



**Vilnius
University**

Eglė
ŠATAVIČĖ

Neolithic Communities and their Pottery in Southeast Lithuania

SUMMARY OF DOCTORAL DISSERTATION

Humanities
History and Archaeology **H 005**

2023

VILNIUS UNIVERSITY
LITHUANIAN INSTITUTE OF HISTORY

Eglė Šatavičė

Neolithic Communities and their Pottery in Southeast Lithuania

SUMMARY OF DOCTORAL DISSERTATION

Humanities,
History and Archaeology (H 005)

VILNIUS 2023

The dissertation was prepared in 2005–2022 at Vilnius University.

Academic supervisor – Assoc. Prof. Dr. Algimantas Merkevičius
(Vilnius University, Humanities, History and Archaeology – H 005).

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

Chairman – Assoc. Prof. Dr. Giedrė Keen (Vilnius University, Humanities, History and Archaeology – H 005).

Members:

Prof. Dr. Adomas Butrimas (Vilnius Academy of Arts, Humanities, History and Archaeology – H 005);

Assoc. Prof. Dr. Raimondas Giraitis (Center for Physical Sciences and Technology, Natural Sciences, Chemistry – N 003);

Prof. Habil. Dr. Algirdas Girininkas (Klaipėda University, Humanities, History and Archaeology – H 005);

Dr. Vygandas Juodagalvis (Lithuanian Institute of History, 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 10th March 2023 in Room 218 at Faculty of History (Vilnius University).

Address: 7 Universiteto St, Vilnius, Lithuania

Tel. +3702687280; e-mail: if@if.vu.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

Eglė Šatavičė

Neolito bendruomenės ir jų keramika Pietryčių Lietuvoje

DAKTARO DISERTACIJOS SANTRAUKA

Humanitariniai mokslai,
Istorija ir archeologija (H 005)

VILNIUS 2023

Disertacija rengta 2005–2022 metais Vilniaus universitete.

Mokslinis vadovas – doc. dr. Algimantas Merkevičius (Vilniaus universitetas, humanitariniai mokslai, istorija ir archeologija – H 005)

Gynimo taryba:

Pirmininkė – doc. dr. Giedrė Keen (Vilniaus universitetas, humanitariniai mokslai, istorija ir archeologija – H 005).

Nariai:

prof. dr. Adomas Butrimas (Vilniaus dailės akademija, humanitariniai mokslai, istorija ir archeologija – H 005);

doc. dr. Raimondas Giraitis (Fizinių ir technologijos mokslų centras, gamtos mokslai, chemija – N 003);

prof. habil. dr. Algirdas Girininkas (Klaipėdos universitetas, humanitariniai mokslai, istorija ir archeologija – H 005);

dr. Vygandas Juodagalvis (Lietuvos istorijos institutas, humanitariniai mokslai, istorija ir archeologija – H 005).

Disertacija ginama viešame Gynimo tarybos posėdyje 2023 m. kovo mėn. 10 d. 15 val. Vilniaus universiteto Istorijos fakulteto 218 auditorijoje. Adresas: Universiteto g. 7, Vilnius, Lietuva, tel. +370 2687280; el. paštas: if@if.vu.lt

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

TABLE OF CONTENTS

INTRODUCTION	6
1. PREVIOUS RESEARCH ON THE NEOLITHIC COMMUNITIES IN SOUTHEAST LITHUANIA.....	8
2. THE TERM ‘NEOLITHIC COMMUNITIES’ IN LITHUANIA AND ABROAD.....	9
3. METHODS.....	13
4. THE NEOLITHIC SETTLEMENTS IN SOUTHEAST LITHUANIA AND THEIR NATURAL ENVIRONMENT	15
5. THE ARCHAEOLOGICAL CERAMIC ANALYSES	17
6. RECONSTRUCTION OF NEOLITHIC POTTERY PRODUCTION AND USE PROCESSES	20
6.1. Preparation of the ceramic paste.....	20
6.2. Pottery forming practices	23
6.3. Decoration	25
6.4. Firing	29
6.5. Pottery use	31
7. THE SOCIAL-CULTURAL CONTEXT OF STONE AGE POTTERY-USING COMMUNITIES	35
CONCLUSIONS	38
REFERENCES	44
LIST OF PUBLICATIONS.....	50
BRIEF INFORMATION ABOUT THE DOCTORAL CANDIDATE.....	51

INTRODUCTION

Southeast Lithuania has the greatest density of discovered Stone Age settlements in the country, the absolute majority in the sandy Dainava glaciofluvial plains in its southern part. The region is distinguished by a dense network of rivers, areas of aeolian dunes, poor acidic soil, stunted flora, and pine forests, which were favourable for a hunter-gatherer lifestyle, but not so much for farming. The abundance of bodies of water and the availability of high grade, grey Baltic erratic flint on the surface greatly contributed to the high density of Neolithic settlements. Due to its geographical location near the border between hunter-gatherer and farmer communities, Southeast Lithuania must have been the site of many important interactions between different communities in the 6th–2nd millennium BC, which are best reflected in the variety of pottery. However, natural conditions unfavourable for the survival of organic material and the intermingling of artefacts from different periods in the sandy settlement sites have limited the possibility to precisely date and reconstruct the long, distinctive process of Neolithisation in Southeast Lithuania. The theoretical models and interdisciplinary approaches presented in this dissertation allow a better understanding of the very diverse but poorly representative archaeological material and, through it, an insight into the life of the Neolithic communities.

The aim of this dissertation is to provide new ways of understanding and interpreting the Neolithic communities of Southeast Lithuania through their living environment as well as the pottery they produced and used, and to encourage a holistic perspective of the multifaceted social and economic processes of the time.

To achieve this aim, the following tasks have been set:

- To define criteria and terms for understanding the Neolithic culture in Southeast Lithuania in a general European context.
- To reconstruct the hydrographic network and evaluate the Neolithic landscape, natural conditions, and other factors that

influenced the local lifestyle in Southeast Lithuania as well as the preservation of archaeological material there.

- To present the most important material science approaches for the study of pottery and the results, thereby enabling other archaeologists to develop and apply this research.

- On the basis of qualitative and quantitative research approaches, to study the peculiarities of Stone Age pottery, the technological choices made in its production, and the clay and temper sources used by different communities.

- On the basis of experimental and ethnoarchaeological material and the results of archaeometric research, to reconstruct the processes involved in the production and use of pottery, showing how they reflect the lifestyles, social complexity, transmission of traditions, and local artistic expression.

- To analyse the socio-economic interactions, and the transmission of cultural traditions between the Neolithic communities of Southeast Lithuania.

The dissertation consists of four main parts. The first discusses the concepts of *Neolithic communities*, and *archaeological culture*, theoretical models of Neolithisation, and the socio-economic context, the second a study of the archaeological material and the natural environment of the settlements as well as the identification of various factors that influenced the choice of living sites, the third the results of archaeometric studies in the science of ceramic materials, which show the technological choices made in the production of the pottery, and the fourth a reconstruction of the production processes and use of Neolithic pottery on the basis of ethnoarchaeology, experimental archaeology, and archaeometry.

1. PREVIOUS RESEARCH ON THE NEOLITHIC COMMUNITIES IN SOUTHEAST LITHUANIA

Southeast Lithuania was among the earliest Lithuanian regions to be investigated, flint artefacts and potsherds already being collected on its sandy riverbanks and lakeshores at the turn of the 20th century. The first professional archaeological investigations there are connected with Rimutė Rimantienė's activities. The paradigm of the Southeast Lithuanian Stone Age, which was presented in her 1984 monograph, *Akmens amžius Lietuvoje*, has essentially remained unchanged to the present day (Rimantienė 1984).

The 1990s saw greater interest in theoretical archaeology, the Neolithisation processes, ideas about community lifestyles and structures, and the search for methods capable of answering such questions. A new generation of archaeologists: Džiugas Brazaitis, Algirdas Girininkas, Vygandas Juodagalvis, Tomas Ostrauskas, Gytis Piličiauskas, and Egidijus Šatavičius began to investigate Southeast Lithuanian Stone Age settlements. Two interdisciplinary scientific projects were realised together with geologists in 1994–2001, but the large quantity of new investigation material has remained poorly interconnected and interpreted (Baltrūnas et al. 2001).

Later there was little interest in the Neolithic Southeast Lithuanian material as it seemed to provide poor information about the communities of that time. Isotopic and biomolecular analyses of food residue on pottery have yielded the most information in recent years about the nutrition and lifestyle of Southeast Lithuania's Neolithic communities (Courel et al. 2020; Piličiauskas et al. 2018). However, this pottery's structure and production processes have yet to be investigated. Theoretical models and a holistic approach that take into account the diversity of the various communities, a diversity amplified by differences in the natural environment, social tensions, deep-rooted traditions, and individual decisions, are also lacking.

2. THE TERM ‘NEOLITHIC COMMUNITIES’ IN LITHUANIA AND ABROAD

The concept of ‘Neolithic’ was initially connected with the material culture: polished stone tools of various shapes (Lubbock 1865, 60). Representatives of the German cultural-historical paradigm also named Neolithic pottery as the most important indicator in distinguishing cultures, which in turn reflect ethno-linguistic groups (Kossina 1911, 11–12). Already by the turn of the 20th century, it was noted in the context of Childe’s ‘Neolithic Revolution’ (Childe 1936) that economic development is more important than technological, meaning that the discovery of a production economy and its inseparable components: (1) domesticated plants and animals, (2) exponential population growth, (3) the storage of surplus and a system of delayed returns from productive resources, (4) sedentism, (5) trade networks focusing on nonessential items, (6) decentralized social mechanisms for the coordination of collective activities, (7) associated and enabling magico-religious traditions that focus on the promotion of fertility, (8) ground stone implements, (9) pottery, and (10) weaving implements like spindle whorls (Zeder 2009), became the main criterion for identifying a Neolithic culture. An attempt was made to apply this advanced ‘Neolithic package’ in describing the material culture of not only all European, but also Asian Neolithic communities. However, the detail studies of individual regions have shown only a selective adoption of distinct ‘Neolithic package’ elements (Gibbs, Jordan 2016).

Not only the different processes that occurred in various parts of Europe, but also the uneven distinction of the essential Neolithic features generated a different conception of Neolithisation. Soviet archaeologists essentially continued the traditions of cultural-historical archaeology by accenting the shift in the material culture. In the absence of clearer signs of economic changes, the beginning of the Neolithic was connected with the emergence of pottery, either as part

of the same Neolithisation process or the earlier development of agriculture (Rimantienė 1984, 107).

The connection of the early Neolithic in the East Baltic region with the emergence of pottery in hunting communities frequently appears to be outdated. An attempt has been made to connect the beginning of the Neolithic in Lithuania with the migration of the Globular Amphora and Corded Ware cultures. It has been proposed that the pre-existing communities that used pottery be called ‘Subneolithic’ (Piličiauskas 2016) or, in accordance with the Nordic and Estonian archaeological example, assigned to the ‘ceramic Mesolithic’ (Kriiska et al. 2017). In fact, the arrival of the Globular Amphora and Corded Ware cultures also failed to introduce the complete ‘Neolithic package’ to the East Baltic region, where agriculture only became established during the Final Bronze Age. It has recently been noted that a unique East European Neolithisation scenario exists. In the second half of the 6th–5th millennia BC, hunter-gatherers in the East Baltic region, who had only rare contacts with farmers, accepted ‘ceramisation’, which occurred independently of the ‘Agrarian Neolithic’. Not only can intensive interaction between different agrarian and hunter-gatherer communities be seen in the 4th–3th millennia BC, but also the ‘Forest Neolithic’ society (which is connected with the hunter-gatherer Nemunas culture) so expanded the boundaries of its influence that in the south, it reached to nearly the Carpathian Mountains and, in the west, to the right bank of the Oder (Novak 2019).

Many theories have been developed in an attempt to understand the causes of Neolithisation; many of them see the transition to farming as an advancement, but for Stone Age peoples, this change may have had a closer association with risk or uncertainty than progress. The theoretical models of processual archaeology have highlighted environmental determinism, the demographic pressure created by a sedentary lifestyle, and the influence of food resource diversity in selecting a ‘calorie-seeking’ strategy (Binford 1983). Meanwhile, post-processual archaeology values symbols over economic factors, accenting the opposition between *domus* (Lat. home) and *ager* (Lat.

field, outside the domus) or *agrios* (Gr. wild, savage). Up until the Neolithic, only *agrios* existed, the Neolithic being associated with ‘agri-culture’, i.e., ‘culturing the wild’ or the process of social and cultural domestication (Hodder 1990, 86). Decoding the symbols helps to better perceive the social-cultural processes that occurred in the Neolithic societies, but offers scant explanation for the causes of those changes. Recent DNA studies, which show the demographic composition of Europe was changed by a massive migration, seem to refute the theories of moderate cultural diffusion and steady development (Haak et al. 2015; Kristiansen et al. 2017). However, massive migrations with coercive assimilation can hardly explain the global processes, while the social theory of structuration, which is based on an analysis of the social interaction, an agent’s activity within the social system, space, and time, is important in attempting to explain the Neolithisation processes that occurred in the East Baltic region (Zvelebil 2005). An extensive interaction through the adoption of early pottery as well as other novelties allows the conclusion to be drawn that the spread of ideas likely occurred within the existing supra-regional interaction networks (Hommel 2018; Furholt 2020; Kolář 2020). Human multilevel sociality and the absence of strictly spatially / temporally defined cultural entities makes the old concept of an ‘archaeological culture’, i.e., a classification of block-like exclusive units, seem incompatible with the archaeological material. Meanwhile, David Clarke’s polythetic model of cultural interaction (Clarke 1968) can explain the settings of local and supra-regional social relationships. Authors previously strove in archaeological literature to strictly define the chronological and spatial boundaries of archaeological cultures and to clearly distinguish their individual features, but it has recently become clear that it is more important to examine archaeological material for tendencies for development through interaction rather than for regional differences.

The emergence of earthenware vessels can be connected with a practical need to have hotter, wetter, more digestible food as well as a desire to demonstrate identity and status in social life through aesthetic

artistic expression using easily sourced, local materials. The modestly decorated pots that began to be produced in the upper reaches of the Volga in the first half of the 7th millennium BC are thought to have been the source of the Baltic region's pottery. Through mutual contacts, the tradition of producing this pottery reached the East Baltic region c. 5500 BC and led to the start of the Neolithic Narva culture. The earliest Dubičiai type pottery of the Nemunas culture or a separate Dubičiai culture (in Belarus and Poland – the Pripjat-Neman culture), which is associated with southeastern influences, i.e., the Dnieper-Don culture from north of the Black Sea, was discovered in Southeast Lithuania (Girininkas 2005). Both of these very early pottery traditions influenced each other's development and the emergence of Ertebølle-type pottery in the Southwest Baltic region (Piezonka 2015).

3. METHODS

The lifestyle, behaviour, nutrition, and mobility of Neolithic communities were strongly influenced by the natural environment. In order to investigate those conditions influencing the selection of Neolithic habitation sites, an analysis of the palaeolandscape was made. Nine environmental variables were identified and examined using GIS applications: elevation above sea level, terrain ruggedness, slope length and steepness, intensity of solar radiation, visibility, topographic wetness, distances to the reconstructed lake shores and waterways, and the site's height above the water level.

Scanning electron microscopy with energy dispersive X-ray (SEM-EDS), X-ray fluorescence (XRF), X-ray diffraction (XRD), and Fourier transform infrared spectroscopy (FTIR) were used to study the specific properties of the pottery and to develop hypotheses about the raw material and technology choices present. Considering that ceramic heterogeneity can be influenced by both natural and cultural factors as well as by post-depositional alterations, XRF was employed to obtain bulk chemical signatures for the pottery samples. The Marine Research Institute at Klaipėda University used a Xepos HE energy-dispersive XRF spectrometer to analyse pressed pellets of the powdered pottery. The Vilnius University Institute of Chemistry used a Rigaku MiniFlex II diffractometer to perform an XRD analysis in order to determine the mineral phases. The diffraction patterns of powdered samples were recorded at 2θ angles in a 10–60° range. The Vilnius University Institute of Chemistry employed FTIR to detect the presence of crystalline and amorphous phases as well as to determine the firing temperatures. The Department of Characterisation of Materials Structure at the Center for Physical Sciences and Technology prepared polished cross-sections of the potsherds by cutting them vertically, mounting them in epoxy resin, and polishing the cut surface. A Helios Nanolab 650 station with a second electron detector (SEM-EDS SE) was used to perform microstructural geochemical analyses and to take images. The Open Access Centre of

the Nature Research Centre used a Quanta 250 SEM-EDS with a backscattered electron detector (BSE) to determine the mineralogical chemistry of those polished cross-sections.

The ethnoarchaeological material was studied and archaeological experiments were performed to reconstruct pottery *chaînes opératoires*. The technological processes and choices reflect the experiences, skills, and customs of the potter and his / her community, which are embodied in the manufacture of a ceramic vessel: from the selection of the raw materials and the composition of the clay paste to the shaping, firing, and preparation of a final product, which can have a unique range of properties.

4. THE NEOLITHIC SETTLEMENTS IN SOUTHEAST LITHUANIA AND THEIR NATURAL ENVIRONMENT

The majority of the Neolithic settlements in Southeast Lithuania have been discovered in three Varėna District microregions: Varėnė-Glūkas; Grūda, and Dubičiai-Rudnia. In the vicinity of the River Varėnė and Lake Glūkas, around 14 multiperiod settlements, four of which have been more broadly excavated, are known. Varėnė 2, 5, and 10 settlements are situated on high eroding bluffs on the River Varėnė, and Glūkas 3 on the short, nameless stream connecting Lakes Varėnis and Glūkas. Attempts have been made to interpret the diverse pottery discovered in these settlements as the typical heritage of the Nemunas and Corded Ware cultures, but their distinctive features are actually characteristic of other cultures, mainly the Narva culture. A typical Dubičiai type pot has been found at only Glūkas 3.

About 30 Stone Age sites are known in the vicinity of Lake Grūda, the majority with a Neolithic cultural layer. The three more broadly investigated Neolithic settlements: Grūda 3, Kabeliai 7, and Kabeliai 23 yielded mainly Middle–Late Neolithic Nemunas culture pottery, but no traces of Corded Ware culture.

Nearly a hundred Stone Age settlements have been found in the Dubičiai-Rudnia microregion, near the Lithuanian–Belorussian border. The large lakes of Duba, Pelesa, and Matarai must have been very important in selecting the settlement sites and lifestyle based on fishing and other freshwater resources. Multiperiod settlements with a heritage of various archaeological cultures shows that different communities settled multiple times beside the lakes and rivers in the Dubičiai-Rudnia microregion.

A palaeolandscape analysis of the Dubičiai-Rudnia microregion was performed in order to study the conditions that influenced the selection of Neolithic settlement sites. In using density histograms and predictive modelling to analyse the environmental variables at those locations where Neolithic settlements once existed and those where they had not, the influence of the topographic wetness, the distance

from a body of water, the site's height above it, the elevation above sea level, the terrain's ruggedness, and the visibility were noted.

In the 1960s, the systematic excavation of Stone Age settlements began in the Dubičiai-Rudnia microregion with the Dubičiai 1, 2, 3, Barzdis Forest, Margiai 1, 2, Lynupis, and Šakės settlements. The majority of them were non-stratified, multiperiod sandy sites with an abundance of material from various Stone Age periods, mostly flint artefacts. At the turn of the 21st century, the settlements of Karaviškės, Gribaša, Kašėtos, Katra, and Paramėlis were excavated. The highest concentration of settlements in Lithuanian territory that are connected with the Globular Amphora and Corded Ware cultures occurs in this microregion, settlements, in the absolute majority of cases, that had existed prior to the appearance of these two cultures. Their large habitation areas and high density of various flint and ceramic artefacts are probably less a reflection of large populations and more a long occupation during which either homes were routinely moved to pristine areas or residents returning from periodic, perhaps seasonal, migrations, settled in such locations. Nevertheless, the impression has formed that the Neolithic communities in the Dubičiai-Rudnia microregion were fairly sedentary with a very good likelihood of displaying only small-scale mobility and a continuity of habitation right up to the Bronze Age.

5. THE ARCHAEOMETRIC CERAMIC ANALYSES

Twelve potsherds from the Dubičiai-Rudnia microregion's Margiai (Rimantienė 1999a), Šakės (Rimantienė 1992), and Barzdis settlements (Rimantienė 1999b): six of various cord-decorated styles assigned to the first farming communities and six from the indigenous hunter-gatherer heritage, were selected as representatives in a comparison of the microstructures and the geochemical and mineralogical compositions. The pottery samples varied in thickness from 5.08–6.36 mm, for a thin-walled cup or Corded Ware beaker, to 7.20–11.73 mm for cooking and storage pots. Their cores varied in colour from light brown or marble to very black. The early cord-decorated potsherds were only found at the Margiai settlement. Because cord-decorated pottery from the Globular Amphora culture in Southeast Lithuanian has been until now usually assigned to the Corded Ware culture, sample *CW-E_M1* from the Globular Amphora culture was selected intentionally in order to analyse the differences in early cord-decorated pottery. Samples *CW-E_M2* and *CW-E_M3* represent typical vessels from the classic Corded Ware culture: a beaker and a short-wave moulded pot. The two samples of late Corded Ware beakers (*CW-L_S1* and *CW-L_S2*), which were found in a concentration of similar cord-decorated sherds at the Šakės settlement, were selected in order to analyse possible technological differences in the pottery produced by the same community. Samples *HG-E_M5* from Margiai 1 and *HG-E_S3* from the Šakės settlement represent classic Neman culture pottery with typical ornamentation and surface treatments. Meanwhile, the four fragments (*HG-L_B1–B4*) of the late hunter-gatherer pottery with straw and mineral temper from the Barzdis settlement, which can be assigned to the Narva culture as well as the Nemunas culture, best reflect the diversity and synthesis of different cultural traditions.

The amounts of ten major elements in the bulk ceramic paste and clay matrix compositions (XRF, SEM-EDS) and eleven trace analytes in the bulk compositions (XRF) were compared with the Clarke values

and tested to highlight the significance of the differences in the elemental quantities between the clay matrix and bulk compositions as well as between the lighter and darker clay matrices. Compared to the mean content in the upper continental crust, the clay matrix and the bulk geochemical composition display a marked enrichment of P and slightly lower enrichment for K, Ti, Fe, and Al. However, the ceramic samples are characterised by lower amounts of Ca, Na, and Si. A statistically strong difference was confirmed for the higher enrichment of Mg, Fe, Ti, Ca, Al, and K in the clay matrix compared to the bulk composition and lower amounts of Na, Si, and Mn. No statistically strong difference was found for any of the ten major elements, compared to their amounts in the composition of the lighter and darker material of the clay matrix but at the $0.01 < p < 0.05$ significance level it was confirmed that the lighter clay matrix is richer in P and poorer in Si.

The XRD and FTIR analyses indicated that samples of classic Neman and Globular Amphora culture pottery were fired at low to medium temperatures (650–800° C). The other studied ceramic samples show a decrease in the firing temperature of both the cord-decorated and hunter-gatherer pottery with the emergence of the classic Corded Ware traditions. Despite the black cores of the potsherds, the FTIR and XRD results are not indicative of firing in a reducing atmosphere.

The XRD and FTIR showed a predominance of iron-rich illite clay, quartz, and alkali feldspar raw materials in the bulk composition. Meanwhile, the SEM-EDS with SE and BSE imaging allowed mineralogical and textural differences in the ceramic paste to be investigated. The SEM-EDS point analysis showed the gradual and sudden changes in the chemical composition of the clay matrix, which may be explained by an intentionally mixing of the clay or a specific pottery surface treatment. No grog temper characteristic of classic Corded Ware was detected, only clay pellets, ferruginous nodules, and weathered minerals, which may look like grog to the naked eye. The ceramic samples were made from variegated hydromicaceous clay

with a different degree of weathering from the local Quaternary glacial sediments, which contain granitoid fragments. A detailed mineralogical analysis of these samples is published in Šatavičė et al. (2022).

Hierarchical clustering using Ward's method by calculating the city block (Manhattan) linkage distances and conditionally formatted colour scaling of the geochemical ceramic paste bulk compositions (by XRF) were used as a tool for inter-correlating pottery samples in attributing them to specific communities and locations. The Dubičiai-Rudnia microregion's Quaternary sediments that were deposited by several glaciations complicates the study of provenance but a geochemical analysis revealed the ceramic paste preparation process – 'ceramic taskscape' (Jasiewicz et al. 2021), which contributed significantly to the pottery samples' chemical signatures. The hierarchical clustering of the pottery by the major and trace elements in the bulk compositions revealed main clusters, which reflect five technological styles displaying different technological choices for the clay paste preparation, surface treatment, and firing strategies (Šatavičė et al. 2022). The combination of the research methods not only allowed for a bulk chemical and mineralogical characterisation, but also the microstructural composition and the variables that affect the pottery's bulk chemical signature to be obtained for the pottery samples.

6. RECONSTRUCTION OF NEOLITHIC POTTERY PRODUCTION AND USE PROCESSES

6.1. Preparation of the ceramic paste

Potters selected clay on the basis of its availability and physical properties: plasticity, impurities, shrinkage of the clay paste, and hardness of the resulting ceramic material (Rice 1987, 54). Ethnographic research has shown that they sought clay and temper sources within a radius of less than 7 km from their work site (Arnold 1985, 35–50). Raw materials in Southeast Lithuania must have been accessible locally, but mixed Quaternary sediments deposited by several glaciations complicates the study of a ceramic item's provenance. It was previously thought that pots were produced from glaciolacustrine or varved glacial clays, which were exposed by the wind blowing away the thin layer of aeolian sand covering them (Kriiska 1996), but it is unlikely that varved clays were easy to access in Southeast Lithuania. Clay can usually be found there under a thick layer of glaciolacustrine, glaciofluvial, and aeolian sand. Morainic till and silt layers appear on the surface only in a few places, mostly near rivers or former lakes. An analysis of the breaks and cross-sections of sherds from Southeast Lithuania frequently show the layering of the clay body and traces of various-sized organic material, even in sherds with mineral temper, as well as round particles of fine clay and considerable quantities of rounded sand grains, features characteristic of silt from shallow waters (Bobrinsky, Vasilyeva 2012), which is typically of glacial or post-glacial lacustrine origin. It is likely that the earliest Southeast Lithuanian pottery with organic inclusions was made from natural silty clay raw materials found on the edges of lakes and rivers without any added temper. The inclusion of ground shell, dung, or plant temper can be considered a later replacement for lacustrine silt (Bobrinsky, Vasilyeva 2012, 73). Ground shell temper is more characteristic of the Narva culture tradition, but it is also encountered in Southeast Lithuania, for example in the Dubičiai-

Draciliškė settlement (Šatavičius 2006). Large shallow lakes existed in the Dubičiai-Rudnia microregion during the Neolithic. In the similar microregions of Kretuonas (Švenčionys District, East Lithuania) and Biržulis (Telšiai District, West Lithuania) the abundant legacy of the fishing communities with Narva culture traditions allows one to expect that a network of communities that exploited water resources also existed in the vicinity of Dubičiai (Marcinkevičiūtė 2016).

The use of organic temper was probably connected not only with cultural traditions but also with positive practical features: lightness, greater strength and durability, reduced permeability, and better heat conductivity. Horse dung was successfully used in reconstructing Narva culture pottery with fine organic temper. The resultant pottery was in fact light, strong, very heat conductive, and displayed a similar appearance to Narva-type pottery at a sherd break (Mikšaitė 2005). While the use of herbivore dung in pottery made by farmers is not in doubt, hunters and fishermen were unlikely to have gathered wild herbivore dung. Thus, if the use of herbivore dung is definitely proven in hunter-gatherer pottery, it would confirm a theory that livestock were kept prior to the Late Neolithic.

Previously all pottery with organic temper from Southeast Lithuania was ascribed to the early Dubičiai type pottery (Rimantienė 1999c, 19–20), but the pottery there is extremely diverse and poorly understood. The plant species, the part of the plant used, and the piece size all differ and it is not clear whether specially harvested plants or detritus were used. The preparation method used for clay body with plant temper also differs. The earliest pottery with plant temper is porous and fairly crude while, for example, the thin-walled pottery with a compacted clay body discovered at the Šakės or Barzdis settlements can more likely be dated to the end of the late Neolithic. The plant temper seen in the cross-section of this latter pottery consists of not only leaves but also perhaps some *Poaceae* spikelet pieces.

Pottery with mineral temper appeared in Southeast Lithuania in the Middle Neolithic, i.e., the early 4th millennium, and is associated with

the classic Nemunas culture. The ceramic paste was poorly homogenized and contained fine to very coarse (up to 2 mm) crushed granite temper as well as sparse organic temper. The coarse rock fragments containing a combination of quartz, feldspars, micas, and hornblende found in the ceramics suggest that well-weathered granite gravels and erratic cobbles, which crumble easily during low energy mechanical treatment, were used as temper or that granite fragments and angular minerals were found naturally in the clay matrix from subglacial till sediments. In the studied pottery sample, which is assigned to the Globular Amphora culture, coarse quartz minerals were observed isolated from feldspar and no coarse mica was detected. This may be due to the thermal treatment of the granite: at temperatures above 573° C, the quartz minerals in the rock fragments undergo a significant change in volume and make the stone fairly crumbly. It looks like the pottery producers must have been familiar with not only the various properties of these minerals but also crushing, grinding, and sieving technologies, which could have been adopted from food preparation methods.

Late Neolithic Corded Ware culture pottery is frequently distinguished by grog, i.e., crushed ceramic temper. It is, however, also encountered in Dubičiai type pottery (Tkachou 2018, 83) and even older pottery from the Rakushechny Yar site (Dolbunova et al. 2020, 126). An increase in the use of grog is definitely observable circa 5000 BC in the pottery of the Lengyel culture (Kreiter et al. 2017) as well as in the Brześć Kujawski group of the Funnel Beaker culture in the Polish plain (Kukawka 2015). Thus, grog is not just a Corded Ware cultural phenomenon. It appears that the interpretation of grog is much more diverse than has previously been stated (Piličiauskas 2018, 122). Even the particles of crushed old pots found in thin-section sherds can easily be confused with argillaceous grains or clay pellets, but it is possible to distinguish between them on the basis of certain features (Kreiter et al. 2017). It has also been observed that grog temper is very similar to weathered feldspar or mica minerals, as well as ferruginous nodules (Štavičė et al. 2022), which are very common

in glacial clays (Larsson 2009, 137). In examining the old sherd breaks, grog was seen to have perhaps occurred in some of the sherds from the Margiai 1, Lynupis, Karaviškės 6, Gribaša 4, and Varėnė 5 and 10 settlements, but a determination with the naked eye during an analysis of old breaks on sherds is prone to many doubts. This does not mean that particles of old pots were not deliberately added, but it is important to properly evaluate this diverse component, which is often called grog.

6.2. Pottery forming practices

Vessel shapes are often interpreted as behaviourally significant indicators of societal and cultural changes (Arnold 1985, 234), but the small size of the ceramic fragments and the scarcity of bottom sherds make it difficult to reconstruct vessel sizes and shapes. The earliest pots had pointed or round bottoms and walls that usually rose in a fairly straight line to the top. The Middle–Late Neolithic Nemunas culture pots, which had both pointed and flat bottoms, are already somewhat curved with slightly bulging sides while in the Late Neolithic the sides of both Globular Amphora culture and other pots were fairly clearly bulging and also flared out at the top to end in an S-shaped rim.

The Neolithic pottery of Southeast Lithuania displays a diversity of hand building techniques, the three principal identified ones being:

- 1) pinching and paddle-and-anvil techniques using a solid lump of clay. These are usually attributed to the initial stage in the evolution of pottery production (Tsetlin 2020, 8), but seem to have also been used with some of the Late Neolithic delicate, thin-walled cups and beakers from the Margiai and Barzdis settlements.

- 2) slab building or patchwork – pinched or pressed discs assembly on a hump mould using laminated seams finished using pinching and paddle-and-anvil techniques. This shaping strategy was identified in several Early Neolithic pots from the Gribaša 1, Kašėtos 1, and Katra 1 settlements but is also thought to have been used for Late

Neolithic Corded Ware (Kholkina 2017). In the Late Neolithic, it may have been used to create a vessel's round bottom or together with coils in vessel walls.

3) coil building. This was the main strategy of the Early Neolithic – Bronze Age hunter-gatherer and agrarian communities.

Based on the coil blending technique, the pottery was assigned to U, H, N, or S joint type. U joints, which are considered to be characteristic of Narva culture hunter-gatherer communities (Girininkas 1994, 22), are formed by pinching both sides of the top coil and pushing evenly straight downwards. H joints, which are characteristic of Ertebølle culture ceramics, which, although not seen in Lithuanian Neolithic material, display a similar development to Narva culture pottery, are formed in a similar manner, but with both upwards and downwards movement on both sides. N joints, which are the most common in Southeast Lithuania, especially in Early Neolithic Dubičiai type and Middle Neolithic Nemunas culture pottery, seem to have been formed at first by diagonally flattening the top of the lower coil and laminating the upper coil to its front or rear face, but later by simply vertically pinching downwards on one side of the vessel wall while simultaneously pinching upwards on the opposite side. S joints are formed by irregular pinching and distortion of the coils, which are stacked alternately on the outer or inner upper face of the lower coil. They may be characteristic of Late Neolithic Southeast Lithuanian pottery, which has sometimes been determined to have been built using coil spirals. Some sherds, possibly from the Late Neolithic, show undistorted coils and an outer layer of clay slurry.

Although an attempt has been made to associate the quality of the smoothing at the coil joint site with cultural traditions, i.e., by noting that Corded Ware joints are invisible (Piličiauskas 2018, 123), nevertheless vessel construction quality and thoroughness are more connected with the potter's personal qualities. The ceramic paste recipe as well as the vessel's size, shape, and construction method may reflect the community's traditions, while the shaping quality is connected with the experience, skill, and customs of the individual

potter. In reviewing Southeast Lithuanian Neolithic pottery, very similar style sherds of different quality are frequently noted. This has prompted a hypothesis that the children of Stone Age communities learned to build pots by mimicking the adults. A search was made for fingerprints on Southeast Lithuanian Stone Age pottery to conduct dermatoglyphic research but only fingerprints without papillary lines, which yield statistically unreliable results, were found. Only one clear child fingerprint with an epidermal ridge breadth of 0.391 mm was discovered on a sherd from the Katra 1 settlement. Based on the applicable age calculation formula (Králík, Novotný, 2003), it was made by a 12.3-year-old child.

In analysing the pottery from the Middle Neolithic Nemunas culture, extremely large fingerprints uncharacteristic of those on other pottery were immediately noticed. The paleo dermatoglyphic pattern discovered on the rim of the very skilfully made vessel from the Šakės settlement confirmed these observations. An epidermal ridge breadth of 0.492 mm is definitely ascribable to an adult male (Králík, Novotný, 2003). The Nemunas culture pottery made by adult males not only refutes the established stereotype that only women were involved in the production of pots, but also reflects a new, more advanced stage of pottery development, which was perhaps connected with a specialisation of travelling potters. It is likely due to a demand for high quality vessels that such professional potters possessed special status in the society.

6.3. Decoration

Vessel decoration is perhaps the main feature allowing individual vessels to be ascribed to one cultural group or another. But, in fact, the personal artistic expression of a separate individual often exists alongside the community's traditions. Vessel decoration begins with the preparation of its surface. From the earliest times the surface, both inside and out, of the majority of the vessels was finished by scraping with a hard toothed instrument (a bone or flint flake) or by brushing

with soft material (a handful of grass, birch bark), both of which left lines. Some sherds from the Nemunas culture have a very smooth, glossy external surface, which archaeologists have long interpreted as having been coated with a clay slip (Rimantienė 1984, 121), but which might have been created by smoothing or burnishing with a smooth stone, a simple bone, leather, or some other very smooth material. Experimental archaeology has shown that in burnishing the surface with a stone or bone, the ground granite particles of temper are pushed inside the vessel's walls, thus allowing the surface to be smoothed to sheen (Šatavičė 2020, 132).

Neolithic pottery decoration is quite scarce in Southeast Lithuania. A row of deep pits or other impressions around the rim, frequently a vessel's only decoration, predominated up until the Bronze Age. Finishing designs can be divided into three groups based on their complexity:

- 1) One or several separate rows of simple repeating impressions;
- 2) Impressions that form a composition or were made by a purpose-made tool (double or multi-toothed stamps or a cord wrapped on stick or cord core);
- 3) 3-D ornaments created with a tool that was pressed into the clay at varying angles and to varying depths.

Impressions ascribable to the first group are frequently encountered in pottery from various periods. They require little time or imagination and the tool that was used allows one to easily guess the rest of the design on the vessel wall. Experimental archaeology has shown that some of the fascinating impressions on the Dubičiai type and Nemunas culture pottery could have been made using animal (probably wild boar) teeth.

Impressions of small irregular pits, which were not always made by a sharpened stick, are frequently encountered. Traces of domesticated plants have been identified on Late Neolithic pottery from the Stary'e Jurkovichy 1 and Kamen 6 settlements in Belarus (Grikkpėdis 2021, 228). In Lithuania, imprints of *Panicum miliaceum*, *Triticum* sp., and *Hordeum vulgare* seeds have only been identified on

Bronze Age pots from Narkūnai Hillfort (Podėnas et al. 2016, 214), but judging from the Neolithic material from neighbouring countries, it may be possible to assume the first domesticated plants appeared in Southeast Lithuania as early as the Late Neolithic. A few unidentified distinct impressions resembling seeds or pits have been observed on pottery from the Gribaša 4, Paramėlis 2, and Varėnė 5 settlements. The exterior of a pot from the Barzdis settlement was decorated with unevenly arranged, irregularly oval impressions. A stereomicroscopic analysis revealed a rough surface characteristic of seeds as well as a distinct similarity in size and shape to *Rubus caesius* L. seeds. While it is often thought that the seeds of wild or domesticated plants found their way onto vessel walls accidentally, they could have also been a deliberate decoration. The frequent plant inclusions, especially of domesticated species, in the pottery of various Neolithic cultures may have also had some ritual meaning.

Cord impressions should also be ascribed to the first, more ordinary decoration group because various cords were often needed in the home, meaning that no additional preparation was needed to make a design. Although experimental archaeology has shown that the cords could have been made of flax, because this plant had yet to reach Lithuanian territory, supple lime bast or grass were more likely to have been used (Grömer, Kern 2010, 3142). The cord impressions on Neolithic pottery often exhibit a diversity: while some cords were twisted very thoroughly and impressed at an even depth so that the structure of the cord's strands is clearly visible, the majority of the impressions are from unevenly twisted cords that were haphazardly pressed into a poorly smoothed surface. Although this diversity is usually explained as the difference between the work of a 'master' and an 'apprentice' (Grömer, Kern 2010, 3144), it could also reflect chronological differences. It should be noted that overlapping impressions of different sized cords are more characteristic of classic Corded Ware where the cord impressions appear to have had a more ritual significance, as if attempting to bind or protect the vessel's contents. Meanwhile evenly deep impressions of neat, hard-twisted

cords are more characteristic of the very Late Neolithic and represent an aesthetic function.

The idea of using a cord to decorate pottery already existed in the Southeast Baltic region in the 5th millennium BC but those motifs are, in fact, more complex and should be ascribed to the second group on the basis of the construction method. Impressions made by string wound on a cord or a stick and arranged in dense compositions covering a vessel's entire surface are characteristic of the traditions of not only the Narva, but also the Comb Ware culture, which was further north (Akulov 2019). While various imprints of thin string wrapped around a thin stick are especially characteristic of Middle Neolithic pottery in East and West Lithuania, they are also found in Southeast Lithuania.

For a long time, the use of a comb stamp for decorating was considered the main criterion for assigning the entire East Baltic region to the Comb Ware culture but it instead represents the spread of ceramic ideas within supra-regional interaction networks (Hommel 2018). Despite some similarities with these comb in decorations, Southeast Lithuania's early Dubičiai type pottery shares similarities to Narva culture decorations to the north, but has clear differences with Comb Ware decorations according to a statistical correspondence analysis (Piezonka 2015).

While similar pottery motifs characteristic of hunters-fishers-gatherers were used in the pottery of the Early Neolithic communities, classic Nemunas and Narva culture pottery became a distinct representative element of different communities in the Middle Neolithic. The pottery of the Nemunas culture is characterised by complex decorative designs requiring skill. One of the most characteristic elements is a 'cascading band', as it is known in Lithuanian, i.e., a row of dense impressions, which were usually made on an especially smooth surface. The most impressive thing are the Nemunas culture rims which are not characteristic of the neighbouring lands and have a shape created by impressing very deep pits (without piercing the rim) from inside and out. Frequently several rows of

decorative elements, impressed to different depths, are found on the inside and outside of the rim of the same vessel. The design transcends the 2-D boundaries and becomes 3-D.

It should be noted that pottery with the complex designs characteristic of the classic Nemunas culture is fairly rare in Lithuania, compared to Northeast Poland or Belarus, as fewer than 30 vessels have been found. The small number of impressive pots probably may be explained by the agency of only a few potters. It is likely that various pottery production traditions converged in Southeast Lithuania during the 4th–3rd millennia BC. These same settlements saw the discovery of vessels with designs reminiscent of the Narva culture traditions, a shape and clay body reminiscent of the Nemunas culture, and perhaps also of the Funnel Beaker culture traditions. In addition, the discovered Globular Amphora and Corded Ware culture pottery, based on its style elements in Southeast Lithuania, is also frequently reminiscent of the traditions of the same Nemunas culture.

6.4. Firing

Only after passing through the fire does the clay irreversibly transform from natural sedimentary rock into a man-made solid material – ceramics. Drying and firing are the most dangerous stages of the ceramic formation process, as the stresses within the shaped body and physico-chemical modifications can cause cracks, deformations, and even explosions. It is likely that among the Neolithic sherds found in Southeast Lithuania, at least some of them are from earthenware vessels that were defective during the firing phase and were never used for their intended function.

There is a high variability in the transformations, which depends on the firing conditions, the fuel, the soaking time, the shape of the vessel, and especially the clay paste's properties. Firing structure is usually considered both in ethnographic and archaeological reports as the major factor in thermal efficiency. Most Neolithic sherds from Southeast Lithuania seem to have been fired under poorly controlled

or oxidizing conditions in open structures: a bonfire, depression, or pit (Gosselain, Livingstone Smith 1995).

Generally, the clay matrix transforms irreversibly into a fired ceramic at temperatures in excess of 400° C and the firing process can be completed at temperatures of 650–700° C. Four firing temperature ranges can be distinguished based on the microstructural changes:

1) very low fired (below 600/650° C) (after Mentésana et al. 2019; Maniatis et al. 1982), which produces a non-vitrified, flaky or lath-like structure microstructure similar to that of unfired raw clay.

2) low fired (600/650–700/750° C), which produces a non-vitrified microstructure with some separate minerals but with some of the clay minerals looking deformed and buckled.

3) medium fired (700/750–800° C), which produces initial microstructural vitrification with fine glassy clay threads or filaments in places and a transformation of the amorphous and crystalline phases.

4) high fired (above 800° C), which produces a compact vitrified microstructure with specific pores and causes the formation of new amorphous and crystalline phases.

The macroscopic observations and detailed microscopic examinations of the ceramic samples suggest that the majority of Neolithic pottery in Southeast Lithuania belongs to the very low or low firing range and only a few samples to the medium firing range.

The black cores of potsherds are usually interpreted as being the result of reduction firing conditions or as incompletely oxidised organic matter trapped inside the clay paste. However, the black interiors of the Southeast Lithuanian Neolithic ceramics seem to be mostly due to an abundance of charred organic matter and very low firing temperatures with a short soaking time. While the few black pottery samples look to be the result of reduction firing conditions, it is not clear how those conditions were created.

6.5. Pottery use

The majority of the Neolithic pottery in Southeast Lithuania consists of pots lacking any cooked-on food residue or other signs of use due to the poor conditions for the survival of organic material. Their function can be interpreted from their projected size and from geochemical analyses, but it is difficult to calculate their shape due to the sherd size. No very large (over 50 litre capacity), stationary vessels intended for long-term storage have been found in Southeast Lithuania. Judging by the potsherds discovered in Southeast Lithuania and the reconstructions from neighbouring regions (Józwiak 2003; Wawrusiewicz et al. 2017; Tkachou 2018), the majority of the Early and Middle Neolithic ceramics may have consisted of a medium-size vessels (roughly 5–8 litre capacity) with a 24–27 cm diameter rim, a size likely convenient for the daily food needs of one family. Some of the Dubičiai type and especially the classic Nemunas culture pots stand out from the general context due to their unique design and large size: a 34–40 cm diameter rim (roughly 15–25 litre capacity). Such a size and weight would have been more suitable for stationary food storage, but the main advantage of mineral-tempered pottery is connected with its resistance to thermal shock; a microstructural analysis showed that the Nemunas culture pots had indeed been used for cooking (Šatavičė et al. 2022). The communities to which these vessels belonged must have been sedentary enough to be able to not only precisely decorate, dry, and fire vessels of this size, but to also use them at just one location. The lack of dating possibilities makes it difficult to determine whether the larger and smaller pots were contemporaneous. While the large vessels, both the Dubičiai type and the classic Nemunas culture ones, seem to have been used collectively by the whole community, the Middle Neolithic decrease in pot size and the diffusion of various cultural elements with individual expression point to the gradual rise of individual households.

Ceramic temper is often considered a cultural-chronological indicator in Southeast Lithuania, but it seems that organic inclusions

were used not only in the Early Neolithic, but also later, especially for food storage and serving vessels. The majority of the widely investigated Stone Age settlements in Southeast Lithuania have yielded small, thin-walled, mostly organic tempered cups and bowls with a difficult-to-determine chronology. These personal vessels, the shape and size of which possibly derived from ones found in Narva culture or agrarian communities, were perhaps the first to date to the Middle Neolithic.

In the Late Neolithic, the appearance of amphora, beakers, and various-shaped pots is seen and should be connected with Globular Amphora and Corded Ware culture influence. Such vessel differentiation not only reflects an augmented diet with more diverse food, but also demonstrates an altered perception of individual property and a need for personal vessels.

Isotopic and biomolecular analyses of food residue on pottery have yielded the most information in recent years about Neolithic nutrition and the food prepared in Lithuanian ceramic vessels. A bulk $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ stable isotope analysis was conducted on 11 samples of encrusted charred food from Southeast Lithuania (Piličiauskas et al. 2018). The one sample from Dubičiai (from the Margiai 1 settlement) and the three from Nemunas culture pottery (from the Kabeliai 23, Margiai 1, and Šakės settlements) displayed the low $\delta^{15}\text{N}$ values characteristic of terrestrial food. These samples are very different from the aquatic material on so-called Subneolithic Narva culture pottery from Šventoji (Palanga District, West Lithuania) as well as the shores of Lakes Biržulis (Telšiai District, West Lithuania) and Kretuonas (Švenčionys District, East Lithuania), but the samples from Margiai 1 and Kabeliai 23 settlements are fairly close to some of the samples from Narva culture pottery from the Papiškės (Vilnius District) and Daktariškė (on the shore of Lake Biržulis) settlements (Piličiauskas et al. 2018, 24–28). Neolithic settlements in Southeast Lithuania existed on the shores of large lakes and therefore, based on environmental determinism, at least a slight exploitation of the water resources would have been likely.

The remaining seven samples of encrusted charred food from Southeast Lithuania: from the Karaviškės 6 (1 sample), Katros Ištakos 1 (2), and Margiai 1 (4) settlements were of Corded Ware. They did not differ from the general context of the Lithuanian Corded Ware culture inland settlements and were also fairly close to the earlier Southeast Lithuanian pottery (Piličiauskas et al. 2018). If a transition from aquatic to terrestrial food can be seen on the coast and in the Narva culture inland settlements, a transition connected with the keeping of domesticated animals, then it would seem that the subsistence strategy could have remained unchanged in Southeast Lithuania right up until the Bronze Age.

An organic residue analysis using molecular and isotopic characterization techniques has yielded more detailed information about the diversity of the food prepared in the ceramic vessels. Of the 667 samples of Baltic region hunter-gatherer pottery examined, only seven were from Southeast Lithuania (the Dubičiai 3, Glūkas 3, Gribaša 4 (2 samples), Karaviškės 6 (2 samples), and Varėnė 10) settlements and 15 from the Narva culture Kretuonas and Daktariškė settlements. Food prepared from predominantly non-ruminant terrestrial animals was found in the former, from fresh water resources mixed with fats and oils from terrestrial foods in the latter (Courel et al. 2020).

In Southeast Lithuania, no dairy was found in either the Early – Middle Neolithic or Corded Ware vessels, which latter are associated with first farmers. Eight samples attributed to pottery from the first Southeast Lithuanian farming settlements were examined (2 Corded Ware beakers from Dubičiai 2, a Globular Amphora culture amphora and a pot from Gribaša 4, and 3 Corded Ware beakers and an amphora from Karaviškės 6) (Robson et al. 2019). While Southeast Lithuanian vessels usually contained only terrestrial foods, mainly ruminant fats, West Lithuanian ones predominantly had both ruminant animal fats and aquatic foodstuffs. Residues from non-ruminant animal sources were also found on Southeast Lithuanian Corded Ware beakers (Dubičiai 2 and Karaviškės 6) (Piličiauskas 2018, 140, Table 5). The

diversity of the food discovered in beakers shows that archaeologists have erroneously interpreted their purpose. Judging by their 0.5–0.8 l size, they were used as personal vessels, not only for beverages, but also various solid foods.

7. THE SOCIAL-CULTURAL CONTEXT OF STONE AGE POTTERY-USING COMMUNITIES

Ceramic traditions are dynamic processes, which are unable to spread pell-mell across cultural and social boundaries but can transform and develop through interactions between communities as well as through agency within a community. The long-distance spread of ceramic production ideas, styles, cultural behaviours, and other socio-economic or technological transformations is more likely to be due to an exchange of information via long-established supra-regional communication networks than to random massive migrations. No doubts exist about the greater or lesser mobility of Neolithic people and its influence on the transmission of innovations, but only a certain closeness and social kinship between communities can ensure an exchange of ideas, whereas the socio-cultural boundaries between hostile groups may be reflected in the geographically proximate, but stylistically very distinct technologies, like in pottery production.

The Stone Age pottery discovered in Southeast Lithuania was previously simply divided up on the basis of the archaeological cultures: that with organic temper to the Dubičiai type or the Pripyat-Neman culture; with ground stone temper to the Nemunas culture; and with sand temper and corded impressions, pinching, or an incised fishbone motif to the Corded Ware culture. However, these ceramics are often characterised by a certain individuality, which is more a reflection of the convergence of influences from several different traditions there.

The various technological choices used in the early production of pottery suggest that the emergence of ceramics in the 6th millennium BC was not a one-off event and that ideas spread from several different sources. The first, very rare ceramics, which reflect a process of learning or even a kind of experimentation, perhaps due to a lack of information and experience, show that local communities had adopted ceramic production ideas. The first ceramics production technology in Southeast Lithuania may have been coil spiral assembly using a

mould, a technique that may have originated in northeast Europe and the upper reaches of the Volga. This undecorated pottery was probably made from natural organic-rich silty clay from shallow waters. Such sherds are probably found in many settlements, but their small size makes identification difficult.

The strongly shaped ceramics from the turn of the 5th millennium BC or earlier are probably another impulse in pottery production ideas. Such pronounced shapes are not typical of either upper Volga culture or Dubičiai type pottery, where relatively straight rims predominate, but bears some resemblance to early Ertebøle culture and Elshan culture (middle Volga) pottery (Andreev, Vybornov 2021).

In the 5th millennium BC, Dubičiai type or Pripjat-Neman culture pottery emerged in Southeast Lithuania as a well-developed pottery tradition with specific ceramic features. However, Southeast Lithuania was only the northwest periphery of the large cultural sphere of the Dnieper-Don cultural tradition, which was widespread in the Nemunas river basin, Belarus, and North Ukraine (Tkachou 2018).

The development of the Nemunas culture in the 4th millennium BC is attributed to the influence of agrarian Funnel Beaker culture (Józwiak 2003). The main innovation of Middle Neolithic pottery was mineral temper with crushed granite fragments. However, some similar decoration motifs as well as the shape and size of the large cooking pots have allowed the further development of the same Early Neolithic communities to be traced in the Middle Neolithic. In addition to Nemunas culture ceramics, pottery with classic Narva culture features is often found in Southeast Lithuania, which is sometimes associated with active raw flint trading (Girininkas 2005). The presence of pottery with both Narva and Nemunas culture features suggests that the Narva culture communities may have been indigenous to Southeast Lithuania and may have lived on the shores of the large lakes while using freshwater resources.

The Globular Amphora and Corded Ware cultures are often interpreted as parts of the same unified process that introduced a new economy of animal husbandry to the East Baltic region in 3rd

millennium BC (Robson et al. 2019). Genetic studies have shown significant differences between the populations of these cultures and, in addition, the mass graves found in Central Europe are considered to be the result of violent conflicts (Schroeder et al. 2019), which may have been triggered by competition for the same landscape and economic niche. In the Southeast Lithuanian Neolithic material, it is difficult to trace any features of the economic shift created by the Globular Amphora or later Corded Ware cultures, but their influence cannot be denied and may be linked to a differentiation in vessel size and use, a reflection of social change. The emergence of the Corded Ware culture in Europe, including Southeast Lithuania, is often associated with massive migrations (Haak et al. 2015; Kristiansen et al. 2017; Mittnik et al. 2018; Piličiauskas 2018). However, the lack of radiocarbon data directly related to archaeological material and the presence of pottery with similar features but characteristic of different cultural traditions in the region make it difficult to estimate the extent of those migrations. Most of the pottery associated with the first farmers is concentrated in a few multiperiod settlements in the Dubičia-Rudnia microregion, which had been previously inhabited by hunter-gatherers and possibly were again later.

Southeast Lithuania's Corded Ware reflects ephemeral traditions rather than fully established colonisation by foreign communities with a new economic and social structure. The major demographic changes seem to have occurred later, in the 2nd millennium BC. But in the Neolithic, probably due to its specific environmental conditions and low population, Southeast Lithuania may not have been the site of intense competition. Thus, a peaceful but dynamic interaction between the hunter-gatherer and farming communities is more likely.

CONCLUSIONS

1. Southeast Lithuania's first clay vessels, which date to the late 6th millennium BC reflect the beginning of multiple protracted processes, which inspired a transformation of the way of life, nutrition, artistic expression, and identifying symbols of the communities that made and used the pottery. They can, therefore, be associated with the beginning of the Neolithic. The traditional concept of the 'Neolithic', which is defined by sudden economic changes, is not very suitable for describing these processes; thus an alternative model of Neolithisation should be selected for Southeast Lithuania. The natural environment, perfectly suited to the hunter-gatherer lifestyle and unfavourable to agriculture, was probably a principal factor in the hunter-gatherer / agricultural border remaining there for several millennia. The indigenous 'Forest Neolithic' hunter-gatherers selectively adopted certain innovations from the agricultural and non-agricultural communities and adapted them to fit their own needs.
2. The emergence of pottery in Southeast Lithuania, like in the rest of the Baltic region, is connected not with Central European farmers, but with the influence of non-agrarian communities from the east. The pottery making tradition and other innovations should have spread through supra-regional interactions within existing networks formed in the Mesolithic or even earlier, rather than through massive migrations that eradicated or assimilated local populations. The term 'archaeological culture' can only be used for Southeast Lithuania's Neolithic society in the context of a polythetic culture model, where the same cultural elements can emerge irregularly in various directions and in different cultural environments. Every community has its own *habitus*, i.e., socialised norms that guide behaviour and thinking, but changes in thinking, behaviour, beliefs, symbols, and other

- cultural elements occur constantly due to the multilevel sociality and agency of individuals.
3. The adoption of the first ceramics and, later, some elements of a food production economy, occurred multiple times; the pottery production traditions spreading from the northeast and southeast may have been adopted several times from different sources. The first ceramics in Southeast Lithuania should have been organic tempered coil spirals assembled using a mould. This pottery differed little from the Narva culture traditions that existed to the north. In the 5th millennium BC, distinctive Dubičiai type pottery appeared through the influence of the Dnieper-Don culture. However, Southeast Lithuania was only its northwest periphery and the prevalence of this type of pottery has been overestimated. The abundant pottery with organic temper found in Southeast Lithuania was previously attributed to the Dubičiai type, but the diversity of production technologies has allowed most of this pottery to be associated with the influence of other, chronologically very different cultural traditions. Judging by the Dubičiai type pottery analogues from Belarus, only large pots with a straight profile belong to this pottery type, while the small cups are considered to be Middle or Late Neolithic food serving vessels.
 4. In the Middle Neolithic, from the 4th millennium BC, pottery became a clear representative symbol of various communities. The limited pottery of the classical Nemunas culture, characterised by burnished surfaces and unique decoration requiring skilfulness and extraordinary spatial thinking, can be associated with the work of traveling skilled potters who used local clay resources. The large pots, similar in size to the Dubičiai type pottery, but considerably heavier due to their mineral temper, must have been stationary vessels shared by the whole community and point to semi-sedentism. Ceramics with features characteristic of the contemporaneous classic Narva culture style have also been found in Southeast

Lithuania. It is difficult to evaluate the interaction of these different hunter-gatherer traditions or to determine the dominance of one community over the other, but the appearance of different cultural elements on the same vessel may be evidence of an equal and peaceful cooperation.

5. The transition to the Late Neolithic is marked by a differentiation in vessel size and the spread of decoration embodying various cultural influences. Pottery ascribable to the Corded Ware culture is scarce and very diverse in Southeast Lithuania; it is, therefore, unlikely that a massive migration occurred in this region. Pottery seems to have gradually lost its significance as a community's main representational symbol, being associated more with the domestic environment than male status. The fairly primitive decoration composed of nail and finger impressions and their size suggest that pottery production had become a domestic task performed by women.
6. The combined analysis of the geochemical and mineralogical structure of Neolithic pottery, applied for the first time in Lithuania, has not yet allowed broad generalisations to be made, but it has revealed clear trends in the various cultural traditions. The raw materials must have been accessible locally, but the mixed Quaternary sediments deposited by several glaciations complicates the investigation of a sherd's provenance. However, the geochemical and mineralogical analyses of the pottery samples revealed the strong impact of the production process, i.e., the 'ceramic taskscape'. The hierarchical clustering analysis using the geochemical data allows the various production technologies to be objectively classified, while the mineralogical investigations are important for understanding the factors that determine the geochemical composition. The XRD analyses of the ceramic samples showed high levels of quartz in all of them as well as high levels of alkali feldspars in those deliberately made leaner with

mineral impurities. The XRD peaks of the clay mineral phyllosilicates are most significant in the sherds of plastic fat clay from the Barzdis Forest settlement. The FTIR spectra are also dominated by quartz bands, but still show crystalline water preserved in the clay. The ceramics examined by FTIR were found to have been fired at low and very low temperatures, only one sherd that should probably be assigned to the Globular Amphora culture falling within the medium firing range. The SEM-EDS with SE and BSE imaging and a point analysis allowed the detailed mineralogical and chemical composition of the ceramic pastes and tempers to be determined. The SEM-EDS SE and BSE images showed textural differences in the clay matrix, some of which may be explained by intentionally mixing the clay or using a specific pottery surface treatment. The others may be attributed to internal differences in glacial till formation. No grog temper, which is characteristic of classic Corded Ware, was detected, only clay pellets, ferruginous nodules, and weathered minerals, which may look like grog to the naked eye.

7. Pottery with organic temper is very diverse in Southeast Lithuania: not only in respect to the type of organic material, but also the clay preparation styles. The microstructural study revealed that silty clay of different weathering grades, which had been found in shallow bodies of water or on the shore, was the most common material used for the Neolithic pottery from the various traditions. Such sedimentary clay may naturally contain a variety of decomposed plants or broken shell fragments. The voids left by coarse *Cyperaceae* or *Poaceae* leaves reflect other technological choices, possibly in imitation of the agrarian traditions seen in the thin-walled Middle or Late Neolithic pottery. The black cores with small vughs of the Late Neolithic Corded Ware sherds can probably be interpreted as the use of domestic herbivore dung. Similar internal textures can be seen in Narva culture pottery, but it is unlikely that

hunter-gatherers also gathered wild dung. The Nemunas and Globular Amphora culture pottery is likely to have been made from subglacial till, which may have naturally contained variegated residual clay as well as weathered granitoid fragments.

8. The potsherds of varying structural and decorative quality that have been discovered in Southeast Lithuania reflect the learning process. Stone Age children likely began making pots, but the adults could have also copied skilfully made vessels or improved their skills. The first pots were probably built from joined coil spiral assemblies with varying coil and joint sizes, which is the main technique used with Neolithic pottery. The attitude towards the aesthetic qualities differed greatly between the communities. The outer and inner surfaces of pottery were usually smoothed with various sharp or flat polished tools, but a very smooth, glossy external surface, typical for classic Nemunas culture pottery, was probably burnished. One or several separate rows of repeating impressions around the rim, which is frequently the only decoration, predominated up until the Bronze Age.
9. Firing is the riskiest stage in the production process, where at least some of the items can be lost. The archaeological material found in the settlements may include not only sherds of used vessels but also those from vessels that crumbled during firing. Post-depositional conditions in Southeast Lithuania make it difficult to identify the sherds of used vessels, but the phosphorus-enriched layers or traces of specific surface attrition may be associated with particular activities. The isotopic and biomolecular analysis of food residue on the pottery suggests that the Narva culture communities exploited water resources, while the inhabitants of the Nemunas, Globular Amphora, and Corded Ware cultures obtained their proteins from terrestrial animals, mainly ruminants.

10. The natural environment and the spatial distribution of the settlements show that a dense network of rivers was important for mobility and the spread of innovations, while large lakes could be intensively exploited by the semi-sedentary communities living on freshwater resources. The multiperiod settlements of Southeast Lithuania were probably inhabited not only after the passage of several hundreds or thousands of years, but also by the same, possibly seasonally shifting or simultaneous competing communities. The elements of different cultural traditions, blended in the same vessels, provide an insight into the encounters between various hunter-gatherer and agrarian societies, and allow one to speak of a mutually beneficial cooperation. Meanwhile, the diversity of the pottery-making techniques reflects a potters' individual agency in light of the influence of the environmental conditions and cultural traditions.

REFERENCES

Akulov, A., 2019. A Preliminary Attempt to reconstruct some tools and techniques of ornamentation of the Comb-Pit Ware from the site of Hepojarvi (Karelian Isthmus, Leningrad Oblast, Russia). *EXARC Journal Issue*, 2 [online]. <https://exarc.net/ark:/88735/10421>.

Andreev, K.M., Vybornov, A.A., 2021. Ceramic Traditions in the Forest-Steppe Zone of Eastern Europe. *Open Archaeology*, 7(1), 705–717. <https://doi.org/10.1515/opar-2020-0169>

Arnold, D. E., 1985. *Ceramic Theory and Cultural Process*. Cambridge: Cambridge University Press.

Baltrūnas, V., Barzdžiuvienė, V., Blažauskas, N., et al., 2001. *Akmens amžius Pietų Lietuvoje*. Vilnius: Geologijos institutas.

Binford, L. R., 1983. *In Pursuit of the Past. Decoding the Archaeological Record*. London: Thames and Hudson.

Bobrinsky, A. A., Vasilyeva, I. N., 2012. Plastic raw materials in Neolithic pottery production. *Documenta Praehistorica*, 39, 67–74.

Childe, G., 1936. *Man Makes Himself*. London: Watts.

Clarke, D. L. 1968. *Analytical Archaeology*. London: Methuen.

Courel, B., Robson, H. K., Lucquin, A., Dolbunova, E., Oras, E. et al., 2020. Organic residue analysis shows sub-regional patterns in the use of pottery by Northern European hunter–gatherers. *Royal Society Open Science*, 7 (4). <https://doi.org/10.1098/rsos.192016>.

Dolbunova, E. V., Tsybryi, V. V., Mazurkevich, A. N. et al., 2020. Subsistence strategies and the origin of early Neolithic community in the lower Don River valley (Rakushechny Yar site, early/middle 6th millennium cal BC): First results. *Quaternary International*, 541, 115–129.

Furholt, M. 2020. Social Worlds and Communities of Practice: a polythetic culture model for 3rd millennium BC Europe in the light of current migration debates. *Préhistoires Méditerranéennes*, 8. <https://doi.org/10.4000/pm.2383>

Gibbs, K., Jordan, P., 2016. A comparative perspective on the ‘western’ and ‘eastern’ Neolithics of Eurasia: Ceramics; agriculture and sedentism. *Quaternary International*, 419, 27–35.

Girininkas, A., 1994. *Baltų kultūros ištakos*. Vilnius: Savastis.

Girininkas, A., 2005. Neolitas. *Lietuvos istorija, I. Akmens amžius ir ankstyvasis metalų laikotarpis*. Vilnius: Baltos lankos, 102–196.

Gosselain, O. P. and A. L. Smith 1995. The Ceramics and Society Project: An Ethnographic and Experimental Approach to Technological Choices. In Lindahl, A., Stilborg, O., eds. *The Aim of Laboratory Analyses of Ceramics in Archaeology*. Stockholm: Kungliga Vitterhets Historie och Antikvitets Akademien, 147–160.

Grikpēdis, M., 2021. *Kultūrinių augalų kilmė Lietuvoje Rytų Baltijos regiono kontekste (archeobotanikos duomenimis iki XIV a.). Daktaro disertacija*. Vilnius: Vilniaus universitetas. <https://doi.org/10.15388/vu.thesis.255>

Grömer, K., Kern, D., 2010. Technical data and experiments on corded ware. *Journal of Archaeological Science*, 37, 3136–3145.

Haak, W., Lazaridis, I., Patterson, N. et al. 2015. Massive migration from the steppe was a source for Indo-European languages in Europe. *Nature*, 522, 207–211.

Hodder, I., 1990. *The Domestication of Europe*. Oxford: Blackwell.

Holmqvist, E., Larsson, A., Kriiska, A., Palonen, V., Pesonen, P., Mizohata, K., Kouki, P., Raisanen, J., 2018. Tracing grog and pots to reveal neolithic Corded Ware Culture contacts in the Baltic Sea region (SEM-EDS, PIXE). *Journal of Archaeological Science*, 91, 77–91.

Hommel, P., 2018. What’s the Point?: Globalization and the Emergence of Ceramic-using Hunter-gatherers in Northern Eurasia. In: Boivin, N., Frachetti, M., eds. *Globalization in Prehistory: Contact, Exchange, and the ‘People Without History*. Cambridge: Cambridge University Press, 15–42.

Jasiewicz, J., Niedzielski, P., Krueger, M., Hildebrandt-Radke, I., Michałowski, A., 2021. Elemental variability of prehistoric ceramics from postglacial lowlands and its implications for emerging of pottery

traditions—An example from the pre-Roman Iron Age. *Journal of Archaeological Science: Reports*, 39, 103177. <http://doi.org/10.1016/j.jasrep.2021.103177>

Józwiak, B., 2003. *Spoleczności subneolitu wschodnioeuropejskiego na Niżu Polskim w międzyrzeczu Odry i Wisły*. Poznań: Uniwersytet Adama Mickiewicza.

Kholkina, M., 2017. Some aspects of Corded Ware on Rosson River (Narva–Luga Klint Bay). *Estonian Journal of Archaeology*, 21(2), 148–160.

Kolář, J., 2020. Migrations or local interactions? Spheres of interaction in third-millennium BC Central Europe. *Antiquity*, 94(377), 1168–1185. <https://doi.org/10.15184/aqy.2020.151>

Kossinna, G., 1911. *Die Herkunft der Germanen: zur Methode der Siedlungsarchaologie*. Würzburg: Curt Kabitzsch.

Králík, M., Novotný, V., 2003. Epidermal Ridge Breadth: An Indicator of Age and Sex in Paleodermatoglyphics. *Variability and Evolution*, 11, 5–30.

Kreiter, A., Kalicz, N., Kovacs, K., Siklosi, Z., Viktorik, O., 2017. Entangled traditions: Lengyel and Tisza ceramic technology in a Late Neolithic settlement in northern Hungary. *Journal of Archaeological Science: Reports*, 16, 589–603.

Kriiska, A., 1996. The Neolithic pottery manufacturing technique of the lower course of the Narva River. In: Hackens, T., Hicks, S., Lang, V., eds. *Coastal Estonia: Recent Advances in Environmental and Cultural History*. Strassbourg: Rixensart, 373–384.

Kriiska, A. Oras, E., Lougas, L., Meadows, J., Craig, O., Lucquin, A., 2017. Late Mesolithic Narva Stage in Estonia: Pottery, Settlement Types and Chronology. *Estonian Journal of Archaeology*, 21(1), 52–86.

Kristiansen, K., Allentoft, M. E., Frei, K. M., Iversen, R., Johannsen, N. N. et al. 2017. Re-theorising Mobility and the Formation of Culture and Language Among the Corded Ware Culture in Europe. *Antiquity*, 91, 334–347.

Kukawka, S., 2015. Początki Kultury pucharow lejkowatych na niżu Polskim. *Folia Praehistorica Posnaniensia*, 20, 277–300.

Larsson, Å. M., 2009. *Breaking and Making Bodies and Pots. Material and Ritual Practices in Sweden in the Third Millennium BC. (Aun 40)*. Uppsala: Uppsala University.

Lubbock, J., 1865. Pre-historic Times, as illustrated by Ancient Remains, and the Manners and Customs of Modern Savages. London and Edinburgh: Williams and Norgate.

Maniatis, Y., Katsanos, A., Caskey, M. E., 1982. Technological examination of low-fired Terra cotta statues from Ayia Irene Keos. *Archaeometry*, 24, 191–198. <http://doi.org/10.1111/j.1475-4754.1982.tb01001.x>

Marcinkevičiūtė, E., 2016. A New Perspective on Neolithic sites in the Dubičiai Microregion Using a GIS spatial analysis. *Archaeologia Lituana*, 17, 57–76.

Mentesana, R., Kilikoglou, V., Todaro, S., Day, P. M. 2019. Reconstructing change in firing technology during the Final Neolithic–Early Bronze Age transition in Phaistos, Crete. Just the tip of the iceberg? *Archaeological and Anthropological Sciences*, 11, 871–894. <https://doi.org/10.1007/s12520-017-0572-8>

Mikšaitė, S., 2005. Production of Ceramics of Narva Culture (Reconstructions based on Experimental Archaeology). *Estonian Journal of Archaeology*, 9(1), 60–72.

Mittnik, A., Wang, C. C., Pfrengle, S., et al., 2018. The genetic prehistory of the Baltic Sea region. *Nature Communication*, 9 (442). <https://doi.org/10.1038/s41467-018-02825-9>

Nowak, M., 2019. The first vs. second stage of neolithisation in Polish territories (to say nothing of the third?). *Documenta Praehistorica*, 46, 102–127.

Piezonka, H., 2015. *Jäger, Fischer, Töpfer. Wildbeutergruppen mit früher Keramik in Nordosteuropa im 6. und 5. Jahrtausend v. Chr. (Archaologie in Eurasien, 30)*. Bonn: Habelt-Verlag.

Piličiauskas, G., 2016. Lietuvos pajūris subneolite ir neolite. Žemės ūkio pradžia. *Lietuvos archeologija*, 42, 25–103.

Piličiauskas, G., 2018. *Virvelinės keramikos kultūra Lietuvoje 2800–2400 BC*. Vilnius: Lietuvos istorijos institutas.

Piličiauskas, G., Skipitytė, R., Heron, C., 2018. Mityba Lietuvoje 4500–1500 cal BC maisto liekanų keramikoje bendrųjų mėginių izotopinių tyrimų duomenimis. *Lietuvos archeologija*, 44, 9–41.

Rice, P.M., 1987. *Pottery Analysis*. Chicago: The University of Chicago Press.

Rimantienė, R., 1984. *Akmens amžius Lietuvoje*. Vilnius: Mokslas.

Rimantienė, R., 1992. Šakės – neolito gyvenvietė. *Lietuvos archeologija*, 8, 16–34.

Rimantienė, R., 1999a. Margių 1-oji gyvenvietė. *Lietuvos archeologija*, 16, 109–170.

Rimantienė, R., 1999b. Barzdžio miško gyvenvietė. *Lietuvos archeologija*, 16, 171–208.

Rimantienė, R., 1999c. Neolitas ir ankstyvasis žalvario amžius Pietų Lietuvoje. *Lietuvos archeologija*, 16, 19–29.

Robson, H. K., Skipitytė, R., Piličiauskienė, G., et al., 2019. Diet, cuisine and consumption practices of the first farmers in the southeastern Baltic. *Archaeological and Anthropological Science*, 11, 4011–4024.

Schroeder, H., Margaryan, A., Szmyt, M., Theulot, B., Włodarczak, P., et al. 2019. Unraveling ancestry, kinship, and violence in a Late Neolithic mass grave. *PNAS*, 116(22), 10705–10710. <https://doi.org/10.1073/pnas.1820210116>

Štavičė E., 2020. Neolithic societies and their pottery in South-eastern Lithuania. *Lietuvos archeologija*, 46, 111–145. <https://doi.org/10.33918/25386514-046004>

Štavičė, E., Skridlaitė, G., Grigoravičiūtė-Puronienė, I., Kareiva, A., Selskienė, A., Suzdalev, S., Žalūdienė, G., Taraškevičius, R., 2022. Corded Ware and Contemporary Hunter-Gatherer Pottery from Southeast Lithuania: Technological Insights through Geochemical and Mineralogical Approaches. *Minerals*, 12, 1006. <https://doi.org/10.3390/min12081006>

Šatavičius, E. 2006. Žvalgymai ir žvalgomieji tyrimai Rytų ir Pietų Lietuvoje. *Archeologiniai tyrinėjimai Lietuvoje 2004 metais*, 291–305.

Tkachou, A., 2018. Early Neolithic Pottery from Western Belarus. *Archaeologia Baltica*, 25, 82–99.

Tsetlin, Yu. B., 2020. Patterns of Multi Linear Evolution in Pottery Production. *Annals of Archaeology*, 3(2), 1–14.

Wawrusiewicz, A., Kalicki, T., Przeździecki, M., Frączek, M., Manasterski, D., 2017. *Grądy-Woniecko. Ostatni łowcy-zbieracze znad środkowej Narwi*. Białystok: Muzeum Podlaskie w Białymstoku.

Zeder, M. A., 2009. The Neolithic Macro-(R)evolution: macroevolutionary theory and the study of culture change. *Journal of Archaeological Research*, 17, 1–63.

Zvelebil, M., 2005. Homo habitus: agency, structure and the transformation of tradition in the constitution of the TRB foraging-farming communities in the North European plain (ca 4500–2000 BC). *Documenta Praehistorica*, 32, 87–101.

LIST OF PUBLICATIONS

Marcinkevičiūtė, E. Daugiasluoksnių archeologinių objektų erdvinė analizė / The Spatial Analysis of Multilayer Archaeological Sites. *Lietuvos archeologija*, 2010, t. 36, 87–102.

Marcinkevičiūtė, E. A New Perspective on Neolithic sites in the Dubičiai Microregion Using a GIS spatial analysis. *Archaeologia Lituana*, 2016, t. 17, 57–76.
<https://doi.org/10.15388/ArchLit.2016.17.10682>

Marcinkevičiūtė, E. The Neolithic in South-east Lithuania. In: Zabiela, G., Baubonis, Z., Marcinkevičiūtė, E., eds. *A Hundred Years of Archaeological Discoveries in Lithuania*. Vilnius: Lietuvos archeologijos draugija, 2016, 50–65.

Štavičė, E. Neolithic Societies and their Pottery in South Eastern Lithuania. *Lietuvos archeologija*, 2020, t. 46, p. 111–145.
<https://doi.org/10.33918/25386514-046004>

Štavičė, E.; Skridlaitė, G.; Grigoravičiūtė-Puronienė, I.; Kareiva, A.; Selskienė, A.; Suzdalev, S.; Žalūdienė, G.; Taraškevičius, R. Corded Ware and Contemporary Hunter-Gatherer Pottery from Southeast Lithuania: Technological Insights through Geochemical and Mineralogical Approaches. *Minerals*, 2022, 12, 1006.
<https://doi.org/10.3390/min12081006>

Марцинкевичюте, Э. Нарвская культура в Южной Литве / The Narva culture in the Southern Lithuania. *Даследаванні каменнага і бронзавага вякоў (Матэрыялы па археалогіі Беларусі*, т. 18). Мінск: Беларуская навука, 2010, 147–160.

BRIEF INFORMATION ABOUT THE DOCTORAL CANDIDATE

Eglė Šatavičė (née Marcinkevičiūtė) graduated Vilnius University with a master's degree in archaeology in 2004 (with the thesis, 'The Southern Border of the Narva Culture'). During 2006–2020, she worked on archaeological heritage research and promotional projects at the Society of the Lithuanian Archaeology (Asociacija „Lietuvos archeologijos draugija“) and since 2020, at the Cultural Heritage Salvage Group (VšĮ „Kultūros paveldo išsaugojimo pajėgos“). For over twenty years, she has participated in field surveys at new archaeological sites and in excavations at known Stone Age settlements in Southeast Lithuania.

Her main research interests:

- Neolithisation processes and models;
- Geographic information system (GIS) and spatial analyses;
- Archaeometry, materials science, and experimental archaeology in connection with the analysis of ceramic technologies in the context of socio-cultural innovation.

Vilnius University Press
9 Saulėtekio Ave., Building III, LT-10222 Vilnius
Email: info@leidykla.vu.lt, www.leidykla.vu.lt
Print run 15