VILNIUS UNIVERSITY
LITHUANIAN INSTITUTE OF HISTORY

Vytenis
PODĖNAS

Fortified settlements in the Eastern Baltic 1100-400 cal BC

SUMMARY OF DOCTORAL DISSERTATION

Humanities,
History and Archaeology (H 005)

VILNIUS 2022

The dissertation was written between 2016 and 2022 at the Lithuanian Institute of History. The research was supported by the Research Council of Lithuania

Academic supervisor – Dr Agnė Čivilytė (Lithuanian Institute of History, Humanities, History and Archaeology – H 005)

This doctoral dissertation will be defended at a public meeting of the Dissertation Defence Panel:

Chairwoman – Dr Giedrė Keen (Lithuanian Institute of History, Humanities, History and Archaeology – H 005).
Members:
Assoc. Prof. Dr Algimantas Merkevičius (Vilnius University, Humanities, History and Archaeology – H 005),
Assoc. Prof. Dr Gintautas Vėlius (Vilnius University, Humanities, History and Archaeology – H 005),
Dr Manvydas Vitkūnas (General Jonas Žemaitis Military Academy of Lithuania, Humanities, History and Archaeology – H 005),
Assoc. Prof. Dr Gintautas Zabiela (Klaipėda University, Humanities, History and Archaeology – H 005).

The dissertation shall be defended at a public meeting of the Dissertation Defence Panel at 3:00 p.m. on 30th September, 2022 in Meeting room 320 of the Lithuanian Institute of History.
Address: 17 Tilto St, Vilnius, Lithuania
Tel. +370 261 4436; e-mail: istorija@istorija.lt

The text of this dissertation can be accessed at the libraries of the Lithuanian Institute of History and Vilnius University, as well as on the website of Vilnius University:
www.vu.lt/lt/naujienos/ivykiu-kalendorius

VILNIAUS UNIVERSITETAS
LIETUVOS ISTORIJOS INSTITUTAS

Vytenis
PODĖNAS

Įtvirtintos gyvenvietės Rytų Baltijos regione 1100–400 cal BC

DAKTARO DISERTACIJOS SANTRAUKA

Humanitariniai mokslai,
Istorija ir archeologija (H 005)

VILNIUS 2022

Disertacija rengta 2016–2022 metais Lietuvos istorijos institute.
Mokslinius tyrimus rėmė Lietuvos mokslo taryba.

Mokslinė vadovė – dr. Agnė Čivilytė (Lietuvos istorijos institutas, humanitariniai mokslai, istorija ir archeologija – H 005).

Gynimo taryba:
Pirmininkė – dr. Giedrė Keen (Lietuvos istorijos institutas, humanitariniai mokslai, istorija ir archeologija – H 005).
Nariai:
doc. dr. Algimantas Merkevičius (Vilniaus universitetas, humanitariniai mokslai, istorija ir archeologija – H 005),
doc. dr. Gintautas Vėlius (Vilniaus universitetas, humanitariniai mokslai, istorija ir archeologija – H 005),
dr. Manvydas Vitkūnas (Generolo Jono Žemaičio Lietuvos karo akademija, humanitariniai mokslai, istorija ir archeologija – H 005),
doc. dr. Gintautas Zabiela (Klaipėdos universitetas, humanitariniai mokslai, istorija ir archeologija – H 005).

Disertacija ginama viešame Gynimo tarybos posėdyje 2022 m. rugsėjo mėn. 30 d. 15 val. Lietuvos istorijos instituto 320 posėdžių salėje. Adresas: Tilto g. 17, 320, Vilnius, Lietuva, tel. +370 261 4436; el. paštas istorija@istorija.lt

Disertaciją galima peržiūrėti Lietuvos istorijos instituto ir Vilniaus universiteto bibliotekose ir VU interneto svetainėje adresu: *https://www.vu.lt/naujienos/ivykiu-kalendorius*

TABLE OF CONTENTS

SUMMARY

INTRODUCTION

The emergence of fortified settlements is an important phase in prehistory, during which communities made fundamental changes to their way of life and daily routines, with significant additional investments of time and labour to ensure their security. The Eastern Baltic region in Europe had undergone a distinctive economic development characterised by a late[1] process of Neolithisation, with the earliest evidence of crop agriculture identified around 1400–1200 cal BC (Piličiauskas et al. 2021). During this period, bronze artefacts reflecting the ideas of the European Bronze Age culture had already been imported for some time. It is likely that metalwork, which was initially new and alien to local communities, gradually became accessible and culturally inherent. The changing socio-economic environment from the Early Bronze Age (EBA) to the Late Bronze Age (LBA) is also indicated by the emergence of intensive agriculture, the significant increase in artefact types associated with the Scandinavian tradition, the doubling of bronze consumption, an almost quadrupling of the number of hoards, and the development of ritual practices such as the emergence of the stone ship graves that were likely made by groups from Scandinavia or Gotland (Luchtanas, Sidrys 1999: 22, Table 1–2; Vasks 2010: 156; Wehlin 2013; Minkevičius et al. 2020). At a similar time, there were probably considerably more changes in the culture, behaviour, economy, diet and burial practices of the Eastern Baltic population. Thus, it is possible to consider not only the opportunities for economic and social development, but also the increased social tensions between different communities in the region.

[1] Cf. the earliest crop farming in Scandinavia and Gotland had emerged in 4000–3700 cal BC (Sørensen, Karg 2014), i.e., ca. 2300–2800 years earlier than in the SE Baltic region.

The data on fortified settlements collected so far have not been sufficiently interpreted on a larger regional scale. Previous studies have concentrated on individual sites, on a particular area of the region, or have summarised knowledge gathered within the boundaries of individual countries, devoting a small part of the discussion to contextual information from the wider region. The application of ^{14}C dating has been scarce in understanding the more complete regional development of fortified settlements. The economy and diet of these communities has been understood mostly through zooarchaeological data, which provide only one-sided information. All this did not allow for an understanding of when, how and why fortified settlements emerged in the Eastern Baltic.

Recent research on fortified settlements has significantly contributed to the accumulated knowledge of their chronology and defensive systems. Therefore, it is necessary to review critically the growing database of ^{14}C dates and to discuss the most probable scenarios of development that would allow analysing the factors determining the appearance of fortified settlements.

A synthesis of archaeological data requires a reassessment of the social processes that the fortified settlements indicate. How is the fortified settlement understood in archaeology in general? Are they still thought to reflect phases of long-term settlement, lasting several hundred years, or, on the contrary, were they formed in short phases, lasting several dozen years at most? In the latter case, they would represent a dynamic settlement pattern. However, it seems that this kind of approach is still missing in the development of archaeological syntheses on early fortified settlements.

The aim of this thesis is *to determine the timing of the emergence of early fortified settlements, the process of their spread in the Eastern Baltic, and the reasons for changes in the behaviour of communities between 1100 and 400 cal BC*. The objectives are as follows:

1. To define the concept of a fortified settlement, the spatial and chronological framework of the study;

2. To discuss the problems of evaluating archaeological sources in the study of human behaviour and its perception in different paradigms;

3. To review the history of research on fortified settlements in the Baltic States;

4. To summarise the research data on fortified settlements in the Eastern Baltic region, which allows studying human behaviour in the LBA:

4.1. To describe early fortified settlements;

4.2. To analyse the defensive systems, buildings and other archaeological structures of fortified settlements;

4.3. To review the range of artefacts found in fortified settlements;

5. To determine and review the chronology of fortified settlements;

6. To identify the spatial pattern of early fortified settlements in the Eastern Baltic region;

7. To discuss the economy and diet of fortified settlement communities;

8. To discuss the economic, social and cultural aspects of the behaviour of fortified settlement communities.

Archaeological research was carried out at three fortified settlements in north-eastern Lithuania during the preparation of the dissertation: the Antilgė, Garniai 1, and Mineikiškės hillforts. The latter two settlements date back only to the end of LBA – the very beginning of the pre-Roman period. This means that the data collected there are highly chronologically representative: the finds allow us to formulate statements about the types of wares, livestock, cultivated plants and fortification systems produced in the same period. There are only a few other such sites in the whole Eastern Baltic region, such as the fortified settlements at Kukuliškiai, Luokesai 1, Ridala and Vīnakalns.

The thesis presents 27 new ^{14}C dates from the fortified settlements of Garniai 1, Kurmaičiai, Mineikiškės, Narkūnai,

Nevieriškės and Sokiškės. In addition, another 10 ^{14}C dates were published separately during the preparation of this thesis (Podėnas 2020). This thesis is the first to publish the results of carbon and nitrogen stable isotope analyses of charred organic residues in LBA pottery. Finds from 8 sites were analysed, and a total of 127 measurements were carried out by the *FTMC* (*Center for Physical Sciences and Technology*, Vilnius). ^{14}C dates were used to refine the chronology of three pottery groups (Early Striated, Fine-Rusticated and LBA Smooth Surfaced wares).

The economic development of the Eastern Baltic region is linked both to the developing agricultural economy and to the influence of metallurgy. The thesis seeks to reveal which of these processes is more closely related to the emergence of fortified settlements. The present work distinguishes itself from previous studies on fortified settlements by the size of the defined study area (corresponding to the Baltic States) and by the fact that it is not limited to the material of a single archaeological culture. This allows for a broader analysis of the social development of the communities, their cultural and economic relations and their integration into the interregional contacts that influenced human behaviour.

The following summary is focused on the material and methods, a presentation of the main results, as well as a short discussion of the main questions raised in this thesis.

1. MATERIALS AND METHODS

Fortified settlements in Eastern Baltic archaeology encompass inhabited places surrounded by defensive systems, such as enclosures of irregularly placed stakes, fences interwoven with branches, palisades, wooden walls, raised wooden structures on ramparts and stone walls.

1.1. Fortified settlements in the Eastern Baltic

In the Eastern Baltic region, 53 fortified settlements with LBA horizons have been confidently identified, and the database is supplemented by 22 sites inaccurately dated to the I millennium BC that were also possibly inhabited from the LBA. Most of the latter are located in Lithuania. The list of settlements analysed in this thesis should by no means be treated as an exhaustive list of all possible sites. The present thesis aims to introduce more rigorous chronological criteria in order to address issues related specifically to the Bronze Age economy of the Eastern Baltic communities, the distribution of the fortified settlement pattern, and other synchronous processes. As a result, the sites analysed here are characterised by reliably ^{14}C-dated contexts or high-probability LBA archaeological collections. Such sites include those with finds most characteristic of the Bronze Age, such as bronze artefacts, ceramic casting moulds and bone pins typologically assigned to this period. Archaeological collections with other possible LBA artefacts were singled out separately as being inaccurately dated to the I millennium BC, due to the relatively high probability that the artefacts were made in the Iron Age rather than the LBA. The different dating precision allows for an inclusive analysis of the settlement pattern by reviewing data from more sites.

Fig. 1. Fortified settlements in the Eastern Baltic. Orange dots – sites dated to 1100–400 cal BC, grey dots – sites inaccurately dated to the I millennium BC (see notes 2–6). The base layer map was created by Hnit-Baltic (Lietuvos reljefas n.d.). Drawing by V. Podėnas.

In the absence of other finds or dated contexts in fortified settlements, sporadic finds of pottery (with a striated, smooth or rusticated surface) or isolated stone axes are not considered as sufficient to reliably identify a LBA horizon. This criterion is applied

to lower the risk of confusion of LBA sites with ones dated to later periods. Also excluded from this study are sites where stone axes have been found in the vicinity of the hillfort, but not in a permanent habitation site, usually located on hills or promontories. Individual stone axes, as exceptional items, were regularly rediscovered after the first deposition and were taken to other locations up until modern times. Thus, the cases examined in this thesis consist of sites with at least several attributes of the earliest fortified settlements.

The majority of the analysed fortified settlements are located in Lithuania. Horizons in 25[2] of them date to 1100–400 cal BC with certainty and 19[3] sites are dated with less accuracy to the I millennium BC. Accordingly, 19[4] sites from Latvia were reviewed in the thesis and data from 3[5] supplementary sites dated to the I millennium BC were also described. Currently, there are 6[6] LBA fortified settlements known to exist in Estonia.

[2]Antilgė, Dūkšteliai 1, Garniai 1, Juodonys, Kereliai, Kukuliškiai, Kupiškis, Kurmaičiai, Liškiava, Lokėnėliai, Luokesai 1, Mineikiškės, Moškėnai, Narkūnai, Nemenčinė, Nevieriškė, Pakačinė, Petrešiūnai, Sokiškiai, Spitrėnai, Velikuškės 1, Vilnius (Gediminas' Hill), Vorėnai, Vosgėliai, Žagarė 1.

[3] Antaniškės, Aukštadvaris, Bikūnai 2, Bradeliškės, Bražuolė, Imbarė, Jaurelis, Jurkakalnis, Kalnočiai, Kiūčiai, Kukliai, Maišiagala, Mažulonys, Meškučiai 1, Mielėnai, Sauginiai, Šinkūnai, Šišponiškės, Veršvai.

[4] Asote, Baltkāji, Brikuļi, Dievukalns, Dignāja, Jersika, Klaņģukalns, Klosterkalns, Koknese, Krievu kalns, Ķenteskalns, Ķivutkalns, Madalāni, Mūkukalns, Padure, Paplaka, Rušenīca, Sārumkalns, Smārdes Milzukalns, Stupeļu kalns, Tērvete, Vīnakalns.

[5] Daugmale, Stanovišķi, Žaunerānu.

[6] Asva, Iru, Kaali, Kõivuküla, Narva, Ridala.

1.2. Methods

1.2.1. Typology of the artefacts and timber constructions

The chronology of the finds from the fortified settlements was determined on the basis of typological schemes for different groups of finds (e.g., Baudou 1960; Граудонис 1967; Григалавичене 1980; Graudonis 1989; Lang 1992; Jantzen 2008; Čivilytė 2014), in which the periodisation of the Northern European Bronze Age was applied. Such typological schemes are mostly applied to the analysis of bronze artefacts, their ceramic moulds and bone/antler pins and buttons. These groups of finds are characterised by a greater stylistic diversity, and the chronology of artefacts of uncertain dating is usually referred to by generic epoch names such as EBA, LBA, pre-Roman Iron Age.

The typology of timber structures was analysed according to the spatial distribution of postholes and stakeholes; where data is insufficient, more abstract assessments were applied (e.g., wooden structures raised on ramparts, stone walls with wooden structures). The internal structure of the fortified settlements has been analysed on the basis of published archaeological research, as well as experimental and ethnographic studies.

1.2.2. Principles of spatial analysis

In this thesis, spatial analysis was mainly applied at the regional level. In the individual chapters, spatial analysis is presented in the context of the collected data set. In particular, the settlements have been classified according to the ecotone – the periphery of the predominant or most important water bodies next to the site. This has been taken into account in the analysis of the settlement pattern, as well as in the stable isotope data of the organic residues in the pottery. Secondly, the region is divided into the territorial areas of north-eastern Lithuania, the middle and lower reaches of the Neris

River, western Lithuania, western Latvia, eastern Latvia, the lower reaches of the Daugava River, the island of Saaremaa, northern Estonia and eastern Estonia. All 9 areas are discussed as part of anexamination of the processes of emergence and expansion of fortified settlements. Archaeobotanical data and human diet inferred from the bone collagen isotope analysis are discussed at the level of the Eastern Baltic region. Elsewhere, cases are discussed in relation to the geographical location of the region, and in some cases, a territorial area is indicated on similar principles to those mentioned above (e.g. north-eastern Lithuania, western Latvia/Courland).

1.2.3. ^{14}C dating

The chronology of the fortified settlements can currently be analysed on the basis of 108 ^{14}C dates obtained from different types of samples collected from 23 sites. Of these, animal bone collagen was dated on 16, charred plant grains and seeds on 11, charcoal on 33, wood cellulose on 16, and charred organic residues in pottery on 30 samples.

This thesis presents 25 hitherto unpublished dates, and the dating of a further 10 different herbivore bones has been published in a separate paper (Podėnas 2020). Giedrė Piličiauskienė identified the animal bones published in the aforementioned article and, in this work, one more femur of an individual of the *Bos*/*Bison*. The remaining 24 samples were charred organic residues in pottery.

The dating was carried out at the *Curt-Engelhorn-Zentrum Archaeometrie* in Mannheim (MAMS, Germany) and at the *FTMC* in Vilnius (Lithuania). Radiocarbon ages were calibrated using OxCal 4.4 software and the IntCal 20 calibration curve (Bronk Ramsey 2009; Reimer et al. 2020). The calibrated dates are presented within a 95.4% probability range. In addition, dates previously published in the literature and referred in this paper have also been recalibrated in the same way. Conventional dates with error margins greater than

100 years are also excluded from the database as being of insufficient chronological precision.

1.2.4. Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope analysis

Samples of charred organic residues in pottery include macro food residues on the inner side of the pottery (n=114) and thin-layer patina residues on the outer side (n=13). By application of the elemental analyser – a stable isotope mass spectrometer system (EA-IRMS), their $\delta^{13}C$ and $\delta^{15}N$ values as well as their C:N atomic ratio were measured. The carbon and nitrogen isotope ratios allow the identification of the components of marine, freshwater, terrestrial and C_4 plant food in the sample and interpretation of the trophic level of the food consumed, i.e., the position in the food chain (Tauber 1981; Post 2002; Craig et al. 2007).

Stable isotope analyses for carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) were carried out on 127 samples of charred organic remains found in LBA and a small amount of pre-Roman Iron Age pottery. They consist of organic residues from 8 sites (Garniai 1, Juodonys, Kereliai, Kurmaičiai, Mineikiškės, Narkūnai, Nevieriškės and Sokiškai). Of the samples analysed, carbon and nitrogen amounts were sufficient for measurements in 85 cases.

For the analysis of bone collagen data from the Eastern Baltic region (36 individuals dated to the Bronze Age), a diet reconstruction was applied based on stable isotope studies of fauna and cereals found in the same region. The $\delta^{13}C$ values for animals and cereals were raised by +1 ‰ and the $\delta^{15}N$ values by +4 ‰ (according to Drucker, Bocherens 2004: 164), taking into account the fractionation of these isotopes between food and consumers. This resulted in the expected ranges for diets based on herbivores, omnivores, river and lake fish, lagoon fish and marine fish and seals. Bone collagen measurements that fall within a reliable range of C:N ratios (2.9–3.6; see DeNiro 1985) were used in the analysis.

2. RESULTS AND DISCUSSION

2.1. Settlement structure: defensive systems and buildings

Six types of fortifications can be distinguished in the Bronze Age settlements of the Eastern Baltic region according to the spatial distribution of the features: A – enclosures of irregularly arranged wooden stakes, B – fences interwoven with branches, C – palisades, D – wooden walls, E – raised wooden structures on ramparts, and F – stone walls with wooden structures. Types C and D are further subdivided into sub-types, according to their reinforcement level by wooden constructions. Some defensive systems were further reinforced by ditches and stone cobbles. Settlements may have had different types of fortification used simultaneously, e.g., remains of palisades and fences interwoven with branches have been found at Luokesai 1 and Mūkukalns.

The fortifications investigated at 27 sites, for which dating is not uniformly accurate, allow us to analyse the defensive systems developed in the Eastern Baltic region. In some sites the finds in structures related to the defensive system were directly dated by the ^{14}C method (Brikuļi, Kupiškis, Krievu kalns, Luokesai 1, Mineikiškės, Moškėnai), while in other sites the fortifications were analysed on the basis of contextual dating. For example, assuming that the period of the defensive systems is reflected by the typology and ^{14}C dates of the finds found in the cultural layer and other structures (Asva, Kaali, Kereliai, Kurmaičiai, Kukuliškiai, Ķivutkalns, Narkūnai, Nevieriškės, Padure, Ridala, Smārdes Milzukalns, Sokiškiai, Vīnakalns). In multi-period settlements, relatively earlier fortifications are distinguished from later fortifications according to the typology of finds found in the immediate vicinity (Dievukalns, Juodonys, Mūkukalns). Some more questionable cases (Asote, Klosterkalns, Madalāni, Narva and Spitrėnai) were also included with some reserve to observe if they

reflect a deviation from other discussed cases or coincide with the regional and temporal tendencies of the defensive systems established in the Eastern Baltic.

The earliest dated walls of large posts in western Latvia were technologically more advanced than the later fortifications of irregularly arranged stakes in the periphery of the study region (Vasks et al. 2019; Podėnas et al. 2022). The most technologically advanced fortification complexes developed in the most economically important places of the region, such as the lower reaches of the Daugava River. Social tensions in the Baltic Highlands also encouraged communities to develop defensive systems, but these were relatively simpler.

In fortified settlements, buildings are found on the periphery of the enclosed habitation area, leaving the middle part or one side of the site not built up (Grigalavičienė 1986a: 56, Fig. 5; Vasks 1994: 10, Fig. 5; Lang 2007: 59, Fig. 19). Most of the buildings were of wooden construction, elongated (up to 10 x 3–5 m), rectangular in shape and probably had a gable roof (Lang 2007: 58). Their frame consisted of 6–8 large posts (Luchtanas 1992: 63), but there is also some variation in construction. According to the data from the fortified settlement at Mūkukalns, Graudonis proposed a reconstruction of buildings with 12 load-bearing posts and entrances on the sides (Graudonis 1978: 33).

Sunken buildings were very rare. Lang refers to 4 slightly sunken buildings, 3–5 m wide and 8–10 m long, found in the northern part of the Iru fortified settlement (Lang 1996: 549–550). Their walls consisted of load-bearing posts with additional stone reinforcement. Remains of horizontally inserted logs have been found between the posts (Lang 1996: 39, Fig. 8). A row of postholes indicating a gabled roof was also found down the middle of the buildings (Lang 2007: 59, Fig. 20). Krzywicki found a 6 x 3.5 m sized and 1.5 m deep pit in the Dūkšteliai 1 hillfort and interpreted it as a dug-out building with a clay bottom (Krzywicki 1914: 15, Fig. 2). Furthermore, three hearths were found there.

In addition to the structures mentioned above, stone paving has also been found in the fortified settlements, on the ramparts, near the fortifications, on the edges of the hillforts and in the buildings. Inside the buildings, stone paving was made of sett-sized rocks, and sometimes it was located next to fireplaces (Grigalavičienė 1995: 43). A circular cobble with a regular shape was found in the Moškėnai hillfort, with additional cobbles on the south and east sides (Krzywicki 1917: 5, Fig. 2). The researcher considered it to be a hearth. In the vicinity of the fortification there is also irregularly shaped paving made of stones of various sizes (Krzywicki 1917: Table II–IV; Grigalavičienė 1986a: 54). They are associated with fortifications, buildings and slope-strengthening works. Stones may also have been thrown in some places together with waste. In the fortified settlements on the island of Saaremaa, the interior of some buildings was paved with limestone slabs (Lang 2007: 64).

2.2. Finds in the fortified settlements

The fortified settlements of the Eastern Baltic region have revealed a wide variety of artefacts made of antler, bone, ceramics, stone, various copper alloys and wood. Until recent years, their typological classification was mainly used to study the cultural development of fortified settlement communities and the region as a whole (Граудонис 1967; Lang 1992; Luchtanas 1992; Grigalavičienė 1995). Later, these typological schemes began to be refined by radiometric dates (Lang 2007; Piličiauskas et al. 2011; Paavel et al. 2019; Vengalis et al. 2020), but these studies are still scarce and insufficient for the development of more detailed artefact chronology.

Communities in the Eastern Baltic region used stone tools to cut down trees, work wood, process agricultural products and other materials. In fewer cases, maceheads that functioned only as a weapon were produced. Flint production technology, on the other hand, has by this time regressed considerably, with irregular scrapers

rarely found. Researchers have also pointed out that flint knives, awls, drills and triangular arrowheads could be attributed to LBA contexts (Luchtanas 1992: 64). Stone tools, such as axes, chisels, quern stones, and various grinding and smoothing stones, are much more clearly associated with the contexts of fortified settlements. Remains of the manufacture of shaft-hole axes are also commonly found in fortified settlements. Less frequently, there are saddle quern and net weights.

Antler, bone and tooth artefacts are among the most prevalent non-ceramic finds in Bronze Age fortified settlements. Their variety is related to the production of tools for work, hunting, fishing, parts of garments and, less frequently, weapons. It is noted that there were also a number of ad hoc artefacts without typical forms (Luik 2013: 25). The forms of the artefacts were determined by the material available and the functional purpose of the tool produced, but in some cases the forms and decoration of the more labour-intensive artefacts were determined by cultural traditions (Luik, Ots 2007; Luik 2013: 29-30). The skeletal remains of domesticated animals were the main choice for the production of the pieces, with the occasional use of bones, antler and teeth of wild animals as well. The pieces were made by cutting, breaking, splitting, carving, engraving, grinding and smoothing the chosen material (Luik, Maldre 2007: 26–29).

Bone/antler tools include awls, scrapers/chisels, needles, axes, as well as a variety of tools whose purpose is unclear. Weapons and hunting artefacts include arrowheads, spearheads and harpoons. The bone and antler finds consist of a large number of garment elements. The majority of these were pins of various shapes, but there are also much smaller quantities of buttons. Other bone/antler artefacts not belonging to any of the groups discussed above include pendants, cheekpieces of a horse bit, spoons and finds of an uncertain purpose.

Ceramic finds are most abundant in LBA settlement contexts due to the high degree of fragmentation of the wares. The most abundant are vessel fragments. Sometimes the remains of bronze

casting tools constitute a significant part of the assemblages (Podėnas, Čivilytė 2019), while loom and net weights, scoops and pendants are less frequently found (Luchtanas 1992: 69).

Among the possible uses of LBA ceramic vessels, without first conducting chemical analysis, only bowls and pots for cooking, storage and tableware can be considered. More distinct stylistic elements in the complexes of individual sites, such as ornamental variety and surface treatment, are distinguished in the pottery found in the lower reaches of the Daugava River and on the island of Saaremaa.

The similarity of pottery throughout the region has led to the identification of only two styles (Early Striated and Asva). The predominant vessel shapes vary from one area to another in the Eastern Baltic region. The fortified settlements in the Daugava River basin and in the lowlands of Lake Lubāns are characterised by almost straight-walled (I, IC) vessels (Vasks 1994: 117; Visocka 2020: 94). In the Baltic Uplands, especially south of the Daugava River, there are significantly more fragments of profiled (S-shaped) pottery. In the western areas of the region (Sperling 2014: 213–215; Visocka 2020), and less frequently in the middle areas (Simniškytė 2020: 273), there are finds of rusticated pottery, which is sometimes distinguished by a more pronounced wall profile (type CS), or by the more common shape of pottery (type S). The fortified settlements on the island of Saaremaa show a much greater variety of stylistic elements, with a different production technology for the preparation of coarse-grained and fine-grained clay masses, a greater variety of surface treatments, vessel shapes, ornaments and plastic details.

The surface of ceramic vessels produced in the Eastern Baltic region was treated in 5 ways. Most collections from fortified settlements in Lithuania and Latvia are dominated by vessels with a striated surface, whereas vessels from Saaremaa Island, northern Estonia, the area around Lake Lubāns and the Baltic Sea coast are smooth. Fine-rusticated, textile and burnished pottery is also found in the region. In some cases, these different surface treatments were

combined to produce hybrid ceramics, for example, by adding a layer of coarseness over the striated surfaces or by forming textile impressions (Visocka 2020: 91, Fig. 7).

Early Striated pottery is divided, according to the predominant vessel shapes, into Variant A, which is characterised by more S type vessels, and Variant B, which is characterised by the more commonly produced straight-walled (I/IC type) vessels. These variants differ in their spatial distribution. In contrast, Asva-style pottery is traditionally divided into coarse-grained and fine-grained (Lang 2007: 127–129; Sperling 2014: 179, Table 10), but vessels of both functional groups are found in fortified settlements at Asva, Iru, Kaali and Ridala.

Finds of other groups of pottery are much less abundant in fortified settlements. The most common of these was Fine-Rusticated pottery in fortified settlements, which varied in quantity from single vessels to 13–22.1 % in the assemblages. Fine-Rusticated pottery is widely known from the settlements and funerary sites of the West Balt Barrow culture, and it is therefore not surprising that it is found in larger quantities in the peripheral areas of this culture and in the near-neighbouring areas (Vengalis et al. 2020: 25–28).

Ceramic bronze casting tools, such as moulds and crucibles, in the fortified settlements allow us to identify one of the most culturally significant processes in the Eastern Baltic region, which influenced socio-economic relations between communities. Remains of bronze casting tools have been found in 35 fortified settlements in the Eastern Baltic region (Podėnas, Čivilytė 2019: appendix 1). Finds of ceramic moulds and crucibles at these sites vary from single finds to large collections of more than 1200 fragments. These finds have encouraged researchers to develop theories ranging from bronze processing centres to activities of itinerant metallurgists. The rarity of raw material for smelting metal meant that bronze was of high value to the local inhabitants, especially for the production of weapons, tools and jewellery.

The majority of metallurgical ceramics consist of fragments of moulds for ring-shaped artefacts. These moulds may have been used to cast ingots, bracelets or neck-rings. These moulds are characterised by a very high degree of fragmentation, as the cast piece can only be removed after the mould has been completely broken.

The bivalve moulds in the Eastern Baltic region allow a more specific determination of the function and type of the casted artefacts. They were mainly used for the production of bronze axes. Of the moulds whose negatives allow for a more precise identification of the type, the predominant is Mälar axes. In the Baltic States, the moulds for these axes have been found in 10 fortified settlements, and the axes themselves in 9 sites, one of which is a fortified settlement (Kļanģukalns). Like the ring-shaped wares, this type of axe was produced in different sizes and the ornamentation applied varied. Archaeologists who have studied axes and moulds found in the Baltic States agree that their ornamentation is typical of the Western tradition (Luchtanas 1981: 9–11; Grigalavičienė 1995: 105; Čivilytė 2014: 182–183; Podėnas, Čivilytė 2019: 186–188). They also refer to Scandinavia as the main destination from which these axes were imported or from which the itinerant metallurgists who produced these items came (Luchtanas, Sidrys 1999: 30–31; Lang 2007: 119; Podėnas, Čivilytė 2019: 186–188). Typologically, the Mälar axes have been dated by different researchers to the periods IV–VI (Baudou 1960: 19-20; Kuz'minych 1996; Čivilytė 2014: 115–116; Melheim 2015: 196).

Other types of axes were produced less frequently: only the moulds from the fortified settlements of Dievukalns and Sokiškiai are known. Their size varies considerably: at Sokiškiai, a very small axe was produced, slightly longer than 4.5 cm. Its handle was formed in the middle part, which thus contained two elongated semicircular notches (Grigalavičienė 1986b: 119–120, Fig. 24: 1). An exceptional axe was cast at Dievukalns: its mouth was also formed in the middle part of the axe, closer to the opening, which was surrounded by a

horizontal groove. Two L-shaped notches were also formed from the mouth part, which continued along the sides of the axe towards the blade (Podėnas, Čivilytė 2019: 176, Fig. 5). With the exception of the location of the handle, the axe produced in Dievukalns casting mould is very similar to those found in the Kalinówka Kościelna hoard (north-eastern Poland) (Gimbutas 1965: 437, Fig. 295: 4). Typologically, they are dated to the period VI.

The remaining bivalve moulds in the East Baltic region produced bronze spearheads and pins. Casting moulds of spearheads have been found in the fortified settlements of Asva, Brikuļi and Mūkukalns. Most of them were designed for unornamented socketed spearheads, typical for the whole LBA. Only the casting mould from Mūkukalns, 6 small grooves, distributed in groups of 3, were formed near the mouth (Podėnas, Čivilytė 2019: 177, Fig. 6). This ornamental motif is characteristic of Pfahlbau-type spearheads dating from the period V to VI (Baudou 1960: 14, taf. III: IV C). Pins of the Härnevi type, produced in the fortified settlement of Asva, are dated to the same periods (Sperling 2014: 148, 439, Table 10).

Ceramic crucibles in the Eastern Baltic region were of the same forms as in Central Europe, Great Britain and Scandinavia (Jantzen 2008: Table 45–56; Sahlen 2011: 33, Fig. 2.1). These are oval pieces, with a funnel on one side to control the flow of the alloy. They could have been either footed (Graudonis 1989: 44, Fig. 24) or flat-bottomed (Sperling 2014: 440, Table 11; Podėnas, Čivilytė 2019: 173, Fig. 1).

In the LBA, bronze casting was most likely carried out by itinerant metallurgists, who may have also transported ingots. They supplied different markets in fortified settlements (Podėnas, Čivilytė 2019: 176–178). It is likely that the communities of fortified settlements at the time did not have sufficient quantities of bronze material to successfully experiment and adopt metalworking skills. The production of wares from predominantly Scandinavian and Lusitanian traditions also does not support the hypothesis of the existence of local craftsmen.

In addition to vessels and bronze casting tools, loom and net weights, pendants and ceramic sieves from the fortified settlements of the LBA are found in much smaller quantities.

LBA-dated metalwork has been found in at least 3 Lithuanian (Garniai 1, Luokesai 1, Narkūnai), 8 Latvian (Brikuļi, Jersika, Klaņģukalns, Krievu kalns, Ķivutkalns, Mūkukalns, Smārdes Milzukalns, Vīnakalns) and 3 Estonian fortified settlements (Asva, Iru, Ridala). This list could be extended by at least 6 more sites (Kereliai, Mineikiškės, Nevieriškės, Daugmale, Madalāni, Paplaka), but the artefacts found there are not exclusively dated to the Bronze Age, and it remains possible that some were made in the pre-Roman Iron Age or even later. Furthermore, a Härnevi bronze pin of the same period found in the vicinity of the fortified settlement of Kaali (Lang 2007: 77) was most likely left by the community that inhabited the aforementioned site.

A total of 14–19 different types of metal artefacts dating back to the LBA have been found in the fortified settlements in the eastern Baltic region. Most of them were jewellery and parts of garments: mushroom-headed, cylindrical, spiral, flat-headed, and Härnevi-type pins, plain and torsioned neck-rings, banded bracelets, spectacle-shaped pendants, tutuli, buttons/plates, and spiral brooches. Less frequent are finds belonging to the categories of tools and weapons, such as Mälar-type and plain socketed axes, spearheads, razors, awls and chisels. In at least a few fortified settlements, there were also pieces of horse clothing, such as plates for decorating the upper part of the bit. Although the small quantities of metalwork in the region allow us to discuss their high value and the importance of social symbols, they were not only intended to show prestige, but also functioned in everyday activities (e.g., bronze axes; Čivilytė 2014: 154). At Luokesai 1, some of the poles were worked with metal axes (cf. Jennings 2008). Bronze finds are mostly found in areas closer to the sea and potential metal movement routes, i.e., the banks of larger rivers. These findings are consistent with the distribution of bronze casting waste, but also allow us to distinguish a few cases, such as

the importance of the Brikuļi fortified settlement and Lake Lubāns in the LBA metal exchange.

There are significantly fewer artefacts of other materials than those discussed above in fortified settlements. The presence of wooden artefacts in archaeological contexts is limited by exceptional waterlogged conditions, while amber is limited by survival conditions and culture. In the Eastern Baltic region, investigations of the fortified settlement at Luokesai 1 have provided more detailed insight into the variety of manufactured wooden wares. During the investigations, wooden spoons and scoops, axe handles, oars, a crusher, a hook for making nets and fabrics, a rack and a beater-mixer were discovered and some of the finds remain unidentified (Pranckėnaitė 2012: 93, 96–97, 197, 201–202, Fig. 78, 84: 3, 85; 2014: 350, Fig. 10). In addition, 15 fragments of rope, 4 birch bark buckets, remains of a fish trap, fishing floats, a button made of birch bark, and other artefacts were also found in the fortified settlement (Pranckėnaitė 2012: 97, 200, 201, 204, 207, 210, Fig. 83: 1, 84: 1–2, 88, 91, 95: 3–4).

The importance of amber has clearly diminished in the LBA compared to the Subneolithic and Neolithic periods (Bliujienė 2007: 202), so it is not surprising that it is scarce in fortified settlements as well. Raw amber and single articles are found in areas close to the sea, with more in the lower reaches of the Daugava River (Bliujienė 2007: 192, Fig. 118). In the fortified settlement of Ķivutkalns, 3 amber pendants, 2 beads, 7 double buttons and tutuli, 8 unfinished pendants or beads and 59 pieces of raw material were found (Graudonis 1989: 30–32). This small collection is exceptional in comparison with collections from other settlements, which usually consist of sparse and small pieces of raw material, and rarely of fragments of pendants (Bliujienė 2007: 443, appendix 6).

2.3. Chronology and fortified settlement pattern

New ^{14}C dates were obtained by dating samples collected mainly in the fortified settlements established in north-eastern Lithuania, as well as 1 sample of charred organic residues from a fragment of Fine-Rusticated pottery found in the Kurmaičiai hillfort. All of these dates were calibrated to the Halstatt Plateau (800–400 cal BC), therefore it is important to reassess the dates published by other researchers in order to further investigate the process of the emergence and early development of the fortified settlements.

The largest number of accumulated dates are from the contexts of fortified settlement in eastern Lithuania (north-eastern Lithuania and the middle and lower Neris River). There are 64 known dates in total. Eastern Lithuania is also notable for its abundance of dated sites. Data from 12 fortified settlements have been collected: Antilgė, Garniai 1, Kereliai, Kupiškis, Lokėnėliai, Luokesai 1, Mineikiškės, Moškėnai, Narkūnai, Nevieriškės, Sokiškiai and Vilnius (Gediminas' Hill). The area is distinguished by the total number of known fortified settlements in the Eastern Baltic region. With the exception of three dates (Lokėnėliai Vs-2419; Luokesai 1 Vs-1875; Vs-1875(?)), obtained at a conventional laboratory in Vilnius, all the dates fall within the Halstatt Plateau on the calibration curve. The Vs-1875 date of Luokesai 1 may have been influenced by the old wood effect, while the Vs-1875(?) date was obtained on tree root, i.e., probably unrelated to the timber of the fortified settlement. The date of the wood sample from the Lokėnėliai hillfort, which pre-dates the Halstatt Plateau, should also be considered with some reserve: artefacts typologically dated only to the LBA have not been found in the site.

In the area of western Lithuania, 2 fortified settlements have been dated: Kukuliškiai and Kurmaičiai. The period in question includes 9 dates, which are also calibrated within the boundaries of the Halstatt Plateau. However, the date range of Kurmaičiai (FTMC-

OA59-4) also covers a significant part of the pre-Roman Iron Age – 749–235 cal BC.

Contexts of fortified settlements in the western Latvian area have also been dated at two sites: Krievu Kalns and Padure. A total of 6 dates are known, 2 of which cover the period prior to the Halstatt Plateau. One was obtained by dating charcoal (Tln-3519: 2779 ± 50, or 1048–816 cal BC) found in a posthole of Palisade A in Krievu Kalns, the other date was of charcoal from hearth No. 2 in Padure (LE-6682: 2890 ± 100, or 1381–833 cal BC). The contexts of the selected samples are reliable, but they are represented by only one date each for this early period. The remaining dates from other fortified settlement structures on Krievu Hill are calibrated within the boundaries of the Halstatt Plateau.

The development of fortified settlements in the lower reaches of the Daugava River area is known only from the samples collected at Ķivutkalns. The database includes 7 dates from fortified settlement contexts. There is considerable debate in the literature about the formation of the archaeological layer of the fortified settlement of Ķivutkalns, as a burial ground was also found underneath it. It was previously assumed that the fortified settlement was established only after burying in the cemetary had ceased, i.e., there should be no graves in the burial ground later than the fortified settlement. Three different studies have dated 20 burials out of 247 found at the site (Oinonen et al. 2013; Vasks, Zariņa 2014; Mittnik et al. 2018). Most of the dates from the Ķivutkalns burial site are calibrated within the boundaries of the Halstatt Plateau, but some of the dated graves, such as 157 and 209 (194?), were established later. These graves date to 478–204 cal BC. Therefore, it is also important to take into account the possibility that there were several interchanging phases between the settlement and the burial site. The dates of the two charcoal samples found in the settlement cultural layer are even earlier than those of the earliest burials (LE-2032: 2750 ± 40, or 992–813 cal BC; TA-436: 2675 ± 60, or 983–771 cal BC, published in: Graudonis 1989). At least 4 phases of defensive fortification have been

identified in Ķivutkalns, which may also reflect separate periods of occupation. Between these settlement phases, it is quite possible that the site was used as a burial site. In addition, the significant movement of soil during construction of the fortifications may have concealed the traces of some diggings. Of course, the two early charcoal dates mentioned above may have also been caused by the old wood effect, so that no definite conclusions can yet be drawn about the beginning of the fortified settlement at Ķivutkalns. However, it is likely that the first fortified settlements in the lower reaches of the Daugava River were early, as they were close to the sea, established next to the main trade route in the region. Thus, the dating of the fortified settlement of Ķivutkalns from the end of Period IV / Period V is plausible.

The chronology of the fortified settlements established in Eastern Latvia can only be established on the basis of sparse data from Brikuļi. Three charcoal samples collected there in different fortification and cultural layer contexts have been dated to ca. 900–400 cal BC (Vasks 1994: 55–56, 117–118). One of these dates does not fall within the boundaries of the Hallstatt Plateau, namely, of a charcoal sample from a structure found in the posthole of a palisade (LE-1769: 2630 ± 40, or 900–767 cal BC).

Only one fortified settlement at Kõivuküla is known in eastern Estonia, in an area lying further from the sea. There, a cultural layer dated to 922–551 cal BC was discovered under a rampart constructed between 234–576 cal AD (Valk et al. 2012: 30). This dating is consistent with the typological dating of the finds: fragments of casting moulds for ring-shaped artefacts were found in the settlement, while a bone awl, textile and Fine-Rusticated pottery were also found in the layer beneath the rampart.

In northern Estonia, in an area close to the coast, two settlements have been investigated, of which Iru is considered to be fortified, while the fortifications at Narva have been questioned if they are dated to the LBA (Lang 2007: 57–60; 66–67). Most of the early dates for the fortified settlement at Iru are calibrated within the

Halstatt Plateau and indicate a probable occupation period of ca. 900–400 cal BC. The dating of charred organic residue in pottery fragments from Narva resulted in an even earlier period: ca. 1250–900 cal BC. However, the charred organic residues have not been measured by EA-IRMS, GC-MS or GC-IRMS and it is unclear if the risk of freshwater reservoir effect (FRE) is apparent.

Asva fortified settlement has been extensively dated by applying different types of samples (charcoal, charred organic residues in pottery, animal bone collagen). All but one of the published dates are calibrated within the Halstatt Plateau (800–400 cal BC). A sample of charred organic residues from Asva-style coarse-grained pottery was dated to 917–809 cal BC (Sperling 2014: 307–315). Based on this date, the earliest period of occupation of the fortified settlement can only be determined with some uncertainty, as this sample was not measured by EA-IRMS, GC-MS or GC-IRMS to assess the risk of FRE. The lower two horizons separated by a layer of charcoal have been dated within the boundaries of the Hallstatt Plateau in Area G.

Summarising the compiled database of early ^{14}C dates, it can be concluded that it is still too sparse and does not yet provide unequivocal answers to the questions of emergence and early spread of the fortified settlements in the region. As a result, there are two likely concepts of the early development of fortified settlements in the region. The first could assess the Narva dates as reliable reflections of the earliest fortified settlements and point to the direction of socio-economic, and possibly ethnic, impulses from the east in 1250–900 cal BC. Lang developed the theory of multiple waves of migrations of Finno-Ugric hunter-fishermen from the east and suggested that their descendants were at least partly responsible for the first broader wave of fortified settlements no earlier than the first quarter of the 1st millennium BC (Lang 2018: 28). The second conception traditionally associates the emergence of fortified settlements with local communities and their need to defend themselves. It has been argued that defence was needed against external threats or against neighbouring communities, with tensions

arising in certain areas due to socio-economic differences, disagreements over territory and the accumulation of wealth that allowed engagement in a exchange networks (Lõugas 1970; Luchtanas 1992; Podėnas, Čivilytė 2019; Podėnas 2020). By paying attention to the clearer dated contexts of fortified settlements in the western areas of the Eastern Baltic region, it can be assumed that the first fortified settlements emerged in the lower Daugava, in Courland, and on the island of Saaremaa between 1100 and 800 cal BC, and that they spread in the Eastern Baltic region via the coastal, Daugava River, and then other river routes. It is likely that the creation of fortified settlements stimulated a reaction from surrounding communities, resulting in the further spread of this type of sites.

The hypothesis of two independent processes from the west and the east leading to the emergence of fortified settlements has also been considered in the past (Podėnas 2020), but it is questionable due to the lack of evidence of active cultural influence from the east in Lithuania and Latvia. Finally, it is possible that the first fortified settlements in both western and eastern areas appeared at a similar time due to the influence of the same process. After all, the earliest dates of the fortified settlements at Asva, Brikuļi, Krievu kalns, Ķivutkalns and Padure overlap within the 9th century BC. However, almost all of the remaining later fortified settlements are dated broadly and it is difficult to trace further regional development. Therefore it is possible to analyse only the processes of the overall settlement pattern.

The diversity of soils, river and lake networks and topography has contributed to an uneven distribution of fortified settlements. In terms of overall regional trends, the choice of locations near rivers was the most frequent (72%). The Daugava River is the most significant of the major rivers, with as many as 9 fortified settlements dated to the LBA (Asote, Dievukalns, Dignāja, Jersika, Klaņģukalns, Koknese, Ķivutkalns, Mūkukalns, Vīnakalns, Daugmale). In some of these sites, one of the strongest fortifications have also been found.

On other rivers only 2 fortified settlements are known, i.e., near the Nemunas (Liškiava, Veršvai), Neris (Vilnius, Lokėnėliai), Venta (Krievu kalns, Padure), Lėvuo (Kupiškis, Kiūčiai) and Tērvete (Klosterkalns, Tērvete) rivers. Only one fortified settlement is known along the other larger rivers. A number of fortified settlements were also established along small or unnamed rivers. The latter settlements are more typical of north-eastern Lithuania and south-eastern Latvia. There are also a number of fortified settlements established by lakes, therefore at least several settlement approaches can be observed. The fortified settlements where a greater quantity of bronze casting waste was found are located along the major rivers and sea. This correlation reflects the economic importance of trade routes for communities in the LBA, while others seem to be moving away from them, preferring more remote locations away from the main trade routes. It is currently unclear what the earlier settlement network was in the EBA and how it has evolved since the emergence of fortified settlements. Communities in the Eastern Baltic region changed their place of residence at least couple of times during the lifespan of a generation, which may have led to further disputes with other communities over settlement areas.

Evidence from the contemporaneous lake settlements of the Lusatian (Biskupin) and West Balt Barrow cultures (Mołtajny, Pieczarki) cultures suggests that these sites were occupied for up to 40 years (Gackowski 2000; Bleicher 2014: 363–364). The dendrochronological data collected at Luokesai 1 suggests that it was in use for at least 16 years (Bleicher 2014: 363). It is likely that other fortified settlements in the region were inhabited for periods of a dozen to several dozen years, but probably not more than 40 years. The considered reasons for abandonment of fortified settlements range from depletion of natural resources, degradation of fields and climate change to external social pressures.

The developed fortified settlement pattern in the Eastern Baltic region during the LBA can be divided into three main areas, reflecting the economic and subsistence strategies of the

communities. Currently, the available albeit scarce data allows identication of the earliest fortified settlements in areas close to the sea, where the first impulses for the emergence of such sites in the Circum-Baltic economic sphere arose. In the western areas of the region, and on the island of Saaremaa the spread of fortified settlements must have been triggered by the threat of potential danger, and it is likely that coastal contacts were not entirely peaceful. The second group, associated with the most important river in the region, which is also an economic route, connects the fortified settlements established along the Daugava. Most of these may have been established later than the very first fortified settlements in the region and reflect the subsequent development of communities. The decision to move closer to the economic route rather than away from it reflects the active position of these communities and their desire to establish themselves in an important part of the region. In this way, they sought greater control over movement along the Daugava River and enabled themselves to develop exchanges with groups of people travelling from the sea to the mainland. Furthermore, these actions may have caused further conflicts amongst other communities having similar aims. The fortifications enabled them to defend themselves efficiently if necessary. The relevance of the latter need is underlined by the most developed fortifications (Ķivutkalns, Vīnakalns) in the Eastern Baltic region, which were built using complex systems of ramparts reinforced with stone, clay and wooden structures, raised wooden palisades and walls, as well as ditches. The third, and most numerous, group of fortified settlements is spread over a wide stretch of the Baltic Uplands in eastern Lithuania and south-eastern Latvia. These fortified settlements were built along smaller rivers, streams and lakes, i.e., away from major trade routes. However, this does not mean that there is no evidence of exchange and that they were not exposed to bronze imports. Comparably with sites established near the lower reaches of the Daugava and on Saaremaa Island, there are far fewer bronze casting remains in the settlements of this inland area of the region (Podėnas, Čivilytė 2019: appendix 1). In the eastern

part of the region, the quantities of bronze casting waste found in the fortified settlements of Brikuļi and Narkūnai are distinctive from the rest of the sites investigated in this area, suggesting more successful attempts at developing exchange by individual communities. However, there are also a number of fortified settlements in the area where no evidence of bronze exchange has been found, for example at Nevieriškė. The communities of the Baltic Uplands had a larger space to choose from for their settlements compared to those seeking to settle near the Daugava, resulting in different competitive relationships.

2.4. Economy and diet

The economy and diet of the communities that established fortified settlements in the Eastern Baltic region have been studied on the basis of archaeological finds, zooarchaeological and archaeobotanical material. The diet of LBA communities has also been investigated using carbon and nitrogen stable isotope analysis of bone collagen of human remains found in Ķivutkalns, Muuksi, Reznes, Turlojiškės and Zvejnieki. Research on organic residues in pottery found in the fortified settlements has been lacking, a gap that this study aims to partly fill.

Summarising the zooarchaeological studies in the Eastern Baltic region, it can be unequivocally stated that livestock rearing was one of the main economic activities of the population. During the LBA, variations are observed in the species distribution of livestock in different areas of the region: pigs were most common in eastern Lithuania, cattle and possibly horses in western Latvia, cattle and pigs in the lower Daugava River, cattle in the vicinity of Lake Lubāns, and sheep/goats in Saaremaa. Hunting was important for fur in some areas, meat in others and, in the case of Saaremaa, seal blubber. Such variations indicate not only the different economic activities and diets of the inhabitants, but also the availability of possible goods for exchange.

The package of crops cultivated in the Eastern Baltic region during the LBA included a wide range of species, consisting of cereals (*Hordeum vulgare*, *Triticum aestivum/durum*, *Tr. dicoccum*, *Tr. spelta*, *Panicum miliaceum*), legumes (*Lens culinaris, Pisum sativum, Vicia faba*), and oil/fibre crops (*Camelina sativa*) (Minkevičius 2020: 104). The crop package is typical for intensive farming on permanent fields (Minkevičius 2020: 107–109; et al. 2020). Compared to the latter, extensive (e.g., slash-and-burn) agriculture can provide higher yields in the first year after burning, but cannot be developed as a long-term strategy due to the ongoing need for dense, wooded areas in the same area. After one growing season, a fallow break of about 12 years is needed before sufficient wood for a new burn grows again (Rösch et al. 2002: 153).

Communities in fortified settlements also used wild plant resources for food, which allowed them to diversify their diet. Remains of *Trapa natans* have been found at Luokesai 1 (Pollmann 2014: 409, table 1). *Corylus avellana* remains have been found in the fortified settlements of Garniai 1, Kukuliškiai and Luokesai 1 (Pollmann 2014: 409, Table 1; Minkevičius et al. 2020; Grikpėdis 2021: 215, Table 9). Samples from Kukuliškiai also contained macrofossils of *Malus sylvestris* and *Rubus idaeus* (Minkevičius et al. 2020). Remains of *Rubus* sp. were found in the Mineikiškės hillfort (Grikpėdis 2021: 219, Table 13). In posthole No. 7 of Kupiškis hillfort, dated to 755–413 cal BC (2σ), burnt remains of *Fragaria*/*Potentilla*, *Rubus idaeus* and *Sorbus* sp. were found (Simniškytė 2020: 269, Table 2).

In recent years, studies of food remains in pottery have provided significant insights into the development of the Eastern Baltic population's diet from 5200–1000 cal BC (Heron et al. 2015; Oras et al. 2017; Piličiauskas et al. 2018; 2021; Robson et al. 2019). Therefore, organic remains in the pottery of fortified settlements are an excellent source for observing further changes in diet and the culinary practices of Eastern Baltic communities. In this thesis, only the results of carbon and nitrogen bulk isotope analyses are

discussed. Lipid biomarkers, which would allow for a much more precise and broader discussion of the origin of different foodstuffs, have not yet been identified in pottery from fortified settlements. Thus, the data analysed below only offer a rough suggestion of very broad food groups.

The $\delta^{13}C$ and $\delta^{15}N$ values of the charred organic residues found in the pottery indicate a predominantly terrestrial diet in the LBA. The mean values of the food residues in the ceramics are: $\delta^{13}C$ -24.5 ‰ ± 2.4 (1σ), $\delta^{15}N$ 5.3 ‰ ± 1.4 (1σ). The values of the mixed ingredients, reflecting information from up to several cooking events, and the limitations of the method used, allow the identification of only a very broad range of foods. It is also unclear whether the higher nitrogen values are caused by aquatic foods or by plants grown in fertilised fields and animals fed on them. The boundary between terrestrial and aquatic food is distinguished at a range of $\delta^{15}N$ values of 6–8 ‰ (Taché, Craig 2015; Piličiauskas et al. 2018: 15, with further references there). Of the collected data, only 1 case exceeds this range: charred food remains (8.19 ‰) on pottery found at Nevieriškės. 27 cases fall within the distinguished threshold ($\delta^{15}N$ 6–8 ‰). According to this criterion, the probability of the presence of aquatic food is only 32.9 % from the total samples measured. Comparing these results with organic residue studies of earlier periods, a significant change in diet and culinary practices between 1200 and 800 cal BC can be identified (Piličiauskas et al. 2018: 21, Fig. 11; Robson et al. 2019: 4016, Fig. 4). It can be explained by the intensification of agriculture and animal husbandry during the LBA and the decline of the importance of fishing in the economy of the fortified settlement communities. However, these insights are only applicable for two areas in the Eastern Baltic region so far: north-eastern and western Lithuania.

The increase in the importance of agriculture is also reflected in less negative $\delta^{13}C$ values. A group of measurements (n=14) ranging from $\delta^{13}C$ -21.8 ‰ to -17.6 ‰ (mean -20.0 $\delta^{13}C$ ± 1.4 (1σ)) and $\delta^{15}N$ 4.0 ‰ to 6.3 ‰ (mean 5.0 ± 0.7 (1σ)) stand out from the collected

data. The most relevant for the interpretation of this scenario are the C_4 plants with less negative $\delta^{13}C$ values. Thus, in these 14 vessels (16.5 % of all measured), millet was cooked together with other ingredients.

In addition to the criteria discussed above, dietary studies also use a comparison of the C:N atomic mass ratio with $\delta^{15}N$ values. C:N values below 10 are used to identify the likelihood of food of aquatic origin (Piličiauskas et al. 2018). In this respect, one sample, the single sample from the Narkūnai, had a particularly low C:N value of 5.3, but its $\delta^{15}N$ value of 4.4‰ is lower than that of a typical aquatic food. All other samples were much closer to the 10 C:N threshold. Considering the foodstuffs in terms of C:N atomic mass ratios and higher $\delta^{15}N$ values, a higher probability of aquatic-origin foods is observed in material from sites located near rivers.

Organic residue studies suggest that values below 22 C:N reflect terrestrial-derived animal and marine food (Heron et al. 2016: 40). Higher values of the atomic mass ratio could reflect the presence of plant-based ingredients in the food. Charred remains of modern starchy foods exhibit even higher C:N values above 40 (Yoshida et al. 2013, fig. 4). In pottery from fortified settlements, higher values of 22 C:N were detected in 25 cases and higher than 40 C:N in 13 cases.

Stable isotope studies of bone collagen from Bronze Age individuals in the Eastern Baltic region have been carried out in 36 cases (Eriksson et al. 2003; Antanaitis-Jacobs et al. 2009; Laneman, Lang 2013; Oinonen et al. 2013; Tõrv, Meadows 2015; Piličiauskas et al. 2017b; Legzdiņa et al. 2020). This is sufficient for an overview of general dietary trends and their development in the Eastern Baltic region and for comparison with Late Mesolithic, Sub-Neolithic and Neolithic individuals.

Late Mesolithic – LBA dietary changes of the Eastern Baltic population were from predominantly aquatic to predominantly terrestrial foods. More pronounced changes in the diet of the Eastern Baltic population can be seen in the Neolithic and Late Bronze Age

(Piličiauskas et al. 2017b: 535–541). These can be linked to the development of the economy: in the Neolithic, domesticated animals appear and spread, and in the late EBA, crop agriculture spreads. The $\delta^{13}C$ and $\delta^{15}N$ values of individuals from Kivisaare I and Kivisaare II (Tõrv, Meadows 2015) stand out from the rest of the Bronze Age individuals studied and indicate that there were still communities in central Estonia in the EBA that subsisted in a similar way to the Subneolithic fishers and hunters.

In the Bronze Age, the most important changes in the dietary development of the Eastern Baltic region can be seen already in the transition period from EBA to LBA. A decrease of fish from rivers and lakes and an increase in the consumption of meat from herbivores and omnivores can be distinguished in the diet. An even more pronounced increase in the consumption of terrestrial foods is seen in the bone collagen of the LBA population. Their carbon and nitrogen isotope ratio values fall just within the range of diets based on herbivorous and omnivorous animals, while those buried at Turlojiškė, some individuals from the Ķivutkalns cemetery and the Reznes barrows were distinguished by even higher $\delta^{13}C$ values, indicating a significant consumption of millet.

2.5. Economic, social and cultural aspects of Eastern Baltic communities' behaviour

The emergence of fortified settlements is commonly associated with an increase in defence needs, an interpretation supported by ethnographic examples (Poplawski et al. 2012). The existence of defence-ready areas indicates the risk of conflict, attack and loss of accumulated wealth. Researchers attributed the increased need for defence to the emergence of political and economic centres in individual micro-regions (Lang 1996: 620).

In the search for the causes of social tensions in the Bronze Age, previous studies have focused on disagreements between different farming communities over land ownership (Lang 2007: 261–262),

conflicts between livestock breeders over territory and their main asset (livestock) (Daugnora, Girininkas 2004: 169–170), and consequences of the process of social hierarchisation (Merkevičius 2007: 102). Other researchers have pointed out that the earliest hillforts were located near important trade routes and in areas under their influence (Luchtanas 1992: 74). The need for controlled territories for farming would probably lead to a differently developed fortified settlement pattern, concentrating, for example, on more fertile soils, which has not been observed (Minkevičius 2020: 106). It is likely that some social structural changes in the LBA were stimulated by newly developed trade routes, but these were not significant enough to be reflected in ritual practices and funerary customs, as the grave goods were not numerous at the time.

The earliest ^{14}C dates of fortified settlement structures indicate their appearance in the western areas of the Eastern Baltic region. The first fortified settlements ca. 1100–850 cal BC were established sporadically in western Latvia. Isolated early dates are also known from the lower reaches of the Daugava River (ca. 1000–800 cal BC), eastern Latvia, the vicinity of Lake Lubāns (900–750 cal BC) and the island of Saaremaa (917–809 cal BC). The earliest fortified settlements suggest that already during the periods IV–V, exchanges in these areas were developing and that communities were seeking to protect their accumulated wealth. There is evidence of bronze casting in the very earliest fortified settlements, therefore metal exchange probably influenced the development, and possibly the emergence, of fortified settlements. In these areas, the spread of fortified settlements and trade intensified in Period VI, but this type of settlement strategy spread into other areas of the Eastern Baltic region to a much lesser extent. Some communities surrounding the most important trade routes could have established their fortified settlements as a response to increased conflicts. The densest network of fortified settlements developed in north-eastern Lithuania and south-eastern Latvia, but, assessing the likely short-term nature of these settlements, the number of such sites existing at any one time is

probably less than is currently distinguishable across the LBA. Some of the early fortified settlements may have been inhabited only once in the LBA, while others were returned to.

The communities that established fortified settlements were mainly involved in animal husbandry and crop agriculture. Hunting and fishing was observed to be more prominent only in several sites, and the inhabitants of the island of Saaremaa were distinguished by their practice of seal hunting. The data collected so far suggest an economic differentiation in the region, with varying predominating animal species found in different areas. Some communities also hunted smaller wild animals for their fur, which could also be potential objects of exchange, while others hunted large animals to supplement their meat supplies. The most important sources of carbohydrates, proteins and fats could be produced by the communities themselves. Evidence from fortified settlements suggests that subsistence strategies were sufficiently differentiated to reduce the potential risk of food shortages.

Economic differentiation in the East Baltic region has enabled individual communities to acquire a surplus of certain products as potential objects of exchange. These could include livestock, grain, furs (Vasks 1994: 119), wax and amber. However, it is difficult to answer why there are far fewer fortified settlements in other areas of the Eastern Baltic region. To explain this, it is important to note that fortified settlements differ from the unfortified settlements by the presence of bronze casting waste in the archaeological record.

It is likely that fortified settlements first spread along metal trade routes near the sea, and then, via the Daugava River, spread further into the continental part of the eastern Baltic region (cf. Luchtanas, Sidrys 1999: 21, 25, 30, Fig. 3, 8, 13), where the settled communities were also actively involved in the evolving local and interregional exchanges.

Communication networks spanning at least three levels have developed in the Eastern Baltic region as a result of early metallurgy (Podėnas, Čivilytė 2019: 183–188). The first level of communication

networks covered only communities located in the region, ranging from potential Scandinavian settlements to fortified settlements. In addition, metal may have continued to spread to unfortified settlements through fortified settlement communities as mediators. Potential Scandinavian settlements are indicated by burial sites with stone ship graves, of which only 10 are known in the whole region. In Courland, slightly more are known of (Lībe, Mušiņa, Bīlavi, Birznieki, Lielrenda, Paušas, Plintiņi, Pojas; see Граудонис 1967: 68–73), while in Estonia they have been found at only two sites (Lülle, the island of Saaremaa, and Väo, a site close to the fortified settlement at Iru; see Lang 2007: 164–166). Wehlin noted that the Staldzene and Tehumardi hoards could also be associated with these burials (Wehlin 2013: 85, Fig. 5.3). The theoretical model of exchange draws attention to predominantly Scandinavian cast ware types, as well as linking potential contacts between Scandinavian settlements and local fortified settlements and formulating the hypothesis of itinerant metallurgists. Future strontium isotope studies can test the provenance of buried individuals in the stone ship graves and thus extend the discussion on human mobility in the LBA.

The second level of the communication network included Circum-Baltic contacts, which had a significant impact on the communities near the sea. It resulted in the aforementioned stone ship graves in the eastern Baltic, and in small quantities of Fine-Rusticated pottery in fortified settlements in the western areas of the Eastern Baltic region, and in the Staldzene and Tehumardi hoards. More or less all Baltic coastal regions were included in the circum-Baltic communication networks. Compared to Lusatians, Scandinavians had greater influence on the Eastern Baltic region communities in the acquisition of bronze (Podėnas, Čivilytė 2019: 186), but through intermediaries, some metalwork may have penetrated into the southern parts of the eastern Baltic.

The third level of communication network is characterised by further interregional contacts (Podėnas, Čivilytė 2019: 186–188). Mälar-type axes and their casting waste are the best source to study

this network. This hybrid type included the metallurgical traditions of communities located in Scandinavia and the Volga-Kama basin, which were about 2,000 km apart from each other. Researchers have explained this phenomenon as a reflection of the routes of bronze trade, human mobility or cultural contacts. The main areas of axe circulation were located in central Sweden and the areas along the Volga-Kama basin, with production sites localised between and on the periphery of these regions. The casting moulds for Mälar-type axes are smaller in the Eastern Baltic than the axes that were found in Scandinavia, which some researchers believe reflected a locally adapted technical aspect (Luchtanas 1981: 11; Luchtanas, Sidrys 1999: 18). If the moulds of the Mälar-type axes were left behind by itinerant metallurgists, it is possible that their trading expeditions were not limited to the Eastern Baltic region. After all, this region did not have an economic resource advantage over Scandinavia, which is characterised for rich agricultural settlements and amber in the south, and north of the latter there were plentiful forest resources. It is possible that the Scandinavians travelled further along the Daugava River to reach the Valdai Hills, from which the Volga River flows. It provides access to communities far inland that had access to the Ural Mountain mines. The significance of this pathway for Scandinavians should not be overstated, as its reflections are far fewer than the signs of the Scandinavian-Central European-Mediterranean contact network (Earle et al. 2015: 641, Fig. 4). It is possible that the eastern (Daugava River) route was briefly used and neglected, with a later focus on activities in the Circum-Baltic communication network. The significant decline in bronze circulation in the eastern Baltic region during the pre-Roman Iron Age (Luchtanas, Sidrys 1999: 26) and the disappearance of stone ship graves attributed to the Scandinavians were probably also related processes, reflecting the region's economic stagnation in the pre-Roman period.

It is still difficult to discuss the further development of fortified settlements in the pre-Roman Iron Age, but artefacts typical of this

period are also found in the fortified settlements. For example, a leaf-shaped openwork pin found in the Moškėnai hillfort dates back to the 4th–2nd century BC (Luchtanas 1992: 68, Bliujienė et al. 2021: 51). Two samples of charred organic residues in pottery from the Kurmaičiai fortified settlement have been dated to 406–197 cal BC. Lang has published ^{14}C dates for at least 5 fortified settlements (Iru, Jägala, Pada II, Võnnumägi, Alatskivi) covering the pre-Roman period (Lang 2007: 71, Fig. 28). Thus, the practice of fortified settlements that appeared in the Bronze Age was not a short-lived phenomenon, but was characterised by continuity. The current lack of data on pre-Roman Iron Age settlements can be attributed to a lack of research, as there are many potential sites with innacurate dating that have been registered over the years (cf. Merkevičius 2018).

CONCLUSIONS

Fortified settlements in the Eastern Baltic region were first established in 1100–800 cal BC. Their network spread in Period VI and was concentrated in the western part of the region, in the Daugava River basin and in a wide stretch of the Baltic highlands in north-eastern Lithuania and south-eastern Latvia. This distribution was the result of the increased need of the population to protect their accumulated wealth in the areas of the region, where bronze trade intensified. In order to obtain bronze, the inhabitants of the Eastern Baltic region had to establish and develop new contacts. For people settled along the exchange routes, there was also a need to fortify their settlements in order to maintain a convenient location in the evolving communication network. The ability of communities in established settlements to participate in the bronze exchange was limited by the absence of copper and tin ore in the region and their dependence on non-local bronze suppliers. It is most likely that bronze was brought to the fortified settlements through itinerant metallurgists, who cast products according to the existing demand. The bronze artefact types and casting moulds found in the fortified settlements are most characteristic to Scandinavia and Gotland, and the waste from their production suggest this direction of external impulses. Local inhabitants in some of the fortified settlements most likely established direct contact with communities coming from the western Baltic region or the Baltic Sea islands. This is also evidenced by the discovery of stone ship graves in several near coastal-zones in Latvia and Estonia, a type of burial that is uncharacteristic of the local burial traditions. Further development of fortified settlements and changes in the behaviour of communities in the region were the result of complex processes involving economic differentiation, a growing need for security and the further development of exchange.

Fortified settlement communities in the Eastern Baltic region made most of their artefacts from stone, bone/antler and ceramics.

Weaving technology was spreading throughout the LBA, but it was still relatively rare in the Eastern Baltic, as evidenced by the small quantities of artefacts used for textile processing. In contrast, tools for making and repairing leather and fur garments are abundant in the fortified settlements. A significant proportion of the artefacts probably consisted of various wooden tools, but the conditions for their survival were suitable only in Luokesai 1. Due to the similar materials and technologies used, there is little variation in the LBA artefacts found in the different areas of the Eastern Baltic Region. The greatest number of different types of wares and their stylistic (technological and decorative) elements are found in those areas closer to the sea. The island of Saaremaa and the northern coast of Estonia are home to richly ornamented pottery of the Asva style, the production of larger harpoons for seal hunting, and bronze artefacts and ceramic moulds typical of the Western and Southern Baltic Sea regions. The abundance of different stylistic elements in this area is due both to the geographical proximity of the Circum-Baltic communication network and to the distinctive lifestyles of Saaremaa communities and the economic patterns they practised. Of the areas further south, the area around the lower reaches of the Daugava River was characterised by the greatest stylistic diversity of artefacts. The fortified settlements established along the Daugava River produced Early Striated pottery of the Variant B. In this area, bronze casting remains, and, to a lesser extent, tools, weapons and jewellery made of bronze were found more frequently than in other inland areas. A similar variety of bone/antler tools, weapons and jewellery is found in the eastern areas of the region, in the Baltic Uplands. The latter area received less metal and the remains of bronze casting indicate episodic metallurgical activity. South of the Daugava River, communities produced Early Striated pottery Variant A vessels, which have the least stylistic and decorative variety. Two peripheral areas of the Early Striated pottery production zones stand out, allowing for the possibility of a slightly distinct cultural development in the communities living in the lowlands of Lake Lubāns and on the

Baltic coast. This was observed in the Kukuliškiai fortified settlement, and is due to the proximity of the Circum-Baltic communication network and the West Balt Barrow culture. The cultural area of the Lubāns Lake Lowland was close to the communities of the Baltic Uplands, but was different on account of the greater use of smooth surfaced pottery and the more active and frequent attraction of bronze casters. In general, a greater stylistic diversity of wares is characteristic of the cultural peripheries, where there are better conditions for developing contacts with other communities offering alternative markets and supplies to the Eastern Baltic region.

The internal structure of fortified settlements in the Eastern Baltic region varied slightly, mostly in terms of the different types of fortifications. Defensive systems in the LBA consisted of 6 different types of fortifications: A – enclosures of irregularly placed wooden stakes, B – fences interwoven with branches, C – palisades, D – wooden walls, E – raised wooden structures on ramparts, and F – stone walls with wooden structures. In some cases, these structures were combined into a single complex system. Their relative chronological development can only be distinguished at individual sites, however fortification technology did not develop at a uniform pace in the Eastern Baltic region. Most of the defensive systems date to 800–520/400 cal BC, or Period VI and the beginning of the pre-Roman Iron Age. The only earlier fortification, a wooden wall made of large posts at the settlement on Krievu Kalns, is dated to ca. 1000–800 cal BC. The type of the defensive systems used in different areas was determined by varying social tensions and economic activities. The most technologically advanced fortifications, consisting of higher ramparts, ditches and wooden construction systems, were built by communities in the lower reaches of the Daugava. It is likely that the circum-Baltic communication network and the Daugava River trade route were not only responsible for the economic development of the communities living in these areas, but also for the increased risk of conflict.

Economic differentiation between the communities that established fortified settlements in the Eastern Baltic is most evident in the zooarchaeological data. The composition of livestock reared, and the relative importance of fishing and hunting varied in different areas of the region. The macrobotanical data accumulated so far are not extensive, but they suggest that a wide range of cereals and legumes were cultivated in the region, either by intensive or mixed (intensive and extensive) forms of agriculture. This prevalence of a production economy is also supported by dietary studies. Stable isotope studies of human bone collagen indicate the predominance of a terrestrial food component in the LBA population and a general increase in its importance compared with earlier periods. The importance of millet in the diet of the population is also identified from the LBA. The area that has thus far been researched the least has been the study of food residues in pottery, and the results of the carbon and nitrogen bulk stable isotope analysis presented in this thesis have shed some light on at least two areas of the region. The charred food remains in the ceramics of fortified settlements in north-eastern and western Lithuania are characterised by $\delta^{15}N$ values mostly lower than 6 ‰, indicating the predominance of food of terrestrial origin. In summary, the data show a significant change in the diet of the mainland communities from the EBA to the LBA. The decrease in the importance of aquatic food sources can be attributed to the greater focus of the communities on agriculture and animal husbandry, but it is also important to take into account that examination of food remains in LBA ceramics is in its early stages, and that this conclusion does not apply to the whole of the East Baltic region.

REFERENCES

Antanaitis-Jacobs, I., Richards, M., Daugnora, L., Jankauskas, R., Ogrinc, N., 2009. Diet in early Lithuanian prehistory and the new stable isotope evidence. *Archaeologia Baltica* 12: 12–30.

Baudou, E., 1960. *Die regionale und chronologische Einteilung der jüngeren Bronzezeit im Nordischen Kreis* (=*Acta Universitatis Stockholmiensis. Studies in North-European Archaeology*, 1). Stockholm: Almqvist & Wiksell.

Bleicher, N., 2014. Dendrochronological analyses of wood samples from a Late Bronze to early Iron Age site at Lake Luokesa, Lithuania. *Vegetation History and Archaeobotany* 23: 355–365. Doi: 10.1007/s00334-014-0463-1

Bliujienė, A., 2007. *Lietuvos priešistorės gintaras*. Vilnius: Versus aureus.

Bliujienė, A., Petrauskas, G., Bagdzevičienė, J., Babenskas, E., Rimkus, T., 2021. Essential changes in the composition of copper alloys reveal technological diversities in the transition from the Earliest Iron Age to the Early Roman period in Lithuania. *Archaeologia Baltica* 28: 39–62. Doi: 10.15181/ab.v28i0.2281

Bronk Ramsey, C., 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51 (1): 337–360.

Craig, O.E., Forster, M., Andersen, S.H., Koch, E., Crombé, P., Milner, N.J., Stern, B., Bailey, G.N., Heron, C.P., 2007. Molecular and isotopic demonstration of the processing of aquatic products in northern European prehistoric pottery. *Archaeometry* 49 (1): 135–152.

Čivilytė, A., 2014. *Žmogus ir metalas priešistorėje: žvilgančios bronzos trauka*. Vilnius: „Diemedžio“ leidykla.

Daugnora, L., Girininkas, A., 2004. *Rytų Pabaltijo bendruomenių gyvensena XI – II tūkst. pr. Kr.* Kaunas: Lietuvos veterinarijos akademija.

DeNiro, M.J., 1985. Postmortem preservation and alteration of *in vivo* bone collagen isotope ratios in relation to palaeodietary reconstruction. *Nature* 317: 806–809. Doi: 10.1038/317806a0

Drucker, D., Bocherens, H., 2004. Carbon and Nitrogen Stable Isotopes as Tracers of Change in Diet Breadth during Middle

and Upper Palaeolithic in Europe. *International Journal of Osteoarchaeology* 14: 162–177. Doi: 10.1002/oa.753

Earle, T., Ling, J., Uhnér, C., Stos-Gale, Z., Melheim, L., 2015. The Political Economy and Metal Trade in Bronze Age Europe: Understanding Regional Variability in Terms of Comparative Advantages and Articulations. *European Journal of Archaeology* 18 (4): 633–657. Doi: 10.1179/1461957115Y.0000000008

Eriksson, G., Lõugas, L., Zagorska, I., 2003. Stone age hunter-fisher-gatherers at Zvejnieki, northern Latvia: stable isotope and archaeozoological data. *Before Farming* 1: 1–25. Doi: 10.3828/bfarm.2003.1.2

Gackowski, J., 2000. On the dating and cultural aspects of the West Baltic barrow culture lake dwellings. *In*: A. Kola *(ed*.) *Studies in the lake dwellings of the West Baltic barrow culture*. Torun: Torun University Press, 9–63.

Gimbutas, M., 1965. *Bronze Age Cultures in Central and Eastern Europe*. The Hague: Mouton & Co.

Graudonis, J., 1978. Apdzīvotība un celtniecība Mūkukalnā. *Arheoloģija un etnografija* XII: 24–51.

Graudonis, J., 1989. *Nocietinātās apmetnes Daugavas lejtecē*. Rīga: Zinātne.

Grigalavičienė, E., 1986a. Nevieriškės piliakalnis. *Lietuvos archeologija* 5: 52–88.

Grigalavičienė, E., 1986b. Sokiškių piliakalnis. *Lietuvos archeologija* 5: 89–136.

Grigalavičienė, E., 1995. *Žalvario ir ankstyvasis geležies amžius Lietuvoje*. Vilnius: Mokslo ir enciklopedijų leidykla.

Grikpėdis, M., 2021. *Kultūrinių augalų kilmė Lietuvoje Rytų Baltijos regiono kontekste (archeobotanikos duomenimis iki XIV a.)*. Vilniaus universitetas, Lietuvos istorijos institutas. Daktaro disertacija. Doi: 10.15388/vu.thesis.255

Heron, C., Craig, O.E., Luquin, A., Steele, V.J., Thompson, A., Piličiauskas, G., 2015. Cooking fish and drinking milk? Patterns in pottery use in the southeastern Baltic, 3300 – 2400 cal BC. *Journal of Archaeological Science* 63: 33–43.

Heron, C., Junko, H., Katayama Owens, M., Yumiko, I., Eley, Y., Lucquin, A., Radini, A., Saul, H., Debono Spiteri, C., Craig, O.E., 2016. Molecular and isotopic investigations of pottery

and ‘charred remains’ from Sannai Maruyama and Sannai Maruyama No. 9, Aomori Prefecture, Japan. *Japanese Journal of Archaeology* 4: 29–52.

Jantzen, D., 2008. *Quellen zur Metallverbreitung im Nordischen Kreis der Bronzezeit* (=*Prähistorische Bronzefunde*, XIX (2)). Stuttgart: Steiner.

Krzywicki, L., 1914. Grodziska górno-litewskie. I Grodzisko w Duksztach. II Grodzisko w Warańach. *Pamiętnik Fizyograficzny* XXII: 13–32.

Krzywicki, L., 1917. Grodziska górno-litewskie. Grodzisko na Górze Ościkowej pod Rakiszkami. *Pamiętnik Fizjograficzny* 24: 1–42.

Kuz’minych, S.V., 1996. Osteuropäische und fennoskandische Tüllenbeile des Mälartyps: Ein Rätsel der Archäologie. *Fennoscandia archaeologica* 13: 3–27.

Laneman, M., Lang, V., 2013. New Radiocarbon dates for two stone-cist graves at Muuksi, Northern Estonia. *Estonian Journal of Archaeology* 17 (2): 89–122. Doi: 10.3176/arch.2013.2.01

Lang, V., 1992. Eesti labidaspeaga luunõelte dateerimisest. *Stilus* 1 (=*Eesti Arheoloogiaseltsi Teated 1992 (1)*): 8–32.

Lang, V., 1996. *Muistne Rävala. Muistised, kronoloogia ja maaviljelusliku asustuse kujunemine Loode-Eestis, eriti Pirita jõe alamjooksu piirkonnas* (=*Muinasaja Teadus*, 4). Tallinn: Eesti Teaduste Akadeemia Ajaloo Instituut.

Lang, V., 2007. *The Bronze and Early Iron Ages in Estonia (=Estonian archaeology, 3)*. Tartu: Tartu University Press.

Lang, V., 2018. Fortified Settlements in the Eastern Baltic: From Earlier Research to New Interpretations. *Archaeologia Lituana* 19: 13–33. Doi: 10.15388/ArchLit.2018.19.2

Legzdiņa, D., Vasks, A., Plankājs, E., Zariņa, G., 2020. Re-evaluating the Bronze and earliest Iron Age in Latvia: changes in burial traditions in the light of ^{14}C dates. *Radiocarbon* 62 (6): 1845–1868. Doi: 10.1017/RDC.2020.136

Lietuvos reljefas n.d. Prieiga internetu: < https://tiles.arcgis.com/tiles/fFwZ4t9mPyCe14FA/arcgis/rest/services/HBContent_TINTSRELIEF/MapServer>. [žiūrėta 2022 m. birželio 29 d.]

Lõugas, V., 1970. *Eesti varane metalliaeg (II a.-tuh. keskpaigast e.m.a. – 1. sajandini m.a.j.)*. Diss. Kand., Tallinn University.

Luchtanas, A., 1981. Žalvario apdirbimas ankstyvuosiuose Rytų Lietuvos piliakalniuose. *Lietuvos Archeologija* 2: 5–17.

Luchtanas, A., 1992. Rytų Lietuva I tūkst. pr. m. erą. *Lietuvos archeologija* 8: 56–85.

Luchtanas, A., Sidrys, R.V., 1999. Bronzos plitimas rytiniame Pabaltijo regione iki Kristaus. *Archaeologia Lituana* 1: 15–55.

Luik, H., 2013. Late Bronze Age bone crafting in the Eastern Baltic: standardization of artefact types and individual ingenuity. *Estonian Journal of Archaeology* 17 (1): 24–37. Doi: 10.3176/arch.2013.1.02

Luik, H., Maldre, L., 2007. Bronze Age bone artefacts from Narkūnai, Nevieriškė and Kereliai fortified settlements. Raw materials and manufacturing technology. *Archaeologia Lituana* 8: 5–39.

Luik, H., Ots, M., 2007. Bronze Age double buttons in Estonia. *Estonian Journal of Archaeology* 11 (2): 122–140.

Melheim, L., 2015. Late Bronze Age axe traffic from Volga-Kama to Scandinavia? The riddle of the KAM axes revisited. *In*: Hauptmann, A., D. Modarressi-Tehrani, D. (*eds*.) *Archaeometallurgy in Europe III*. (=*Der Anschnitt. Beiheft* 26). Bochum: Deutsches Bergbau-Museum Bochum, 193–202.

Merkevičius, A., 2007. Material Culture and the Bronze Age Society in Lithuania. *In*: A. Merkevičius (*ed*.) *Colours of archaeology. Material culture and the society* (=*Interarchaeologia*, 2). Vilnius: Vilniaus universiteto leidykla, 93–105.

Merkevičius, A. (*sud*.) 2018. *Ankstyvojo metalų laikotarpio gyvenvietės Lietuvoje*. Vilnius: Vilniaus universiteto leidykla.

Minkevičius, K., 2020. *Žemdirbystės raida ir gyvenviečių dinamika Lietuvoje XI a. pr. Kr. – XII a. (archeobotaninių tyrimų duomenimis)*. Vilniaus universitetas, Lietuvos istorijos institutas. Daktaro disertacija. Doi: 10.15388/vu.thesis.62

Minkevičius, K., Podėnas, V., Urbonaitė-Ubė, M., Ubis, E., Kisielienė, D., 2020. New evidence on the southeast Baltic Late Bronze Age agrarian intensification and the earliest AMS dates of

Lens culinaris and *Vicia faba*. *Vegetation History and Archaeobotany* 29(3): 327–338. Doi: 10.1007/s00334-019-00745-2

Mittnik, A., Wang, C.-C., Pfrengle, S., Daubaras, M., Zariņa, G., Hallgren, F., Allmäe, R., Khartanovich, V.I., Moiseyev, V., Tõrv, M., Furtwängler, A., Valtueña, A., Feldman, M., Economou, C., Oinonen, M., Vasks, A., Balanovska, E., Reich, D., Jankauskas, R., Krause, J., 2018. The genetic prehistory of the Baltic Sea region. *Nature Communications* 9 (1): 442. Doi: 10.1038/s41467-018-02825-9

Oinonen, M., Vasks, A., Zarina, G., Lavento, M., 2013. Stones, bones, and hillfort: radiocarbon dating of Ķivutkalns bronze-working center. *Radiocarbon* 55 (2–3): 1252–1264.

Oras, E., Lucquin, A., Lõugas, L., Tõrv, M., Kriiska, A., Craig, O.E., 2017. The adoption of pottery by north-east European hunter-gatherers: Evidence from lipid residue analysis. *Journal of Archaeological Science* 78: 112–119. Doi: 10.1016/j.jas.2016.11.010

Paavel, K., Kriiska, A., Lang, V., Kulkov, A., 2019. Three bronze axes with wooden haft remains from Estonia. *Estonian Journal of Archaeology* 23 (1): 3–19.

Piličiauskas, G., Lavento, M., Oinonen, M., Grižas, G., 2011. New ^{14}C dates of Neolithic and Early Metal Period ceramics in Lithuania. *Radiocarbon* 53 (4): 629–643.

Piličiauskas, G., Jankauskas, R., Piličiauskienė, G., Craig, O.E., Charlton, S., Dupras, T., 2017b. The transition from foraging to farming (7000–500 cal BC) in the SE Baltic: A re-evaluation of chronological and palaeodietary evidence from human remains. *Journal of Archaeological Science: Reports* 14: 530–542. Doi: 10.1016/j.jasrep.2017.06.004

Piličiauskas, G., Skipitytė, R., Heron, C., 2018. Mityba Lietuvoje 4500 – 1200 cal BC maisto liekanų keramikoje bendrųjų mėginių izotopinių tyrimų duomenimis. *Lietuvos archeologija* 44: 9–37.

Piličiauskas, G., Vengalis, R., Minkevičius, K., Kisielienė, D., Ežerinskis, Ž., Šapolaitė, J., Skipitytė, R., Robson, H. K., 2021. The earliest evidence for crop cultivation during the Early Bronze Age in the southeastern Baltic. *Journal of Archaeological Science: Reports* 36: 102881. Doi: 10.1016/j.jasrep.2021.102881

Podėnas, V., 2020. Emergence of hilltop settlements in the Southeastern Baltic: New AMS ^{14}C dates from Lithuania and revised chronology. *Radiocarbon* 62 (2): 1–17. Doi: 10.1017/RDC.2019.152

Podėnas, V., Čivilytė, A., 2019. Bronze casting and communication in the Southeastern Baltic Bronze Age. *Lietuvos archeologija* 45: 169–199. Doi: 10.33918/25386514-045005

Podėnas, V., Minkevičius, K., Micelicaitė, V., Čivilytė, A., 2022. Fortify to develop contacts? A review of Late Bronze Age defensive systems in the East Baltic and new data from Mineikiškės fortified settlement. *In*: V. Vaitkevičius, A. Bliujienė (*sud*.) *Atrasti praeitį. Išsaugoti ateičiai. Straipsniai, skirti Gintauto Zabielos 60-mečiui* (*=Discovering the Past. Preserving for the Future. Essays on the Occasion of Gintautas Zabiela's 60th Birthday*). Klaipėda: Klaipėdos universiteto leidykla, 218–240.

Pollmann, B., 2014. Environment and agriculture of the transitional period from the Late Bronze to early Iron Age in the eastern Baltic: an archaeobotanical case study of the lakeshore settlement Luokesa 1, Lithuania. *Vegetation History and Archaeobotany* 23: 403–418. Doi: 10.1007/s00334-014-0464-0

Post, D.M., 2002. Using stable isotopes to estimate trophic position: models, methods, and assumptions. *Ecology* 83 (3): 703–718. Doi: 10.2307/3071875

Poplawski, P., Kwoka, J.J., Engelbrecht, W., 2012. Rethinking palisades in the Northeast: evidence from the Eaton site. *Northeast Anthropology* 77–78: 71–87.

Pranckėnaitė, E., 2012. *Ežerų gyvenvietės pietryčių Baltijos regione ankstyvuoju metalų laikotarpiu*. Klaipėdos universitetas. Daktaro disertacija.

Pranckėnaitė, E., 2014. Living in wetlands in the southeastern Baltic region during the Late Bronze Age to early Iron Age: the archaeological context of the Luokesa lake settlements. *Vegetation History and Archaeobotany* 23: 341–354. Doi: 10.1007/s00334-014-0462-2

Reimer, P., Austin, W., Bard, E., Bayliss, A., Blackwell, P., Bronk Ramsey, C., Butzin, M., Cheng, H., Edwards, R., Friedrich, M., Grootes, P., Guilderson, T., Hajdas, I., Heaton, T., Hogg, A., Hughen, K., Kromer, B., Manning, S., Muscheler, R., Palmer, J., Pearson, C., Van der Plicht, J., Reimer, R., Richards, D., Scott, E., Southon, J., Turney, C., Wacker, L., Adolphi, F., Büntgen, U.,

Capano, M., Fahrni, S., Fogtmann-Schulz, A., Friedrich, R., Köhler, P., Kudsk, S., Miyake, F., Olsen, J., Reinig, F., Sakamoto, M., Sookdeo, A., Talamo, S., 2020. The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP). *Radiocarbon* 62 (4): 725–757.

Robson, H.K., Skipitytė, R., Piličiauskienė, G., Lucquin, A., Heron, C., Craig, O.E., Piličiauskas, G., 2019. Diet, cuisine and consumption practices of the first farmers in the southeastern Baltic. *Archaeological and Anhropological Sciences* 11: 4011–4024. Doi: 10.1007/s12520-019-00804-9

Rösch, M., Ehrmann, O., Herrmann, L., Schulz, E., Bogenrieder, A., Goldammer, J.P., Hall, M., Page, H., Schier, W., 2002. An experimental approach to Neolithic shifting cultivation. *Vegetation History and Archaeobotany* 11: 143–154. Doi: 10.1007/s003340200016

Sahlen, E.D., 2011. *Ceramic technology and technological traditions. The manufacture of metalworking ceramics in Late Prehistoric Scotland.* University of Glasgow. PhD thesis.

Simniškytė, A., 2020. Kupiškio (Aukštupėnų) piliakalnis: teorinės prielaidos ir tyrimų rezultatai. *Lietuvos archeologija* 46: 255–287.

Sperling, U., 2014. *Aspekte des wandels in der bronzezeit im ostbaltikum. Die siedlungen der Asva-gruppe in Estland* (=*Estonian Journal of Archaeology 18/2S*). Tallinn: Estonian Academy of Sciences.

Sørensen, L., Karg, S., 2014. The expansion of agrarian societies towards the north – new evidence for agriculture during the Mesolithic/Neolithic transition in Southern Scandinavia. *Journal of Archaeological Science* 51: 98–114. Doi: 10.1016/j.jas.2012.08.042

Taché, K., Craig, O.E., 2015. Cooperative harvesting of aquatic resources and the beginning of pottery production in north-eastern North America. *Antiquity* 89: 177–190.

Tauber, H., 1981. ^{13}C evidence for dietary habits of prehistoric man in Denmark. *Nature* 292: 332–333.

Tõrv, M., Meadows, J., 2015. Radiocarbon dates and stable isotope data from the Early Bronze Age burials in Riigiküla I and Kivisaare settlement sites, Estonia. *Radiocarbon* 57 (4): 645–656. Doi: 10.2458/azu_rc.57.18459

Valk, H., Kama, P., Olli, M., Rannamäe, E., 2012. Excavations on the hill forts of South-East Estonia: Kõivuküla, Märdi, Truuta and Aakre. *Archaeological fieldwork in Estonia 2011*: 27–46.

Vasks, A., 1994. *Brikuļu nocietinātā apmetne: Lubāna zemiene vēlajā bronzas un dzelzs laikmetā (1000. g. pr. Kr. – 1000. g. pēc Kr.)*. Rīga: Preses nams.

Vasks, A., 2010. Latvia as part of a sphere of contacts in the Bronze Age. *Archaeologia Baltica* 13: 153–161.

Vasks, A., Zariņa, G., 2014. Ķivutkalna pilskalns un kapulauks: jauni dati un jaunas problēmas. *Latvijas vēstures institūta žurnāls* 92 (3): 5–36.

Vasks, A., Visocka, V., Daugnora, L., Ceriņa, A., Kalniņa, L., 2019. Krievu Kalns Hill-Fort: New Data on the Late Bronze Age and Pre-Roman Iron Age in Western Latvia. *Archaeologia Baltica* 26: 80–107.

Vengalis, R., Piličiauskas, G., Pilkauskas, M., Kozakaitė, J., Juškaitis, V., 2020. The large-scale rescue excavation of a multi-period site at Kvietiniai sheds light on the so far little explored Bronze Age in Western Lithuania. *Archaeologia Baltica* 27: 17–50.

Visocka, V., 2020. Late Bronze and Pre-Roman Iron Age pottery in the lower reaches of River Daugava. *In:* M. Marila, M. Ahola, K. Mannermaa, M. Lavento (eds.) *Archaeology and Analogy* (=*Interarchaeologia* 6). Helsinki: University of Helsinki, 83–104.

Wehlin, J., 2013. *Östersjöns skeppssättningar. Monument och mötesplatser under yngre bronsålder*. (=*Gotarc Series B* 59.). Göteborg: Göteborgs universitet.

Yoshida, K., Kunikita, D., Miyazaki, Y., Nishida, Y., Miyao, T., Matsuzaki, H., 2013. Dating and stable isotope analysis of charred residues on the incipient Jomon pottery (Japan). *Radiocarbon* 55 (2–3): 1322–1333. Doi: 10.1017/S0033822200048232

Граудонис, Я., 1967. *Латвия в эпоху поздней бронзы и раннего железа*. Рига: Зинатне.

Григалавичене, Э., 1980. Древнейшие металлические изделия в Литве (II–I тысячелетия до н. э.). *In*: Э. Григалавичене, А. Мяркявичюс (*ред*.) *Древнейшие металлические изделия в Литве*. Вильнюс: Мокслас, 3–100.

LIST OF PUBLICATIONS

1. Vytenis Podėnas, Agnė Čivilytė, Jurga Bagdzevičienė, Aleksiejus Luchtanas. Technologiniai ir diagnostiniai Narkūnų Didžiojo piliakalnio techninės keramikos tyrimai. *Lietuvos archeologija* 42 (2016): 151–189.
https://www.researchgate.net/publication/338925186_A_technological_and_diagnostic_investigation_of_the_technical_ceramics_found_in_the_'Dydysis'_Narkunai_hillfort_in_Lithuanian_with_English_summary
2. Vytenis Podėnas, Aleksiejus Luchtanas, Agnė Čivilytė. Narkūnų piliakalnių ir papėdės gyvenvietės keramika: elgsenos atspindžiai. *Lietuvos archeologija* 42 (2016): 191–241.
https://www.researchgate.net/publication/338925190_Pottery_from_Narkunai_hillforts_and_foot_settlement_some_reflections_on_behaviour
3. Vytenis Podėnas, Evaldas Babenskas. Eksperimentiniai Narkūnų vėlyvojo bronzos amžiaus techninės keramikos tyrimai. *In*: D. Luchtanienė (sud.) *Eksperimentinė archeologija, II tomas* (2017). Vilnius: Akademinė leidyba, p. 95–110.
https://www.researchgate.net/publication/338925291_Experimental_investigation_of_color_metallurgy_according_to_crucibles_discovered_in_Narkunai_in_Lithuanian_and_English
4. Christopher Troskosky, Vytenis Podėnas, Nathan Dubinin. Quaternary Geomorphology and Viewshed Analysis of the Garniai I. *Chronika* VIII (2018): 64–77.
https://www.researchgate.net/publication/338925358_Quaternary_Geomorphology_and_Viewshed_Analysis_of_the_Garniai_I
5. Karolis Minkevičius, Vytenis Podėnas, Miglė Urbonaitė-Ubė, Edvinas Ubis, Dalia Kisielienė. New evidence on the southeast Baltic Late Bronze Age agrarian intensification and the earliest AMS dates of *Lens culinaris* and *Vicia faba*. *Vegetation History and Archaeobotany* 29 (3) (2020): 327–338.
https://doi.org/10.1007/s00334-019-00745-2
6. Vytenis Podėnas. Emergence of hilltop settlements in the Southeastern Baltic: New AMS ^{14}C dates from Lithuania and revised chronology. *Radiocarbon* 62 (2) (2020): 361–377.
https://doi.org/10.1017/RDC.2019.152

List of conference papers

1. Vytenis Podėnas. Hillforts' appearance in the East Baltic: contemplating political economies and cultural-technological influences in Late Bronze Age societies. International Conference “Hillforts. From emergence to the present day” (=Readings of Prof. Dr. Jonas Puzinas 9), Vilnius (Lithuania), October 19th, 2017.
2. Vytenis Podėnas. Early development of hillforts in the South East Baltic: a review of earliest ^{14}C dates. International Conference “24th meeting of European Association of Archaeologists”, Barcelona (Spain), September 6th, 2018.
3. Vanda Visocka, Uwe Sperling, Vytenis Podėnas. Stylistic and technological aspects of eastern Baltic pottery: a case study of the Asva, Ķivutkalns and Narkūnai hillforts. International Conference “Circum-Baltic interaction in the Bronze Age (CIBA)”, Hamburg (Germany), November 23rd, 2018.
4. Karolis Minkevičius, Vytenis Podėnas, Miglė Urbonaitė-Ubė, Edvinas Ubis, Dalia Kisielienė. Late Bronze Age agrarian intensification in the Southeast Baltic. International Conference “25th meeting of European Association of Archaeologists“, Bern (Switzerland), September 6th, 2019.

BRIEF INFORMATION ABOUT THE DOCTORAL STUDENT

Vytenis Podėnas graduated from Vilnius University with a Bachelor's degree in Archaeology in 2014 and a Master's degree in Archaeology (Magna cum laude) in 2016. From 2015 to 2019, he worked as a senior museum worker at the National Museum of Lithuania, Department of Archaeology. Since 2016, he has been a PhD student at the Lithuanian Institute of History, and a Junior Research Fellow at this institution since 2019. He has been conducting archaeological research since 2015. His main areas of research are the behaviour and economy of prehistoric societies, with the main topics of research being archaeological settlements, pottery, archaeometallurgy, economy and diet.

Published by the Lithuanian Institute of History,
Tilto g. 17, LT- 01101, Vilnius, Lithuania
https://www.istorija.lt/
Print run 20