



Locals or Migrants? Isotope Analysis of Late Bronze – Pre-Roman Iron Age Human Cremations in Ēgliškiai Population

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ARTICLE INFO

Article history:

Received: 25th September 2025

Accepted: 24th March 2026

DOI: <http://dx.doi.org/10.24916/iansa.2026.2.3>

Key words:

East Baltic Region
Western Baltic Barrow culture
strontium isotope analysis (⁸⁷Sr/⁸⁶Sr)
prehistoric mobility
Late Bronze Age
Pre-Roman Iron Age

ABSTRACT

Archaeological data from the Bronze Age and Pre-Roman Iron Age reveal significant cultural changes in the East Baltic Region, often linked to influences from other parts of Europe. Whether immigration played a major role in these transformations, remains under debate. This paper presents the first strontium isotope measurements (⁸⁷Sr/⁸⁶Sr) from 25 human samples (cremations) recovered at the Ēgliškiai barrow cemetery in western Lithuania. The site belongs to the Western Baltic Barrow culture and dates to the Late Bronze – Pre-Roman Iron Age (circa 800–50 BC). Artefacts typology and distribution at Ēgliškiai cemetery differ from other barrow sites in the East Baltic Region, suggesting long distance trade or at least some of the buried individuals being of non-local origin. The aim of this research is to determine whether individuals buried in mounds represent the local population or migrants, using bioarchaeological evidence. To establish an environmental baseline, we created a strontium isoscape based on 51 modern plant samples collected at 17 sites within a 25 km radius around Ēgliškiai. This approach enables not only the assessment of the locality of individuals, but also it brings new insights into the landscape use and possible settlement patterns of the Western Baltic Barrow culture. Strontium isotope ratios (⁸⁷Sr/⁸⁶Sr) and concentrations ([Sr]) from cremated individuals show variations between barrow mounds, indicating differences in landscape use between the Late Bronze Age and Pre-Roman Iron Age groups at Ēgliškiai.

1. Introduction

The Bronze Age in Europe witnessed significant social and economic changes. The onset of horse domestication (Librado *et al.*, 2024) and the demand for metal ore prompted long-distance human mobility (Kristiansen and Larsson, 2006). In addition, severe droughts caused by 4.2 and 3.2 ka events might have prompted human migration, increasingly complex interactions, and new socio-environmental processes (Weiss *et al.*, 1993; Weinelt *et al.*, 2021). The Bronze Age in Europe is also characterised by the widespread phenomenon of transitioning from inhumation to cremation burial practices, and the East Baltic Region is no exception (Sørensen and Rebay-Salisbury, 2023). The Early Metal Period in this region is marked not only by significant changes in burial customs, but also by the beginning of agriculture, which

occurred thousands of years later than in Central Europe (Motuzaitė Matuzevičiūtė *et al.*, 2018). Indeed, the earliest evidence of crop cultivation found in the area dates back to 1400 BC (Grikpėdis and Motuzaitė Matuzevičiūtė, 2018). However, the issues of how and why agriculture arrived so late and whether this was linked with new human migration remains unclear due to the absence of inhumation burials. The cremation custom emerged in the East Baltic Region around 1700–1500 BC, but it spread and became the main burial tradition only in the Late Bronze Age (Muradian, 2024). Moreover, at a similar time, barrows became the predominant place for cremated human remains to be buried in certain areas of this region. These changes could have been determined by various external influences and the internal development of communities. In Lithuania, strontium isotope (⁸⁷Sr/⁸⁶Sr) studies have mainly been carried out on individuals from the Stone Age and the 1st millennium AD, while only four individuals (only inhumations) from the Late

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Bronze Age have been analysed so far (Piličiauskas *et al.*, 2021a; Piličiauskienė *et al.*, 2022; Kurila and Piličiauskienė, 2025; Kurila *et al.*, 2025). The majority of Bronze Age and Pre-Roman Iron Age burial sites in Lithuania contain only cremations and until recently had lesser possibilities in contextualising them due to the limited number of reliable methods available.

Isotopic and genetic research conducted from just a handful of non-cremated individuals recovered from the Late Bronze Age site of Turlojiškė in southern Lithuania suggests that two individuals may be of non-local origin, while data from the other two individuals overlap with bioavailable Sr values in the surrounding area (Piličiauskas *et al.*, 2022). Moreover, geneticists have identified that the individuals from Turlojiškė likely represent the inflow of a new population from Central Europe at the end of the

Bronze Age, during the middle Bronze Age of the Trzcinięc culture (Chyleński *et al.*, 2023). The human remains discovered in Turlojiškė (some with indications of trauma; Jankauskas, 2012) were found disarticulated and scattered in a bog. This wetland context implies special status, as this is an atypical feature of burial practices in the East Baltic Region (Merkevičius, 2012; Motuzaitė Matuzevičiūtė, 2025). This site demonstrates the complexity of Bronze Age populations in this region and raises important questions about whether comparable patterns can be observed at other sites from this period.

However, no studies on human mobility have yet been conducted on Bronze Age or Pre-Roman Iron Age cremated individuals from Lithuania. In particular, the western part of this country contains the largest amount of human remains compared to other sites in the eastern part of this region.

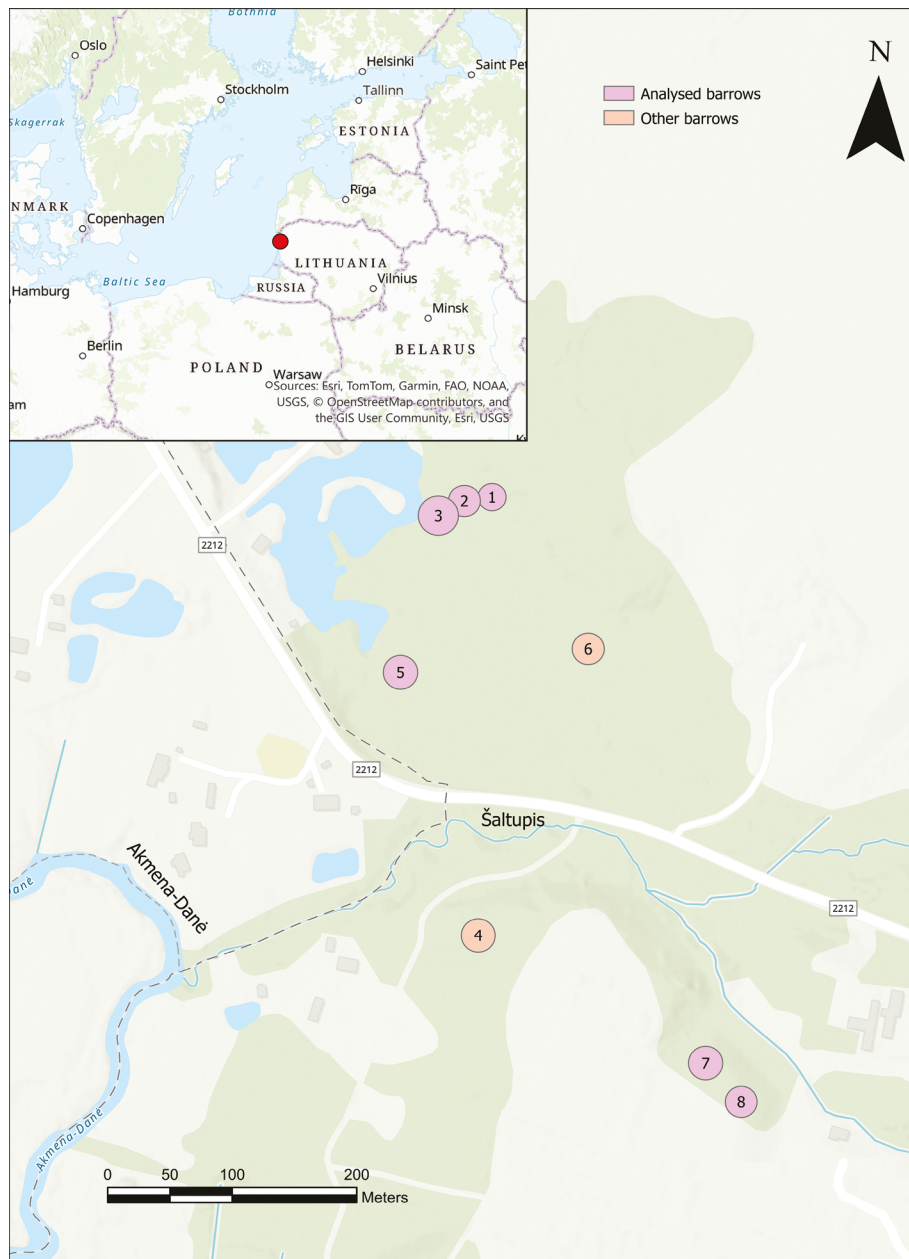


Figure 1. The location and situation plan of the Ēglišķiai barrow site.

Thanks to new methodologies that have been developed for measuring strontium isotopes in cremated materials (Harvig *et al.*, 2014; Snoeck *et al.*, 2015; Snoeck *et al.*, 2022), new opportunities have emerged for exploring wider human populations of the Bronze Age in the East Baltic region. Strontium isotope ($^{87}\text{Sr}/^{86}\text{Sr}$) analyses make it possible to investigate mobility patterns and landscape use within prehistoric communities. This is particularly important for the analysis of periods in which cremation was the dominant burial practice. The additional measurement of strontium concentrations ($[\text{Sr}]$) provides further information on geographical origin and diet (Montgomery, 2010; Dalle *et al.*, 2022).

The emergence of cremation and barrows in the Bronze Age raises the question of whether this new form of burial practice spread through large-scale migration or the diffusion of ideas. Ancient DNA studies suggest that the Bronze Age was characterised by large population migrations (Allentoft *et al.*, 2015). In Denmark, strontium isotope analyses have been used to assess whether cremated individuals were local or non-local (Reiter *et al.*, 2021), and further evidence shows increased human mobility to diverse and distant regions from the Early Bronze Age onwards (Frei *et al.*, 2019).

The Ėgliškiai barrow cemetery represents the largest accumulation of burials dated to the Late Bronze – Pre-Roman Iron Age period found in Lithuania. In addition, it is also one of the most intensively investigated archaeological sites. Due to the fragmentary nature of the cremated remains, previous researchers have traditionally focused on the artefacts of the Ėgliškiai site (Grigalavičienė, 1979;

Merkevičius, 2011). This long history of archaeological excavation has allowed for the accumulation of large artefact collections and the drawing of certain parallels with regions of Europe, thus inferring possible long-distance mobility, migration, or trade. However, such questions cannot be resolved from artefacts alone. The available evidence indicates that during the second part of the Late Bronze Age, cremation was not merely spreading but had become the dominant burial custom, with the Ėgliškiai site situated within this chronological horizon. The aim of this article is thus to provide an interpretation, based on the results of $^{87}\text{Sr}/^{86}\text{Sr}$ and $[\text{Sr}]$ research, on the possible mobility patterns and landscape use of the individuals buried in Ėgliškiai, which would help to analyse the question of the spread of the cremation custom in this region along with explaining population movement. In addition, this article seeks to establish whether the groups buried in different barrows represent a single local community, given the structural variations observed in Western Baltic Barrow culture despite the shared chronological framework.

2. The Study Region and the Ėgliškiai Site

The Ėgliškiai barrow site is located in the Klaipėda district of western Lithuania, near the confluence of the Akmena-Danė and Šaltupis rivers (Figure 1). Ėgliškiai represents one of the largest Late Bronze Age – Pre-Roman Iron Age cemeteries in western Lithuania belonging to the Western Baltic Barrow culture. This culture initially represented a northern branch



Figure 2. Artefacts found in Ėgliškiai Barrows 2 and 3. A: Serial bracelet found in Barrow 2, burial 1; B: Pin with a ring-shaped head found in Barrow 2, burial 1; C: A glass bead from Ėgliškiai Barrow 3; D: Decorative pin with a spiral head and a conical central part found in Barrow 3; E: Neck ring with a hoof-shaped end found in Barrow 3, burial 5. F: Urn from Ėgliškiai Barrow 3. National museum of Lithuania (AR 636:2, 3, 25, 45, 50, 57).

of the cremation custom that began with the Bronze Age urnfield culture. The history of archaeological excavations at Ēgliškiai begins at end of the 19th century (Bezzenberger, 1900; Götze, 1914; Grigalavičienė, 1979; Jablonskis, 1982; Kanarskas, 2006). During this period, detailed data was collected on the burial practices and changes in the Late Bronze Age and Pre-Roman Iron Age.

In Ēgliškiai, a total of eight barrows with cremations and inhumations are known. Cremations represent the majority (n=37) of the burials found in this barrow site, and only a small number of inhumations (n=11) were found. This article analyses ⁸⁷Sr/⁸⁶Sr and [Sr] only from the cremated material of Barrows 1, 2, 3, 5, 7, and 8, as the inhumated bones are poorly preserved. Barrows 4 and 6 are not included in the analysis as both were excavated at the very end of the 19th century, and the bone material is not available (Bezzenberger, 1900; Götze, 1914).

Based on the construction of barrows and the burials contained within them, they can be divided into three main groups: 1) barrows with several burials, including both cremations and inhumations (Barrows 1, 2, and 3); 2) barrows containing only several cremation burials (Barrows 4, 5, and 6); and 3) barrows with single cremation graves (Barrows 7 and 8).

Barrows 1, 2, and 3 were located on the right bank of the Šaltupis River, in the north-western part of the cemetery. The barrows were arranged side by side and their mounds were connected. All these barrows featured stone circles and stone structures in the central area. Barrow 3 contained a total of 22 burials, 13 of which were cremations and 9 inhumations. Barrow 2 was located between Barrows 3 and 1 and a total of 8 cremations and 2 inhumations were found within. Barrow 1 had been partly disturbed, and only three cremations were found in its central area. Some cremations were found in urns, others in pits, and they were sometimes surrounded by stones. The grave goods of the inhumations found in Barrows 2 and 3 consisted of ornaments: a decorative pin with a spiral head and a conical central part, a pin with a ring-shaped head, a serial bracelet, a neck ring with a hoof-shaped end, *etc.* (Figures 2 and 3).

Barrow 5 was located around 100 m south of Barrows 1–3. The mound was surrounded by a single circle of stones 14–15 m in diameter (Figure 4). A gravel pit had been dug on its edge, destroying the south-eastern part of the mound. In total, seven cremations in urns were found, of which only one grave, cremation 5, had a single grave good: a fragment of a bronze ornament, probably a bracelet.

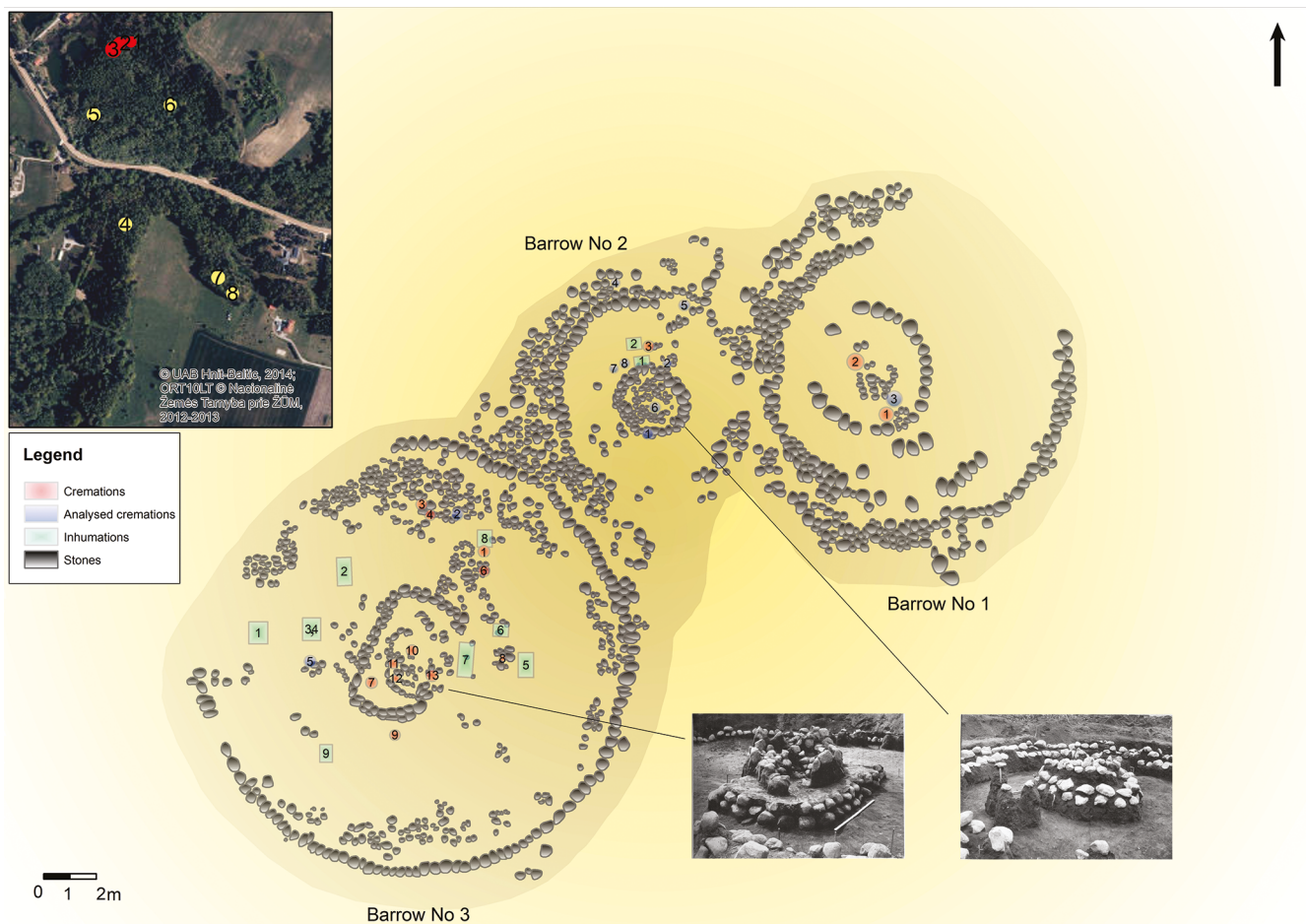


Figure 3. Ēgliškiai Barrows (1–3) with several cremation and inhumation graves. The drawing is based on data from archaeological research reports (Danilaitė 1970; Grigalavičienė 1974; 1975). Only those graves that appeared in the drawings within the archaeological finding reports are marked; other graves, including some analysed in this paper, are not represented.

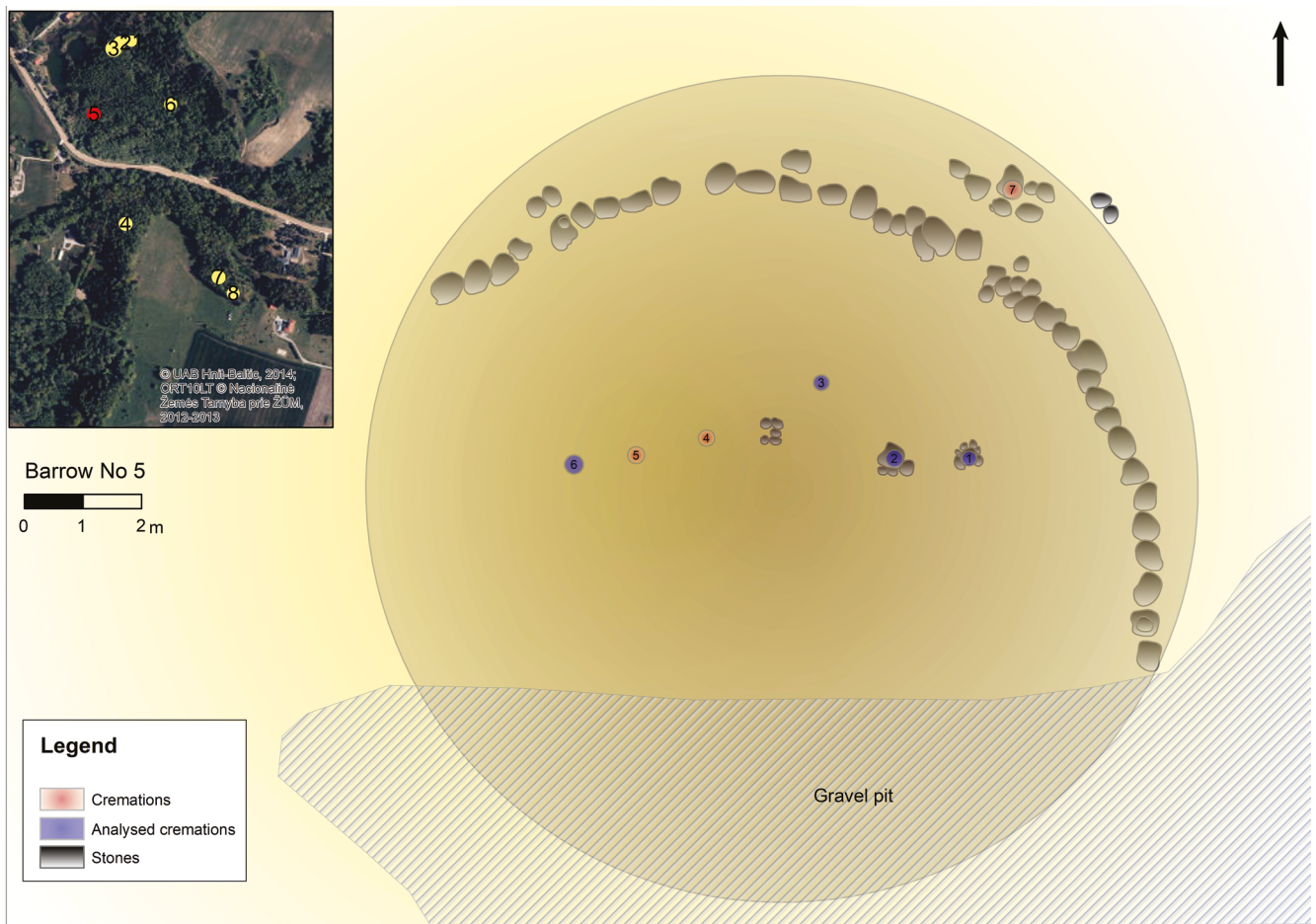


Figure 4. Ēgliškiai Barrow 5 containing several cremation burials. The drawing is based on data from archaeological finding report (Grigalavičienė 1975).

Barrow 7 was located on the left bank of the Šaltupis River. It had a low mound of sand and was surrounded by three stone circles (Figure 5). The inner area of the central circle was paved with small stones. Only one cremation burial without any grave goods was found in the pit in the central part of the barrow.

Barrow 8 was situated close to Barrow 7. The height of the mound was also lower than the barrows in the northern side of this cemetery (Figure 5). The mound was surrounded by two stone circles. As in Barrow 7, only one cremation was found in the central part of the mound between the stones, and this was accompanied by a few ceramic sherds.

The Ēgliškiai barrow cemetery demonstrates cultural links with various parts of Europe. The oldest glass bead in Lithuania, dating to 800–400 BC, was found in Barrow 3, where it had become melted into and encrusted with bone as part of a cremation (Figure 2C). Infrared (IR) spectral analysis confirmed that it was made of clear blue glass (silicates, cobalt sulphate), with remnants of organic material (bones) on its surface. In Lithuania, only two other sites have yielded glass beads from the Late Bronze or Pre-Roman Iron Age. One comes from the Mijaugonys settlement in the south-eastern part of the country, within an archaeological layer radiocarbon-dated to the 8th–4th centuries BC (Piličiauskas *et al.*, 2021b), and the other

from Bajorai (eastern Lithuania), where glass beads were associated with an inhumation radiocarbon-dated to the 6th–4th centuries BC (Vaitkevičius, 2012). The presence of glass suggests connections with the Lusatian culture further south, where glass beads occur in significantly greater numbers during this period (Purowski, 2012, p.555). However, glass beads found in the territory of the Lusatian culture were also imported from the Alpine region or even from the northern coast of Black Sea (Purowski *et al.*, 2012, pp.144–166), leaving open the question of how such rare artefacts reached the East Baltic Region.

Moreover, an urn typical of the Sambia Peninsula was found in Barrow 3, distinguished by its black, smooth, and ornamented surface (Figure 2F). This vessel belongs to the Burnished Pottery class, which is rare in archaeological contexts of this period. Notably, no comparable urns in shape or size have been discovered in Lithuania, whereas parallels are known from the Sambia Peninsula, with some urns closely resembling the example from Ēgliškiai (Hoffmann, 2000). A very similar urn with “double eyebrow” ornamentation was found in a Late Bronze – Pre-Roman Iron Age barrow at Groß Blumenau/Kremnevo (Kaliningrad, Russia) (Bezenberger, 1914, Figures 13 and 112). Only a few sherds of such pottery have been identified in western Lithuania compared to the more common ceramic assemblages from sites of the same

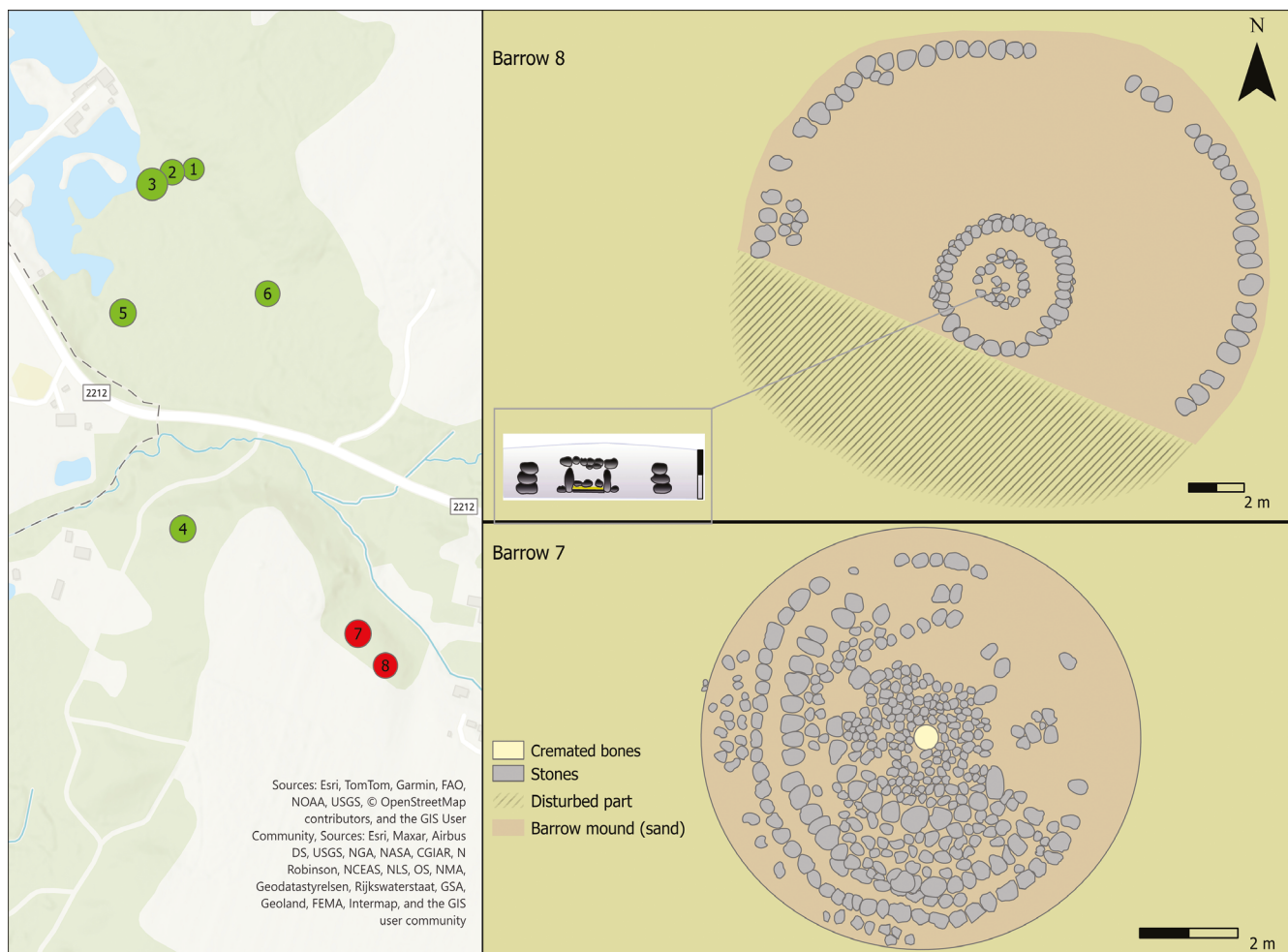


Figure 5. Ēgliškiai Barrows 7 and 8 with a single cremation pit in the centre of each mound. The drawings are based on archaeological research reports (Jablonskis, 1980; 1981).

period (Vengalis *et al.*, 2020; Urbonaitė-Ubė, 2022). Recent studies suggest that Burnished Pottery in Lithuania is unique in its manufacturing techniques; however, mineralogical and chemical analyses indicate that it was produced using local resources (Valančius *et al.*, 2024).

The graves at the Ēgliškiai barrow cemetery contained 53 metal grave goods – the highest number of metal artefacts recorded in any Bronze or Pre-Roman Iron Age cemetery in Lithuania (Merkevičius, 2011). A greater number of artefacts were deposited in inhumation graves at the same Ēgliškiai barrows, although some were also found in cremations (Figure 2). All bronze artefacts were imported, as no non-ferrous metal ores are known in the East Baltic Region. The concentration of metal artefacts within the Western Baltic Barrow culture (to which Ēgliškiai belongs) is notably higher than in neighbouring regions (Luchtanas and Sidrys, 1999, pp.20–28), reflecting intensive connections with broader European and Scandinavian regions through which metals reached the area (Čivilytė, 2014; Podėnas, 2024). Toward the end of the period, the first iron artefacts appeared (Grigalavičienė, 1995; Brazaitis, 2005), although debate continues as to whether these were locally produced.

Of particular interest are two iron brooches discovered in cremation grave 7 of Barrow 3 (Grigalavičienė, 1995, p.189). The parallels of this type of brooch are found in the Sambia Peninsula (Kaliningrad region), North Poland and further south (Engel, 1935; Dzięgielewski, 2017, pp.299–300, Figure 2).

Beyond the cemetery context, numerous bronze artefacts have been discovered as single or multiple depositions (hoards). In western Lithuania, within a 25 km radius of the Ēgliškiai barrow cemetery, such finds demonstrate connections with archaeological cultures extending from the Volga River region in the east to Central Europe and southern Scandinavia (Čivilytė, 2004; Čivilytė, 2014; Chernik *et al.*, 2017; Muradian and Pranckėnaitė, 2024).

Taken together, this archaeological evidence highlights the importance of evaluating the scale of mobility from the Late Bronze Age to the Pre-Roman Iron Age. This is particularly significant when considering not only the presence of unique artefacts at individual sites and their surroundings, but also broader shifts in cultural traditions, such as the adoption of cremation as the dominant funerary practice.

3. Material and methods

To create a bioavailable $^{87}\text{Sr}/^{86}\text{Sr}$ baseline for the region (25 km radius), modern plant samples were taken from 17 locations. These samples were used alongside five additional modern plant samples previously published by Piličiauskas *et al.* (2022). Plants were selected in areas away from anthropogenic influence (urban environments, agriculture, roads) where possible, and at each sampling site three plant samples were collected (grass, shrub, and tree) following Snoeck *et al.* (2020).

Spatial analysis and predictive mapping were undertaken in ESRI ArcGIS Pro 2.8.0 using the Spatial Analyst and Geostatistical Analyst extensions. To identify geological strontium contributions, plant $^{87}\text{Sr}/^{86}\text{Sr}$ sampling sites were spatially joined to a Quaternary Geology map (<https://www.lgt.lt/epaslaugos/elpaslauga.xhtml>) M 1:200 000 from the Lithuanian Geological Survey. To create a bioavailable Sr isoscape for the region within a 25 km radius, a domain mapping approach was employed (Holt *et al.*, 2021). Although Lithuanian bedrock varies regionally, the surface soils and sediments are largely derived from Quaternary glacial and glaciofluvial deposits. These deposits are likely to dominate the BASr across the country, leading to a diverse range of $^{87}\text{Sr}/^{86}\text{Sr}$ across small distances which can be disconnected from the bedrock geology. Domain mapping can reflect these stepwise diverse differences in BASr, without creating artificial gradients as contour mapping approaches would. To create the domain map isoscape, the $^{87}\text{Sr}/^{86}\text{Sr}$ of all sampling sites within each geological unit (Litologija/Lithology category) from the Quaternary Geology map were identified and the mean $^{87}\text{Sr}/^{86}\text{Sr}$ for that unit calculated using the Summarize Within tool. To allow for an assessment of

the robustness of the isoscape, the standard deviation and count of points for each sampled geological unit is provided in the Figure 6.

In total, 25 samples (one sample per cremation deposit in most cases, and two samples from Barrow 2 graves 7 and 8) were selected for $^{87}\text{Sr}/^{86}\text{Sr}$ isotope analysis from the cremations found in Barrows 1, 2, 3, 5, 7, and 8 (Table 2). The samples selected consisted of fully calcined skull or diaphysis fragments. The samples weighed between 13.8 and 15.8 mg. The samples were taken from the cremation burial assemblages kept at the Faculty of Medicine of Vilnius University. The storage location of the anthropological material found in Ēgliškiai Barrows 4 and 6 before the Second World War is currently unknown, and samples were thus not taken from these barrows. It should be noted that the contextual information of four cremations has not been preserved, so in some cases it is not clear to which burial they once belonged. Overall, contextual information is missing for three burials from Barrow 3 and another sample from an unidentified Barrow (1, 2, 3, or 5). The context of the remaining 21 cremation samples has been preserved, and the assignment of the samples to specific barrows and burials is clear.

To refine the chronology of the site, additional radiocarbon dating (AMS ^{14}C) was conducted by selecting additional samples, but not the same which were used for $^{87}\text{Sr}/^{86}\text{Sr}$ isotope analysis (see Sabaux *et al.*, 2024). The samples selected for dating consisted of fully calcined skull or diaphysis fragments that had been burned at high temperatures, showing white colouration on both the interior and exterior surfaces. Sample selection considered the location of the graves within the barrow, the barrow's structural features, and the results of the strontium isotope analysis. Samples were selected from Barrows 2, 3, 5, 7, and 8. In total, 8 samples from six

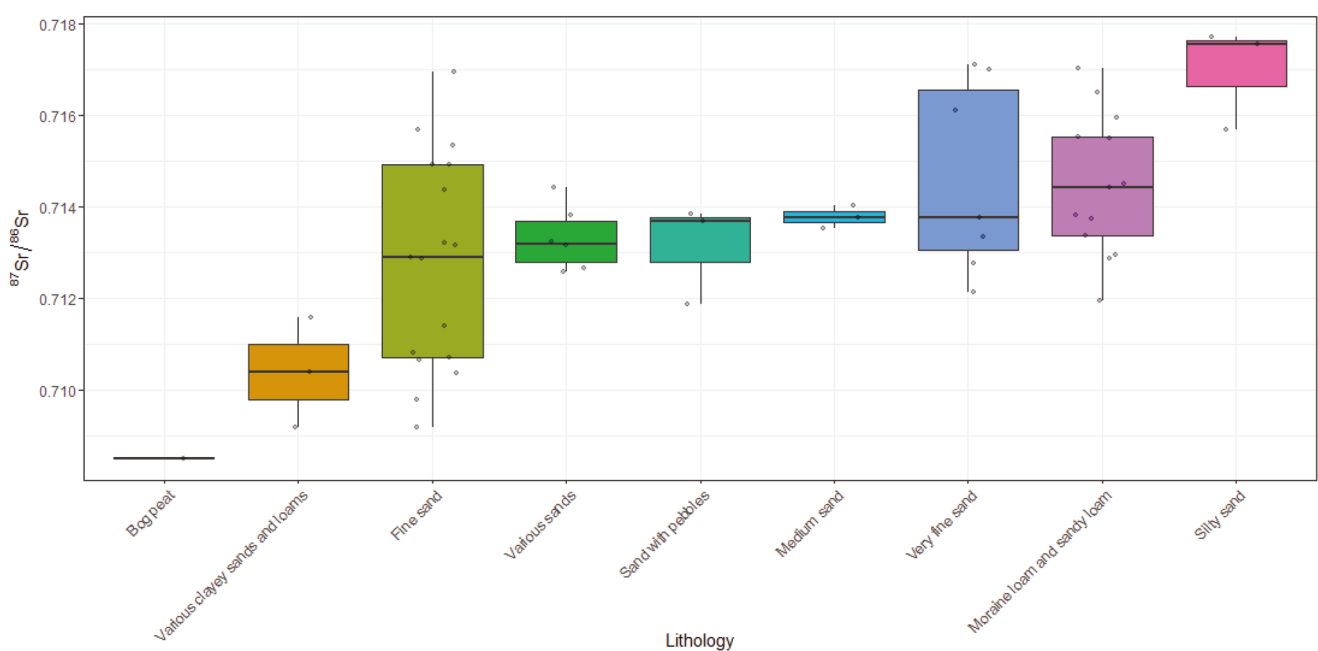


Figure 6. The standard deviation and count of points for each sampled geological unit.

cremations and one inhumation were taken. Unfortunately, poor preservation limited the number of radiocarbon samples available from inhumations. Radiocarbon dating was performed at the Vilnius Radiocarbon Laboratory at the Centre for Physical Sciences and Technology. Conventional radiocarbon dates were calibrated using OxCal 4.4.4 software and the IntCal13 calibration curve (Reimer *et al.*, 2020). Calibrated dates were interpreted at a 95.4% confidence interval. For statistical analysis, both previously published data (Muradian, 2022) and the results obtained in this study were used. Statistical comparison was carried out using the Combine function in OxCal 4.4.4.

For both calcined bone and plants, strontium was extracted and purified following the methods of Snoeck *et al.* (2015) and Gerritzen *et al.* (2024). For the cremated bone, the outer surface was first mechanically cleaned using a diamond tipped hand drill. Samples were then chemically cleaned first with 3x MilliQ, then ~10mL 1M CH₃COOH, then rinsed again with MilliQ. After drying in a 50 °C oven, they were powdered, ~15mg of powder weighed into a Teflon beaker and attacked with 1 mL of 14 M HNO₃. For plants, a ~0.27g sample was microwave digested in a Milestone UltraWAVE, 0.5mL H₂O₂ added, and then evaporated to dryness. Strontium for both bone and plant samples was extracted through column chemistry using ion exchange resin (Eichrom Sr-spec resin). ⁸⁷Sr/⁸⁶Sr and [Sr] were both measured on a Nu Plasma 3 MC-ICP Mass Spectrometer (PD017 from Nu Instruments, Wrexham, UK) at the Archaeology, Environmental Changes & Geo-Chemistry research group (Vrije Universiteit Brussel). Strontium concentrations of bone samples were obtained by comparing the ⁸⁸Sr voltage of each sample to the ⁸⁸Sr voltage of a 300 ppb [Sr] solution of NIST SRM987. A simple rule of three was then applied to obtain the [Sr] of the samples with the precision and accuracy of the [Sr] analyses validated against certified standards.

During this study, repeated measurements of NIST SRM987 returned ⁸⁷Sr/⁸⁶Sr=0.710248±0.000023 (2SD for 46 analyses), which is consistent with the mean value of 0.710252±0.000013 (2SD for 88 analyses) obtained by TIMS (Thermal Ionization Mass Spectrometry) instrumentation (Weis *et al.*, 2006). Measurements were normalised using a standard bracketing method with a NIST SRM987 value of ⁸⁷Sr/⁸⁶Sr=0.710248 (Weis *et al.*, 2006). Procedural blanks were considered negligible (total Sr (V) of max 0.02 versus 9–10 V for analyses; *i.e.* ≈ 0.2%). For each sample, the ⁸⁷Sr/⁸⁶Sr value is reported with a 2SE error (absolute error value of the individual sample analysis – internal error).

Matrix matched standards for both cremated bone and plants were processed and measured in the same manner as samples. NIST SRM1400 bone ash returned an ⁸⁷Sr/⁸⁶Sr of 0.713112 ± 0.000039; 2SD; [Sr]=235 ppm±5% RSD; *n*=32. This agrees with previously published values of ⁸⁷Sr/⁸⁶Sr=0.713120±0.000033 (2SD; *n*=6; Lazzarini *et al.*, 2021). NIST SRM 1515 apple leaves returned an ⁸⁷Sr/⁸⁶Sr of 0.713955 ± 0.000045 (2SD; *n*=12) and [Sr]=23±3% RDS (*n*=12), which is similar to the reported value of 0.713957±0.000035 (2SD; *n*=233; Gerritzen *et al.*, 2024).

Statistical analyses were undertaken in R Studio. To examine differences in ⁸⁷Sr/⁸⁶Sr and [Sr] between barrows, the data was first tested for normality using a Shapiro-Wilk test, then a Kruskal–Wallis test, and finally a pairwise Wilcoxon rank sum test with the Benjamini–Hochberg correction.

All ⁸⁷Sr/⁸⁶Sr data are available as a dataset on the IsoArch database (<https://isoarch.eu/>) under a CC- BY 4.0 license following the FAIR and CARE principles (Salesse *et al.*, 2018; Plomp *et al.*, 2022). Dataset can be accessed here: <https://doi.org/10.48530/isoarch.2026.005> and <https://doi.org/10.48530/isoarch.2026.006>

4. Results of radiocarbon dating – the site chronology

In Lithuania, the period to which the Ēgliškiai barrow cemetery belongs is known as the Early Metal Period and is divided into three main phases: Early Bronze Age (1800/1700–1100 BC), Late Bronze Age (1100–530/520 BC), and Pre-Roman Iron Age (530/520 BC–10 AD).

The quantity of grave goods decreased from the Late Bronze Age onwards, when cremation became the dominant burial practice in this region. Cremation burials can be dated more precisely using the radiocarbon method, as they contain smaller amounts of grave goods compared to inhumation burials, and some artefacts are not useful for dating (see Table 3).

Eight samples from six cremation burials and one inhumation burial were dated using the radiocarbon method (see Table 1 and Figure 7). Calibration of the radiocarbon dates placed the majority within the Hallstatt Plateau (800–400 BC). Only two dates fall outside this range: one from inhumation Grave 6 in Barrow 3 (360–160 cal BC) and one from cremation Grave 17 in Barrow 3 (355–50 cal BC).

The Sequence and Boundary functions in OxCal 4.4.4 were used to determine the time frame of barrow use, by assuming that the dated samples represent the earliest and latest burials. The results indicate that the barrow site started to be used between 989–597 cal BC and ended between 348 cal BC–35 cal AD. The duration of barrow site use may therefore have lasted from 264 to 630 years (Span function, 95.4% probability). It should be noted that, due to the Hallstatt Plateau, the chronological ranges of the Ēgliškiai barrow dates are relatively wide.

Despite this limitation, some dates suggest that the barrow site may have been used for a longer period and certain burials are slightly later in date. This is particularly evident in Barrow 3. Although a few dates alone are insufficient to demonstrate the long use of a site, other evidence, such as the high number of individuals buried in Barrow 3 and the typological data of artefacts and urns (Grigalavičienė, 1979), supports this interpretation.

Comparison of the radiocarbon dates in OxCal 4.4.4 and evaluation of the statistical reliability of their overlap using the Combine function show that most dates overlap statistically (Barrow 2, Grave 7; Barrow 5,

Table 1. Radiocarbon dates of individuals from the Ēgliškiai barrow site. Calibration produced in OxCal 4.4.4 (Reimer *et al.*, 2020; Bronk Ramsey, 2009).

No	Barrow (B), Grave (G)	Sample type	Lab code	Date BP	Cal BC (95.4%)	Reference
1.	B 2, G 7	Cremated bone	FTMC-CZ24-3	2469±31	765–421 cal BC	Muradian 2022, pp.157–183
2.	B 2, G 7	Cremated bone	FTMC-NF71-2	2538±31	796–546 cal BC	This paper
3.	B 3, G 5	Cremated bone	FTMC-CZ24-2	2414±32	746–400 cal BC	Muradian 2022, pp.157–183
4.	B 3, G 17	Cremated bone	FTMC-NF71-3	2145±37	355–50 cal BC	This paper
5.	B 3, G 6	Bone (inhumation)	FTMC-TH47-1	2186±29	366–160 cal BC	This paper
6.	B 5, G 3	Cremated bone	FTMC-CZ24-1	2515±32	790–541 cal BC	Muradian 2022, pp.157–183
7.	B 7, G 1	Cremated bone	FTMC-CZ24-6	2495±31	777–491 cal BC	Muradian 2022, pp.157–183
8.	B 8, G 1	Cremated bone	FTMC-NF71-1	2535±30	795–546 cal BC	This paper

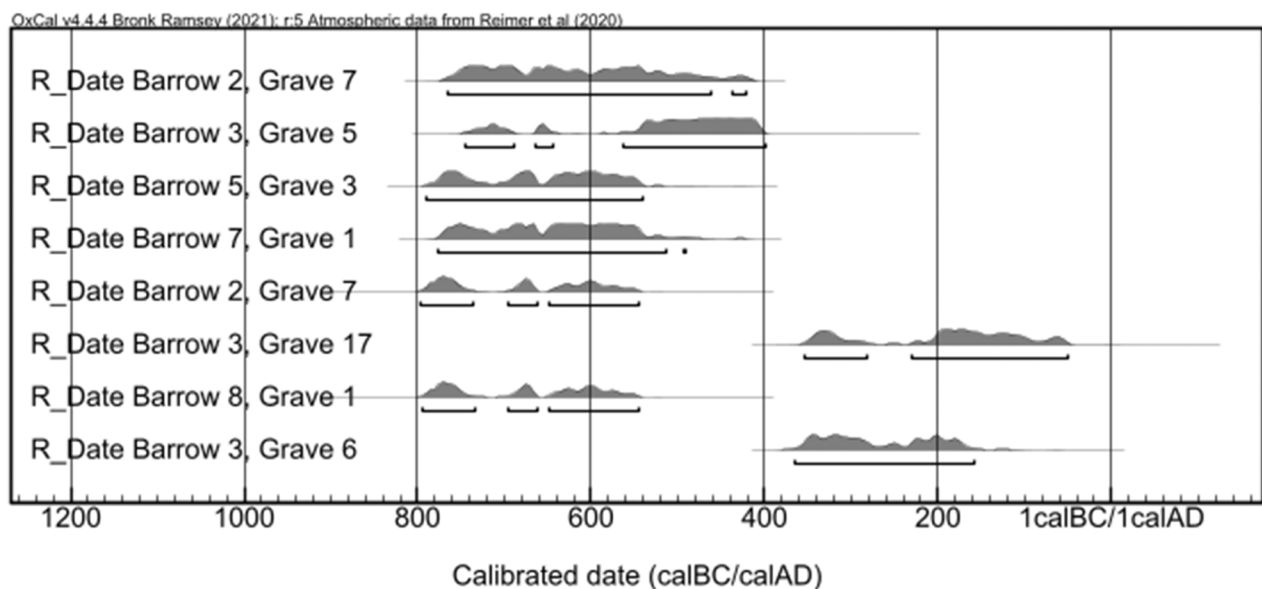


Figure 7. C^{14} calibrated dates, interpreted at a 95.4% confidence interval, produced in OxCal 4.4.4 (Reimer *et al.* 2020; Bronk Ramsey 2009).

Grave 3; Barrow 7, Grave 1; Barrow 8, Grave 1). These results indicate that these barrows were in use around 773–563 cal BC (Acomb=110.0%; An=31.6%). Two dates obtained from the same burial in Barrow 2 allowed the chronological framework of this burial to be refined, indicating that Grave 7 dates to 775–544 cal BC (Acomb=83.5%; An=50.0%).

Barrows 7 and 8, located in the southern part of the site, each contained only one cremation burial at the centre of the mound. In contrast, the barrows in the northern part of the site contained several burials (including cremations and inhumations) in each barrow. Combining the dates from Barrows 7 and 8 indicates that they were used between 777 and 548 cal BC (Acomb=106.7%; An=50.0%). Results suggest that differently arranged barrows, those with one central cremation and those with several burials in mounds (Barrows 2, 3, and 5), may have been constructed during the same period, according to the radiocarbon evidence.

5. Results of $^{87}\text{Sr}/^{86}\text{Sr}$ and [Sr] analysis and the BASr baseline

The $^{87}\text{Sr}/^{86}\text{Sr}$ results range from 0.7120 to 0.7153 for the cremated individuals from the Ēgliškiai barrows (Table 2 and Figure 8). The strontium isotope results from some graves in Barrow 2 and Barrow 3 are different, even though these mounds were located next to each other. In Barrow 2, $^{87}\text{Sr}/^{86}\text{Sr}$ ranges from 0.7120 to 0.7145 (in six cremations these values are even lower and range from 0.7120 to 0.7135), while in Barrow 3 higher $^{87}\text{Sr}/^{86}\text{Sr}$ values were obtained, ranging from 0.7140 to 0.7152. The $^{87}\text{Sr}/^{86}\text{Sr}$ isotope values obtained from Barrows 7 and 8 are also slightly different: 0.7153 and 0.7142, respectively. The values obtained from Barrow 5 range from 0.7143 to 0.7152. Comparing the $^{87}\text{Sr}/^{86}\text{Sr}$ for each barrow, the Kruskal–Wallis test indicated a significant difference ($\chi^2=11.503$, $df=5$, $p=0.042$), but a follow-up pairwise Wilcoxon test (adjusted for multiple comparisons)

Table 2. $^{87}\text{Sr}/^{86}\text{Sr}$ measurements of cremated human bones and anthropological analysis. For cremated remains, sex was determined using qualitative indicators of skeletal sexual dimorphism. Age estimation was based on the best-preserved bone fragments, including the degree of cranial suture closure, tooth root formation, epiphyseal fusion of long bones, and ossification of vertebral apophyseal rings (adult >20 years; subadult <20 years). In cases where only a few fragments were available, age was recorded as “unknown”. The minimum number of individuals (MNI) was calculated by assessing the maximum representation of identifiable anatomical elements. Anthropological analysis conducted by Justina Kozakaitė.

No	Context	Barrow (B), Grave (G)	BB-LAB Code	[Sr] (ppm)	$^{87}\text{Sr}/^{86}\text{Sr}$	2SE	MNI	Sex	Age	Weight (g)	Bone colour	Urn	Gave goods
1.	MIL1_11	B 1, G 3	CS025	59	0.714533	0.000011	1	–	Unknown	35	White, cream	?	–
2.	MIL1_2	B 2, G 1	CS003	70	0.713415	0.000010	1	–	Subadult?	154	Cream	–	–
3.	MIL1_4	B 2, G 2	CS007	36	0.714493	0.000019	1	–	Unknown	9	White, cream	–	–
4.	MIL1_3	B 2, G 2?	CS024	72	0.711967	0.000008	1	–	Unknown	25	Cream	–	–
5.	MIL1_7	B 2, G 4?	CS021	58	0.714889	0.000009	1	–	Unknown	43	Cream	–	–
6.	MIL1_1	B 2, G 5	CS004	48	0.714507	0.000028	1	–	Adult?	234	White, cream	+	–
7.	MIL1_5	B 2, G 7	CS023	47	0.714325	0.000021	1	–	Subadult?	325	Cream	–	–
8.	MIL1_6	B 2, G 7	CS022	86	0.712449	0.000018	1	–	Unknown	35	Cream	–	–
9.	MIL1_10	B 2, G 8	CS014	72	0.712600	0.000015	1	–	Unknown	124	Cream	–	–
10.	MIL1_9	B 2, G 8	CS020	55	0.713484	0.000007	1	–	Adult?	89	White, cream	–	–
11.	MIL1_8	B 2, G 6	CS019	59	0.713535	0.000008	1	–	Adult	437	White, cream	–	+
12.	MIL1_12	B 3	CS017	60	0.714544	0.000008	1	–	Adult?	326	Cream	?	?
13.	MIL1_13	B 3	CS016	44	0.714571	0.000019	1	–	Unknown	241	Cream	?	?
14.	MIL1_14	B 3	CS015	44	0.714796	0.000022	1	–	Unknown	281	Cream	?	?
15.	MIL1_15	B 3, G 2	CS002	39	0.714956	0.000021	1	–	Adult?	347	Cream	–	–
16.	MIL1_16	B 3, G 5	CS005	49	0.715018	0.000024	1	–	Unknown	93	White, cream	+	–
17.	MIL1_17	B 3, G 17	CS012	42	0.715210	0.000022	1	–	Adult	931	Cream	?	?
18.	MIL1_18	B 3, G 27	CS013	43	0.714018	0.000019	1	–	Adult	700	White, cream	?	?
19.	MIL1_26	B 1–3 or 5	CS008	76	0.714959	0.000010	1	–	Adult	614	White, cream	?	?
20.	MIL1_20	B 5, G 1	CS009	61	0.715197	0.000008	1	–	Adult?	314	White, cream	+	–
21.	MIL1_21	B 5, G 2	CS006	72	0.714262	0.000008	1	–	Adult	137	Light grey, cream	–	–
22.	MIL1_22	B 5, G 3	CS010	58	0.714435	0.000009	1	–	Adult?	326	White, cream	+	–
23.	MIL1_23	B 5, G 6	CS018	75	0.714500	0.000008	1	–	Subadult	537	White, cream	+	–
24.	MIL1_24	B 7, G 1	CS011	45	0.715280	0.000023	1	–	Adult	437	White, cream	+	–
25.	MIL1_25	B 8, G 1	CS001	48	0.714161	0.000024	1	Male?	Adult	450	White, cream	?	–

showed only an almost significant result for $^{87}\text{Sr}/^{86}\text{Sr}$ values between Barrows 2 and 3 (Wilcoxon rank sum test, Barrow 2 vs 3, p -value=0.069). However, the small sample size in each barrow group limits the statistical power of these tests.

Strontium concentrations ([Sr]) range from 36 to 86 ppm. The individuals in Barrow 2 show the largest range of

values, covering the whole spectrum (36–86 ppm), while those in Barrow 3 had lower [Sr] (39–60 ppm) and those in Barrow 5 higher (58–75 ppm) [Sr] values. No statistically significant differences between barrows based on the strontium concentrations [Sr] were observed.

of the Ēgliškiai barrow site, only a later hillfort (dated to the end of 1st millennium and the beginning of 2nd millennium AD) has been identified, located approximately 500 m south of Barrow 4 (Bliujienė, 2021, pp.67–76). No settlements dated to the period from 8th to 1st centuries BC have yet been identified in the Ēgliškiai area, a situation that is not unique to this microregion. Within the broader Western Baltic Barrow culture, interpretations are frequently based solely on burial monuments, as contemporaneous settlements located close to cemeteries are rarely known (Hoffmann, 2000). One of the few exceptions is Kurmaičiai, located approximately 8 km north of Ēgliškiai, where a hillfort and a barrow cemetery lie about 1.5–2 km¹ apart on opposite sides of the Akmena-Danė river (Muradian, 2024, pp.163–170). Since both Kurmaičiai and Ēgliškiai share a similar chronological span, it is reasonable to hypothesise that a comparable spatial organisation may have been used by the Ēgliškiai community. On this basis, a local exploitation zone with a radius of approximately 1.5–2 km may be tentatively assumed, with the barrow cemetery situated at the margin of the inhabited and exploited landscape.

A comparison of ⁸⁷Sr/⁸⁶Sr isotope ratios obtained from human bones with the strontium baseline within this defined territory (circa 2 km radius) indicates that, although some differences are observed when a narrower 1 km radius is applied, the isotopic values of the individuals are consistent with the exploitation of food resources within this wider area (2 km radius) (Figure 9B). On this basis, the individuals buried in the Ēgliškiai barrows may be regarded as local, despite individual variation in isotope values. The individual differences in ⁸⁷Sr/⁸⁶Sr isotope values could reflect different patterns of resources used by some individuals.

The comparison of the results shows that the ⁸⁷Sr/⁸⁶Sr isotope values obtained from some graves in Barrow 2 (1, 2, 6, 7, and 8 graves) stand out compared to other graves in this mound, as well as other barrows. This barrow is situated between Barrows 1 and 3, which are connected by overlapping mounds and continuous stone circles (see Figure 3), suggesting that they were constructed during the same period. Graves 7 and 8 in Barrow 2 appear to represent the earliest burials of this mound, found beneath the stone structure constructed in the central part of the barrow (see Table 3). Although no grave goods were found within these graves, the stone structure of the graves do differ from the other cremations within this barrow. Notably, two different strontium isotope values were obtained from cremation burial 7 of Barrow 2 (see Figure 8). As it is often difficult to assess the minimum number of individuals in cremations due to the high burning temperatures and extreme bone fragmentation, the application of ⁸⁷Sr/⁸⁶Sr analysis provides an important means of identifying such cases when sampling an element with a similar bone turnover rate. In this case, two long bones with similar turnover rates

yielded distinct strontium isotope values, suggesting that cremation grave 7 may represent more than one individual. Despite the inability to identify the specific long bones sampled, the similar turnover rates characteristic of long bones supports the interpretation that the differing strontium isotope values are more likely to reflect multiple individuals rather than intra-individual variability. Future isotopic analyses may further refine this interpretation and contribute to a more robust assessment of the minimum number of individuals within this grave.

The strontium isotope values of mentioned graves from Barrow 2 align more with the ⁸⁷Sr/⁸⁶Sr isotope values observed within the 1 km radius, while other graves in Barrow 2 and Barrows 1, 3, 7, and 8 align with areas slightly further afield, but still within a 2 km radius of the centre of the burial site. One interpretation of this fact is that some individuals with lower ⁸⁷Sr/⁸⁶Sr isotope values may have used resources from the Akmena-Danė river valley, while those exhibiting higher strontium isotope values, likely relied more on areas located slightly further from this River valley (Figure 9C). The landscape use would still fall within a 2 km radius from the burial site for all individuals. It is difficult to say whether it was related with certain social aspects as far as the limitation of anthropological data of cremated remains is concerned (see Table 2).

The burial site is located approximately 10 km from the Baltic Sea. The lower ⁸⁷Sr/⁸⁶Sr isotope values and slightly higher [Sr] concentrations observed in Barrow 2 may also indicate that these individuals consumed food sourced from that coastal region. Research has demonstrated the impact of marine strontium on ⁸⁷Sr/⁸⁶Sr in coastal zones. Therefore, it is possible that these individuals originated from the Baltic coastline, where the so-called “sea spray effect” can lead to lower strontium isotope values in bioavailable strontium. Alternatively, they may have consumed food from this coastal area. The hypothesis that these individuals may have originated from the Baltic coast could also be supported by the discovery of several pieces of amber found outside the stone circle of Barrow 1 (Grigalavičienė, 1979, p.7). Although this assemblage was not found within Barrow 2, but rather outside the outer stone circle of Barrow 1, it is important to note that Barrow 1 had been partly disturbed, and the mounds of Barrows 1 and 2 were connected, with their stone circles situated close together. Therefore, an association with Barrow 2 cannot be ruled out.

However, when comparing ⁸⁷Sr/⁸⁶Sr isotope results from the human bones of Ēgliškiai, some of these values also correspond with areas of possible artefacts origin. Lower values (⁸⁷Sr/⁸⁶Sr=0.7119–0.7126) that derive from cremations in Barrow 2 (graves 2, 7, and 8) can also be found in the Sambia Peninsula, Northeastern Poland, Southern Sweden, Northern Estonia, Gotland and Saaremaa Islands, while higher values (⁸⁷Sr/⁸⁶Sr=0.7134–0.7152) of the strontium baseline are observed in Eastern Lithuania, Southern Sweden, Northern Estonia, Northern Latvia, and Saaremaa Island (the comparison is based on the data from Kurila *et al.*, 2025; Suni *et al.*, 2025). Artefacts typical of northern Poland and

¹ A difference of up to 500 m in radius arises depending on whether the distance to the barrow cemetery is measured from the central part of the burial monument or from its outer edge.

Table 3. Cremation and inhumation graves from the Ēgliškiai barrow cemetery. Data based on E. Grigalavičienė's finding reports; cremation graves highlighted.

Barrow No	Grave No	Cremation (C), Inhumation (I)	Funerary architecture	Urn	Grave goods
1	1	C	Cremated bones in pit beneath the stone structure	–	–
1	2	C	Pit with two flat stones on side	–	–
1	3	C	Pit with stone paving and cremated bones	?	–
1	1	I?	?	–	Temple ornament
Between barrows	–	C, I?	–	–	Elongated ornament with looped ends
2	1	C	A circular stone structure with cremated bones heaped in its center	–	–
2	2	C	Pit beneath the stones with cremated bones	–	–
2	3	C	Pit	–	–
2	4	C	Pit	–	–
2	5	C	Pit	+	–
2	6	C	An oval-shaped stone structure, 75×55 cm in size, beneath which cremated bones were deposited.	–	Two iron bracelets and a small cup with a handle
2	7	C	An oval-shaped stone structure, beneath in a small pit, cremated bones were deposited	–	–
2	8	C	In the northwestern part of the same stone structure (as grave 7), in a small pit.	–	–
2	1	I	Pit with 6 stones in a row	–	Pin with ring-shaped head, amber pieces, serial bracelet, and a fragment of an iron object
2	2	I	Pit	–	Bracelet
3	1	C	Pit with a stone beside it	+	–
3	2	C	Pit	–	–
3	3	C	Pit with a stone beside it	–	–
3	4	C	Pit with a stone beside it	–	Melted fragments of a bronze object
3	5	C	Pit	+	–
3	6	C	Pit with two stones	–	–
3	7	C	Pit	–	Iron brooch (crossbow type)
3	8	C	Cremated bones on a stone pavement, additionally covered with other stones	–	Shepherd's crook pin
3	9	C	Stone box made of flat stones with an urn inside	+	–
3	10	C	Cremated bones in an urn, in a small pit, with a stone placed on top	+	–
3	11	C	An oval stone structure, 1.1 meters in height, with a stone pavement at the bottom on which cremated bones were deposited	+	–
3	12	C	A quadrangular stone structure, 60 cm in height, covered with clay, with cremated bones deposited between the stones inside	–	–
3	13	C	In the same structure, east of grave 12. The cremated bones were deposited in a small pit beneath the stone structure	–	–

Table 3. Cremation and inhumation graves from the Ēgliškiai barrow cemetery. Data based on E. Grigalavičienė's finding reports; cremation graves highlighted. (*Continuation*)

Barrow No	Grave No	Cremation (C), Inhumation (I)	Funerary architecture	Urn	Grave goods
3	14	C	An urn with cremated bones placed within a stone pavement	+	–
3	–	C	–	–	Blue glass bead
3	–	C, I?	–	–	Artefacts from different parts of the barrow: a copper-alloy bracelet, neck-ring, spiral head pin, and an iron knife
3	1	I	Pit with circle of stones	–	Copper-alloy neck-ring, two spiral bracelets, and a ring
3	2	I	Pit with circle of stones	–	Copper-alloy temple ornaments and four spirals
3	3	I	Pit with few stones	–	Two copper-alloy bracelets, raw material (?), small stick shape
3	4	I	Pit with few stones	–	Two disk temple ornaments, four spiral temple ornaments, pin, a fragment of an iron object
3	5	I	Pit with one stone	–	Neck ring with a hoof-shaped end, spiral bracelet
3	6	I	Pit	–	Elongated ornament with looped ends, small cup
3	7	I	Pit lined on the sides with a row of stones	–	Two disk temple ornaments, nine spiral temple ornaments
3	8	I	Pit beneath the stone pavement	–	Disc temple ornament, three spiral temple ornaments
3	9	I	Pit	–	Bracelet
4	1	C	Oval stone structure, 90 cm in height, covered with clay, with an urn containing cremated bones placed inside	+	–
4	2	C	Cremated bones in the centre of an oval stone structure, covered with a stone	–	–
5	1	C	Stone box of flat stones with urn inside	+	–
5	2	C	Stone box of flat stones with cremated bones inside	–	–
5	3	C	Stone box of flat stones with urn inside	+	–
5	4	C	Urn on flat stone, covered with another stone	+	–
5	5	C	Urn on flat stone, covered with two stones	+	–
5	6	C	Stone box of flat stones with an urn inside	+	–
5	7	C	Stone box of flat stones with an urn inside	+	–
6	–	C	Disturbed graves with scattered cremated bones	?	–
7	1	C	Stone circle with cremated bones in central pit, covered by stone pavement; flat stones on sides	–	–
8	1	C	Cremated bones with pottery sherds in stone-paved pit	?	–
Outside barrows	37	C	Pit	+	–

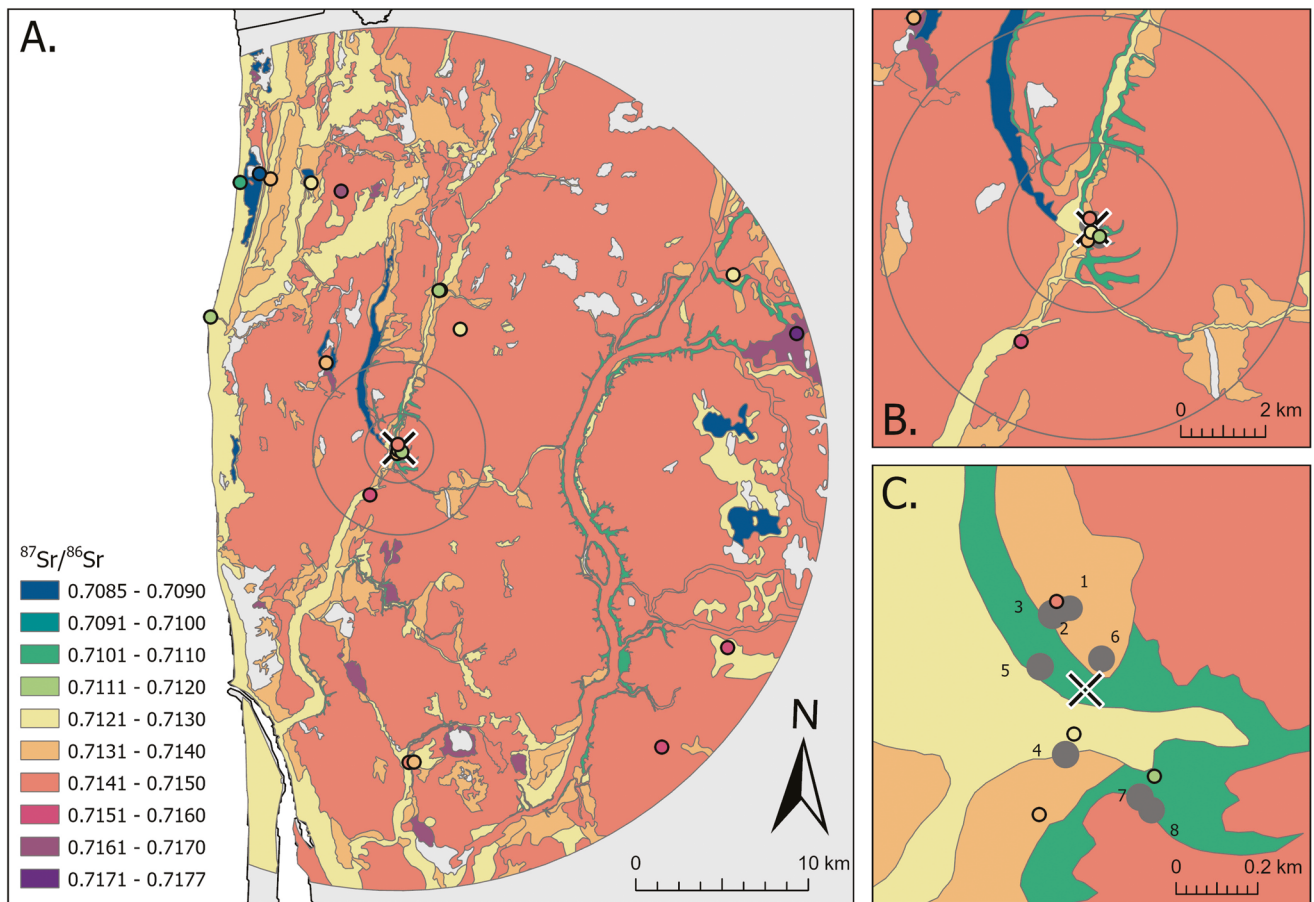


Figure 9. A: Domain mapping $^{87}\text{Sr}/^{86}\text{Sr}$ isoscape for a 25km radius of Ēgliškiai constructed using modern plant $^{87}\text{Sr}/^{86}\text{Sr}$ values, with colours representing the mean of all sampling sites with the lithology category of the Quaternary Geology map, M 1:200 000 from the Lithuanian Geological Survey. Coloured circles represent the median of samples from each sampling site. B: $^{87}\text{Sr}/^{86}\text{Sr}$ within 5 km and 2 km from the site. C: $^{87}\text{Sr}/^{86}\text{Sr}$ around Ēgliškiai with the locations of numbered burial mounds indicated in grey, and the mean centre of these mounds is indicated by an X.

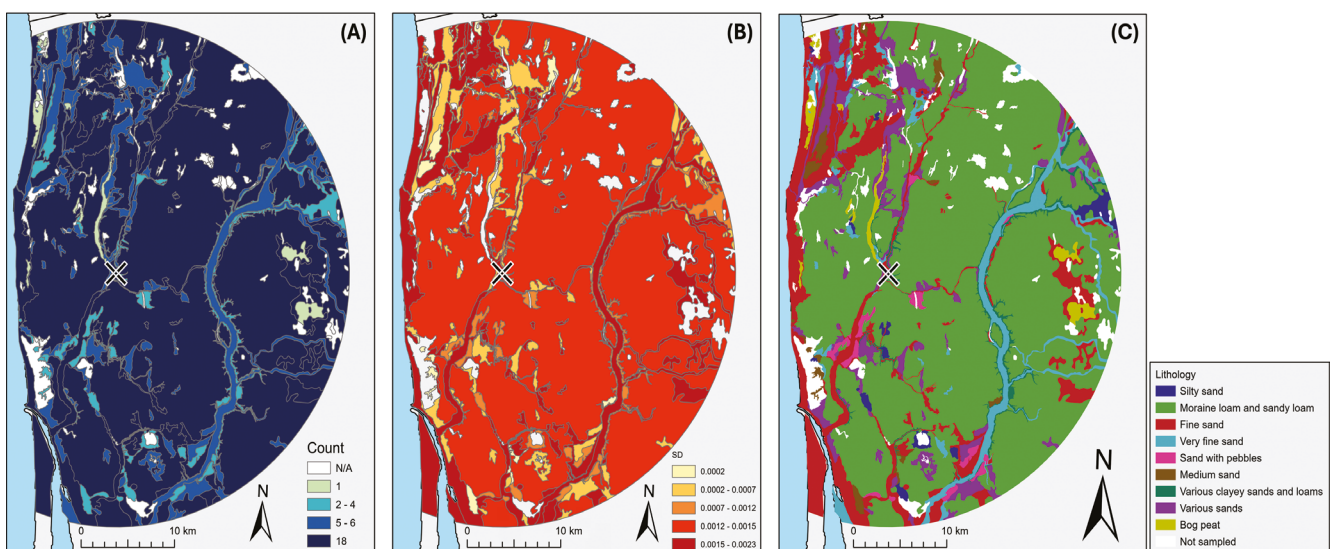


Figure 10. Ēgliškiai isoscape SD Count with the lithology category of the Quaternary Geology map, M 1:200 000 from the Lithuanian Geological Survey.

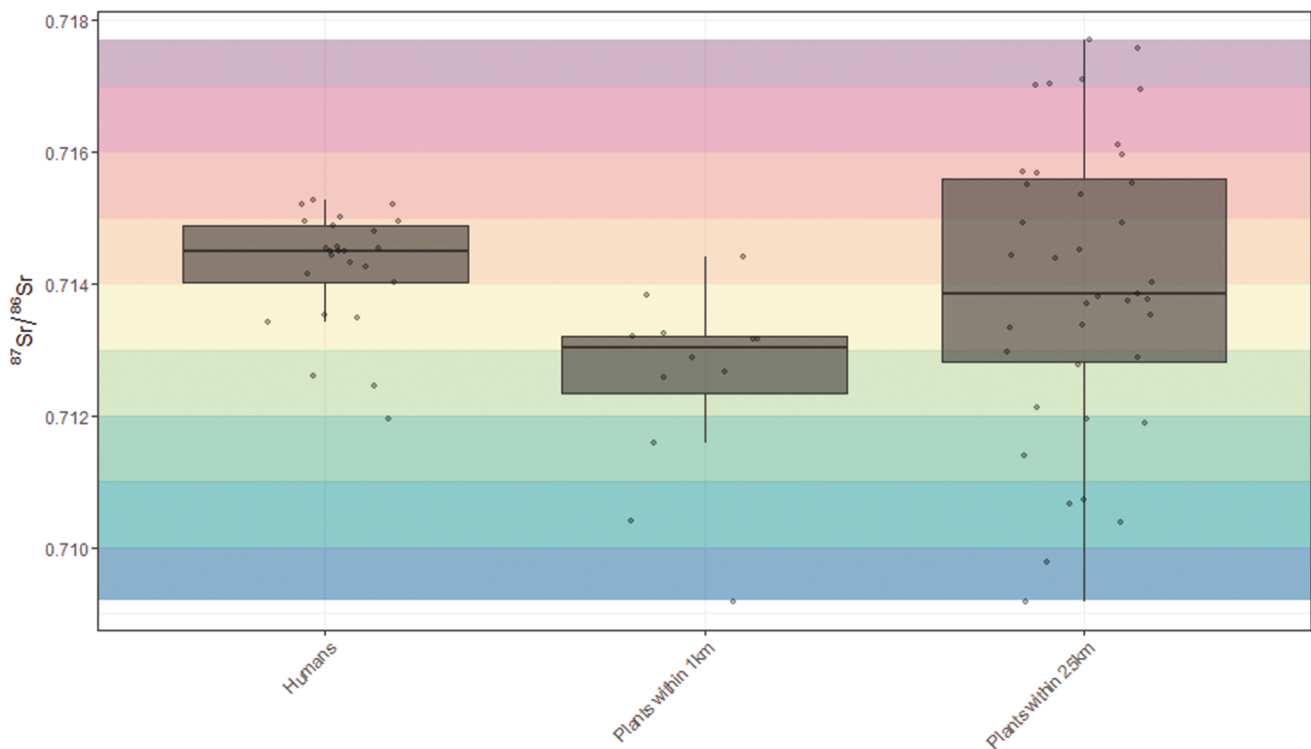


Figure 11. Comparison of $^{87}\text{Sr}/^{86}\text{Sr}$ values in human and plant samples across different areas.

the Sambia Peninsula, such as a burnished urn, glass bead, and iron brooches, were recovered from the cremations in Barrow 3. Barrow 2 contained a serial bracelet and a pin with a ring-shaped head. Serial bracelets of this type are also known from Estonia, Finland, and northern Latvia (Moora, 1938, pp.400–403; Schauman-Lönnqvist, 2006; Lang, 2007, p.182; Ciglis, 2013). Similarly, pins with a ring-shaped head are known from southern and central Estonia (Lang, 2007, p.183) and from one site in southern Lithuania (Bliujienė *et al.*, 2021). Nevertheless, these artefacts may reflect trade rather than migration. The main argumentation would be that the results of this study show that the $^{87}\text{Sr}/^{86}\text{Sr}$ values from the human samples overlap the local baseline (2 km radius) within the site or with the Baltic Sea coast.

Another important aspect to consider is the interpretation of the individuals buried within the barrows based on the arrangement of the mounds in comparison with $^{87}\text{Sr}/^{86}\text{Sr}$ isotope values. This question is especially relevant given that no barrows are known from the Stone Age in Lithuania, and they only appear in the Bronze Age. Moreover, burials differ in their structural arrangement within the single barrow or barrow site, but the reasons behind this are still uncertain. In Ēgliškiai, Barrows 1, 2, 3, and 5 were arranged on the right bank of the Šaltupis River, and they are characterised by a high number of grave goods, the presence of several burials within each mound, which differ in the features of their stone structures for individual burial, some of them even being without stones (see Table 3). In contrast, Barrows 7 and 8 are located on the left bank of the aforementioned river, each containing only a single burial with no grave goods, except for a few pottery sherds in Barrow 8, as well as having

only a simple stone circle in the arrangement of the graves. However, when the strontium isotope values are examined, the distinction implied by the opposing riverbanks, and the different stone constructions used for burials, does not continue. For instance, the data indicates that Barrow 8, grave 1, Barrow 7, grave 1 and Barrows 1, 3, and 5 had similar $^{87}\text{Sr}/^{86}\text{Sr}$ isotopes values ($^{87}\text{Sr}/^{86}\text{Sr}$ variation within these barrows=0.7140–0.7152). Instead, it is some of the burials in Barrow 2 (graves 1, 2, 6, 7, and 8) that shows different $^{87}\text{Sr}/^{86}\text{Sr}$ isotopes values. Even though the individuals from Barrows 1, 2, and 3 may have had access to different diets in life (with those from Barrow 2 potentially consuming more marine resources), they were ultimately buried side by side in death with connected stone structures between the mounds.

7. Conclusions

Thanks to recent advances in the isotopic analysis of cremated bone, it is now possible to investigate human mobility in populations that were previously inaccessible due to the cremation practice that prevailed in the Bronze Age of the East Baltic Region. The Ēgliškiai cemetery in western Lithuania represents a major Late Bronze Age – Pre-Roman Iron Age burial site dominated by cremations, with inhumations being the minority of burials. This research demonstrates that the $^{87}\text{Sr}/^{86}\text{Sr}$ values of 25 cremated individuals vary across different barrows, indicating that the individuals buried at Ēgliškiai consumed food from different, but local areas. Especially those from Barrow 2, which showed distinct strontium isotope values from

Barrows 1, 3, 5, 7, and 8, suggesting that people buried in different mounds may have used resources from different areas, though located within no more than 10 km apart. Nevertheless, when interpreting the possible scale of mobility, several conclusions can be drawn. Although large-scale migration is not evident, multiple pieces of evidence – including artefacts – point to long-distance cultural connections with Eastern and Northern Europe (for example, the Lusatian culture, Sambia Peninsula and further North). Bioarchaeological data further supports the likelihood of smaller-scale mobility within the surroundings of the barrows site, possibly involving local areas or the Baltic Sea coast.

Ēgliškiai serves as a case study demonstrating how cultural exchange intersected during the Bronze Age in the East Baltic Region. This is potentially important in further understanding economic exchange and the introduction of agriculture into the East Baltic Region via the exchange networks that then existed within European regions.

Acknowledgements

This research was funded by the European Union with a Consolidator Grant awarded to Giedrė Motuzaitė Matuzevičiūtė (ERC-CoG, MILWAYS, 101087964). Views and opinions expressed are those of the authors only and do not necessarily reflect those of the European Union or the European Research Council Executive Agency. Neither the European Union nor the granting authority can be held responsible for them. We acknowledge the support of ERC Starting Grant LUMIERE (Landscape Use and Mobility in Europe – Bridging the gap between cremation and inhumation), funded by the European Union's Horizon 2020 research and innovation programme (grant agreement number 948913). Hannah F. James acknowledges support from FWO Postdoctoral Fellowship 1284425N. We would like to acknowledge support from the VUB Strategic Research Program for the general support of the ICP-MS lab. We thank Martyna Kremer (VUB) for her help with the strontium isotope analyses, Valter Lang for his valuable consultation on artefacts parallels, Justina Kozakaitė (Department of Anatomy, Histology and Anthropology at the Faculty of Medicine at Vilnius University) for her anthropological analysis of cremated remains and assistance with sampling cremated bones, and Regina Ulozaitė (National Museum of Lithuania) for the spectral analysis of the glass bead. We are also very grateful for two anonymous reviewers and their valuable comments on the manuscript.

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