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 archaeothanatological 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 ($\delta^{13}C$) and nitrogen isotope ($\delta^{15}N$) 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; Tõrv 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 (Põltsam-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; Becuţ & 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; Aguraiuja-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 m² 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 water-front (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).

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 over-lying or adjacent occupation layer could be associated with it (Lõhmus et al. 2011).

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

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

* 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 $\delta^{13}$C and $\delta^{15}$N values of collagen provide dietary information, primarily indicating protein intake (Ambrose & Norr 1993; Jim et al. 2006). The $\delta^{13}$C value distinguishes between marine and terrestrial C$_3$ plant producers and consumers (as there were no C$_4$ plants in Stone Age Northern Europe). The $\delta^{15}$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

<table>
<thead>
<tr>
<th>Bone element</th>
<th>Time of formation</th>
<th>Age category</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>4 ± 1 year</td>
<td>Young child</td>
</tr>
<tr>
<td>M2</td>
<td>8.5 ± 1 year</td>
<td>Older child</td>
</tr>
<tr>
<td>M3</td>
<td>14 ± 1 year</td>
<td>Adolescent</td>
</tr>
</tbody>
</table>

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 ±0.2‰.

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

<table>
<thead>
<tr>
<th>Pre-treatment</th>
<th>Laboratory</th>
<th>Archaeological Research Laboratory, Stockholm University</th>
<th>Centre for Baltic and Scandinavian Archaeology (ZBSA)</th>
<th>14CHRONO Centre, Queen’s University Belfast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample material</td>
<td>Bone powder</td>
<td>Bone powder</td>
<td>Crushed bone</td>
<td></td>
</tr>
<tr>
<td>Demineralization</td>
<td>0.25 M HCl for ca 48 h</td>
<td>0.5 M HCl for ca 24 h</td>
<td>2% HCl and 0.1 M NaOH for ca 19 h</td>
<td></td>
</tr>
<tr>
<td>Gelatinization</td>
<td>0.01 M HCl, at 58 °C for ca 16 h</td>
<td>0.02 M HCl, at 58–70 °C for ca 16 h</td>
<td>pH2–pH3 solution at 70 °C for 15 h</td>
<td></td>
</tr>
<tr>
<td>Ultrafiltration</td>
<td>Yes (30kD ultrafilter)</td>
<td>No</td>
<td>Yes (&gt;30kD ultrafilter)</td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td>Brown et al. 1988</td>
<td>Tõrv and Meadows 2015</td>
<td>Reimer et al. 2015</td>
<td></td>
</tr>
<tr>
<td>Analysis</td>
<td>EA-IRMS analysis</td>
<td>Stable Isotope Laboratory (SIL), Department of Geological Sciences, Stockholm University</td>
<td>School of Life Sciences, University of Bradford</td>
<td>14CHRONO Centre, Queen’s University Belfast</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>Carlo Erba NC2500 elemental analyser, Finnigan MAT Delta+ isotope ratio mass spectrometer</td>
<td>Thermo Flash 1112 elemental analyser, Thermo Delta plus XL mass spectrometer</td>
<td>Thermo Delta V elemental analyser - isotope ratio mass spectrometer</td>
<td></td>
</tr>
<tr>
<td>Measurement error (δ¹⁵N and δ¹³C)</td>
<td>±0.15‰</td>
<td>±0.2‰</td>
<td>±0.1‰</td>
<td></td>
</tr>
<tr>
<td>Laboratory codes of samples</td>
<td>TAM/VEI</td>
<td>KIA</td>
<td>UBA</td>
<td></td>
</tr>
<tr>
<td>No. of samples measured at Tamula</td>
<td>13</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>δ¹³C Mean ± s.d.*</td>
<td>–24.1 ± 0.5</td>
<td>–24.4</td>
<td>–25.1 ± 0.5</td>
<td></td>
</tr>
<tr>
<td>δ¹⁵N Mean ± s.d.</td>
<td>13.3 ± 0.7</td>
<td>13.5</td>
<td>13.8 ± 0.7</td>
<td></td>
</tr>
<tr>
<td>No. of samples measured at Veibri</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>δ¹³C Mean ± s.d.</td>
<td>–23.3 ± 0.3</td>
<td>–22.9</td>
<td>–23.3</td>
<td></td>
</tr>
<tr>
<td>δ¹⁵N Mean ± s.d.</td>
<td>15.1 ± 0.6</td>
<td>15.8</td>
<td>15.0</td>
<td></td>
</tr>
</tbody>
</table>

* 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 $\delta^{13}C$ and $\delta^{15}N$ 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 $\delta^{13}C$ and 0.4‰ for $\delta^{15}N$ (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 Riņņukalns in the Lake Burtnieks region of Latvia (Eriksson 2006; Bērziņš et al. 2014; Schmölecke et al. 2015; Meadows et al. 2018; Brinker et al.
Buried at home? Stable isotope analysis of foragers at Tamula (Antanaitis-Jacobs et al. 2009; Heron et al. 2015; Piliciusaks 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

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

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.

Continued on the next page
The isotope values from Tamula suggest an isotopically homogeneous diet, with $\delta^{13}$C ranging from $-25.5‰$ to $-23.1‰$ and $\delta^{15}$N from $12.2‰$ to $14.5‰$. Mean and standard deviations of the human values are $-24.4 \pm 0.6‰$ for $\delta^{13}$C and $13.5 \pm 0.7‰$ for $\delta^{15}$N. The lowest $\delta^{13}$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 $\delta^{15}$N value. The other samples showing elevated $\delta^{15}$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 XVII (Fig. 3); in all three cases, the $\delta^{15}$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).
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 δ¹³C ranging from −23.5‰ to −22.7‰ and δ¹⁵N from 14.4‰ to 16.1‰. Mean and standard deviations of the human data are −23.2 ± 0.3‰ for δ¹³C and 15.1 ± 0.5‰ for δ¹⁵N. The elevated δ¹⁵N values among these individuals are most probably an outcome of a nursing effect, as these derive from the dentine samples. The lowest δ¹⁵N 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 0.2–0.5‰ for both δ¹³C and δ¹⁵N, 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 δ¹³C and high δ¹⁵N values demonstrate (Fig. 4), contributing to the inhabitants’ inland identities. The high δ¹⁵N 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 (Jaanits 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
Mari Tõrv and Gunilla Eriksson

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 (Eriksson 2006). 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 rivers 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

**FIG. 4.** Human \(\delta^{13}C\) and \(\delta^{15}N\) 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 \(\delta^{13}C\) and +3‰ for \(\delta^{15}N\), based on faunal data from Tamula (Estonia), Latvia (Eriksson 2006; Bērziņš et al. 2014; Schmöelcke 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://datadoi.ee/handle/33/586.
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 δ$^{13}$C values of adults (adult bone, $-24.8 \pm 0.4\%$o, mean ± s.d., n = 7) and non-adults (dentine and non-adult bone, $-24.1 \pm 0.6\%$o, 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 δ$^{15}$N values are not statistically significant; however, the larger standard deviation within the non-adult group could be due to both tissue differences (dentine

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 Võhandu; Guiry 2019).

**TABLE 5.** P-values of Student’s t-test for independent samples, while detecting differences in δ¹³C and δ¹⁵N 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

<table>
<thead>
<tr>
<th>Compared characteristics</th>
<th>n samples</th>
<th>mean (‰) ± s.d.* (σ)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>δ¹³C</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>-24.7 ± 0.4</td>
<td>0.755</td>
</tr>
<tr>
<td>Male</td>
<td>2</td>
<td>-24.8 ± 0.3</td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td>7</td>
<td>-24.8 ± 0.4</td>
<td><strong>0.018</strong></td>
</tr>
<tr>
<td>Non-adult</td>
<td>11</td>
<td>-24.1 ± 0.6</td>
<td></td>
</tr>
<tr>
<td>Burials with additional structures</td>
<td>8</td>
<td>-24.6 ± 0.7</td>
<td>0.723</td>
</tr>
<tr>
<td>Burials without additional structures</td>
<td>3</td>
<td>-24.7 ± 0.4</td>
<td></td>
</tr>
<tr>
<td>Initial body position: supine</td>
<td>7</td>
<td>-24.4 ± 0.7</td>
<td>0.211</td>
</tr>
<tr>
<td>Initial body position: flexed</td>
<td>3</td>
<td>-25.0 ± 0.3</td>
<td></td>
</tr>
<tr>
<td>Burials with grave goods</td>
<td>7</td>
<td>-24.4 ± 0.7</td>
<td>0.249</td>
</tr>
<tr>
<td>Burials without grave goods</td>
<td>4</td>
<td>-25.0 ± 0.4</td>
<td></td>
</tr>
<tr>
<td><strong>δ¹⁵N</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>13.3 ± 0.2</td>
<td>0.919</td>
</tr>
<tr>
<td>Male</td>
<td>2</td>
<td>13.4 ± 0.7</td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td>7</td>
<td>13.5 ± 0.5</td>
<td>0.956</td>
</tr>
<tr>
<td>Non-adult</td>
<td>11</td>
<td>13.5 ± 0.8</td>
<td></td>
</tr>
<tr>
<td>Burials with additional structures</td>
<td>8</td>
<td>13.4 ± 0.7</td>
<td>0.342</td>
</tr>
<tr>
<td>Burials without additional structures</td>
<td>3</td>
<td>13.9 ± 0.3</td>
<td></td>
</tr>
<tr>
<td>Initial body position: supine</td>
<td>7</td>
<td>13.6 ± 0.8</td>
<td>0.591</td>
</tr>
<tr>
<td>Initial body position: flexed</td>
<td>3</td>
<td>13.3 ± 0.2</td>
<td></td>
</tr>
<tr>
<td>Burials with grave goods</td>
<td>7</td>
<td>13.5 ± 0.8</td>
<td>0.751</td>
</tr>
<tr>
<td>Burials without grave goods</td>
<td>4</td>
<td>13.7 ± 0.5</td>
<td></td>
</tr>
</tbody>
</table>

* 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 $\delta^{13}$C and $\delta^{15}$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 Riņņukalns) 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 (Jaanits 1957; Paaver 1965; Jaanits 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 (Tõrv 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 $\delta^{15}$N and $\delta^{13}$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 $\delta^{13}$C and $\delta^{15}$N. Bold values indicate statistically significant differences at the $p < 0.05$ level. The data for Zvejnieki derive from Eriksson 2006

<table>
<thead>
<tr>
<th></th>
<th>n samples</th>
<th>MNI*</th>
<th>mean (%) ± s.d.** (σ)</th>
<th>Tamula</th>
<th>Veibri</th>
<th>Zvejnieki</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$\delta^{13}$C</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamula</td>
<td>18</td>
<td>11</td>
<td>24.4 ± 0.6</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Veibri</td>
<td>12</td>
<td>4</td>
<td>23.2 ± 0.3</td>
<td>&lt;0.001</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Zvejnieki</td>
<td>37</td>
<td>32</td>
<td>22.6 ± 7.6</td>
<td>0.025</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td><strong>$\delta^{15}$N</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamula</td>
<td>18</td>
<td>11</td>
<td>13.5 ± 0.7</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Veibri</td>
<td>12</td>
<td>4</td>
<td>15.1 ± 0.5</td>
<td>&lt;0.001</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Zvejnieki</td>
<td>37</td>
<td>32</td>
<td>12.0 ± 1.8</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>–</td>
</tr>
</tbody>
</table>

* 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 archaeothanatological 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.
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Buried at home? Stable isotope analysis of foragers at Tamula


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Koju maetud? Tamula kalmistu küttide-korilaste kogukond stabiilsete isotoopide analüüsü valguses

Mari Tõrv ja Gunilla Eriksson

RESÜMEE


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


Mari Tõrv and Gunilla Eriksson
