14,5‰) ja  $\delta^{13}\text{C}$  väärtused (–25,5‰ kuni –23,1‰; tabel 4; joonis 3) näitavad, et Tamula kogukonnal oli homogeenne toitumine, mille oluliseks osaks olid mageveekalad. Kalade tähtsust kinnitavad ka zooarheoloogiline andmestik ja arheoloogiline materjal (joonis 5). Indiviidide III, VIII ja XXII toitumine nende elu ajal ei muutunud. Stabiilsete isotoopide väärtused ei erinenud sooliselt ega indiviididel, kellele said osaks erinevad matmispraktikad (tabel 5), küll aga täheldati statistilist erinevust vanusegruppide vahel: täiskasvanud sõid magevee kalu rohkem kui lapsed.

Veibris oli kollageen oluliselt paremini säilinud ja kõik proovid sai kaasata uurimusse. Sarnaselt Tamulaga oli ka nende nelja indiviidi toitumine homogeenne:  $\delta^{13}\text{C}$  väärtused jäävad vahemikku –23,5‰ kuni –22,7‰ ja  $\delta^{15}\text{N}$  väärtused vahemikku 14,4‰ kuni 16,1‰ (tabel 4). Lisaks näeme, et ühe indiviidi elu jooksul on toitumine püsinud ühetaolisena, mis viitab Tamulaga sarnaselt võrdlemisi paiksele eluviisile.

Kõrvutades saadud tulemusi Zvejnieki materjaliga näeme, et kõik kolm matmispaika kuulusid sisemaa kalastajatele-küttidele-korilastele (joonis 4). Kõigi nende toidulaual olid olulisel kohal magevee kalad. Sellest hoolimata on kolme paiga isotoopväärtused teineteisest statistiliselt erinevad (tabel 6). Nii Tamula kui ka Veibri isotoopväärtused varieeruvad minimaalselt, Zvejniekis on need väärtused oluliselt mitmekesisemad. Isotoopväärtuste variatiivsuse taga võivad olla kolme paiga ajalised piirid: 1) Zvejnieki väärtused kajastavad u nelja aastatuhande pikkust perioodi, 2) Tamula veidi enama kui ühe aastatuhande oma ning 3) Veibri puhul

räägime ühest inim põlvest (ühest sündmusest). Vaadates toitu kui üht kultuurilist võtmelementi sotsiaalsete suhete loomisel ja säilitamisel, pakume, et isotoopväärtuste erinevused tulenevad hoopis neid kasutanud inimrühmade erinevustest. Nende kolme matmispaiga kasutajad defineerivad üksiti ka paiga funktsiooni. Zvejnieki võiks üle 300 matuse, pika kasutusaja, varieeruvate isotoopväärtuste ning iseloomuliku materiaalse kultuuriga olla kalmistu selle traditsioonilises mõttes. See oli paik, kuhu oma surnuid asetasi mitme erineva kogukonna liikmed. Tamula oma võrdlemisi lühikese kasutusaja, samas igapäevaelu peegeldava kultuurikihi ning homogeensete isotoopväärtustega, on aga sootuks teistsuguse funktsiooniga paik. Tamula on ühe kütide-korilaste grupi elupaik, kus teiste igapäevaste tegevuste hulgas toimetati ka matuseid. Veibri on hooajalise migratsiooniraja lähedusse tehtud üksikmatus. Nii Tamula kui ka Veibri puhul on vana DNA uuringud muuhulgas näidanud, et vähemalt osa neisse matmispaikadesse maetutest on omavahel emaliinis sugulased.

Väidame, et toiduidentiteet on samavõrra oluline rühmakuuluvuse näitaja kui mis iganes teine materiaalse kultuuri element. Kolme eriilmelise matmiskoha stabiilsete isotoopide analüüs näitas, et neid paiku kasutasid erinevad sisemaa kütid-korilased ning sellest tulenevalt erinesid ka nende paikade tähendused ja funktsioonid. Baltikumi kiviaja kütid-korilased kasutasid oma lähedaste sängitamiseks nii kalmistuid, elupaiku kui ka rändeteede äärde jäävaid kohti, kuid oluline on silmas pidada, et surnuga tegeletaks viivitamatult.