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Garnys: an underwater riverine site with delayed Neolithisation in the southeastern Baltic

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Abstract

This paper presents the first results of both dryland and underwater investigations at the multi-period Garnys riverine site situated on the Žeimena River in eastern Lithuania. There, during 2017-2020 a professional diver and amateur archaeologist collected hundreds of Mesolithic-Neolithic archaeological finds made of wood, bone, antler, stone, and ceramic from the riverbed and on its bank. Moreover, in eroded places of the riverbed, the wooden remains of several fish weirs were observed. In 2021 professional archaeologists continued the research, including field investigations followed by various laboratory analyses. These included AMS ^{14}C dating of 16 various ecofacts, artefacts and wooden constructions, wood and animal taxa determinations, and the results of traceological analysis of the flint and osseous artefacts. Our research demonstrates that the site was intensively used for hunting, gathering and fishing during the Mesolithic and subsequent Subneolithic and Neolithic. Intriguingly, there was no evidence for agriculture, while the numerous Neolithic ceramics largely follow the Subneolithic traditions. The Garnys site is therefore unique and a clear example for delayed Neolithisation in a forested and lacustrine area in the eastern Baltic region. During the Metal Ages, the site had been used exclusively for stationary fishing.

Keywords: underwater archaeology; riverine sites; hunter-gatherer-fishers; southeastern Baltic; Neolithisation; fish weirs

Introduction

The Neolithic transition, which took place throughout the European continent between 7000 and 2000 cal BC, not only marks the introduction of farming, but also brought significant cultural, social, demographic and genetic changes (Whittle 1996; Bramanti et al. 2009; Haak et al. 2010). In many places, e.g. Southern or Western Europe, this transformation appears to have taken place over the course of several generations, owing to the migration of large numbers of agriculturalists from the Near East (e.g. Rowley-Conwy 2011; Fort 2022). Elsewhere, in more northerly latitudes perhaps less suitable for farming, arriving groups of early farmers may not have been numerous enough to quickly assimilate or displace the indigenous hunter-gatherer-fishers. This appears to have been the case in the eastern Baltic, where forests, lagoons, lakes and rivers provided abundant wild food resources. Here, animal husbandry appeared around 3000-2800 cal BC concomitant with the Globular Amphorae and Corded Ware cultures (hereafter GAC and CWC respectively) (Lõugas et al. 2007; Piličiauskas et al. 2017a; Robson et al. 2019; Piličiauskas et al. 2023). Together with local hunter-gatherer-fishers, they created new cultures and mixed economies in some areas (e.g. the Rzucewo culture) (Piličiauskas and Heron 2015), but elsewhere appear not to have impacted the lives of the indigenous people for hundreds of years and/or even reoriented their pastoral economies towards hunting and fishing (Piličiauskas et al. 2020b; 2023). It seems that Neolithic farmers retreated from some areas soon after their arrival or lived there in small groups for hundreds of years alongside local hunter-gatherer-fishers, maintaining distinctive and separate cultures, ultimately delaying the process of Neolithisation for some time. For instance, evidence for a lack of social interaction between the indigenous hunter-gatherer-fishers and incoming pastoralists can be sought from the pottery assemblages. In eastern Latvia and eastern Lithuania two very distinctive pottery making traditions coexisted during the Neolithic − the Late Porous and the Corded Wares (Loze 1979; Piličiauskas 2018). However, to better understand the process for a delayed Neolithisation, reliably dated settlement layers and human skeletal remains, which are still very scarce, especially in Lithuania are required. Thus, the recently discovered Kaltanėnai and Garnys riverine underwater sites in north-eastern Lithuania are of utmost significance.

Recently, the first Lithuanian underwater riverine prehistoric site, Kaltanėnai, was published. It is situated at the Žeimena River in north-eastern Lithuania (Piličiauskas et al., 2020a). Remains of at least four fish weirs dating from the Bronze Age[1] to the medieval period were recorded, while Subneolithic (= ceramic Mesolithic) and Neolithic materials prevailed among the archaeological finds recovered from the riverbed. Such riverine sites as Kaltanėnai are rarely found in the eastern Baltic (see an overview in Piličiauskas et al., 2020a). Considering the variable conditions for preservation of bones and the usually unstratified nature of these sites, they are highly valuable for several reasons. Firstly, numerous bone and antler tools can be obtained in a very quick and low-cost way at riverine sites with strong currents and erosion – underwater surveys of the riverbed surface. These new and untreated (i.e. not conserved) artefacts are ideal candidates for various laboratory analyses, e.g. AMS ^{14}C dating and the subsequent building of typological schemes and traceological studies. Secondly, compared with other aquatic water bodies, such as estuaries and lagoons, where the remains of prehistoric fishing technologies have previously been found (Girininkas, 1990; Rimantienė, 2005; Charniauski, 2007; Pranckėnaitė, 2014; Loze, 2015; Piličiauskas, 2016), very little evidence has been recovered from

[1] In this contribution the following Lithuanian archaeological periodisation was used — Mesolithic (9000-5000 cal BC), Subneolithic (5000-2900 cal BC), Neolithic (2900-1800 cal BC), Early Bronze Age (1800-1100 cal BC), Late Bronze Age (1100-500 cal BC), pre-Roman Iron Age (500-0 cal BC), Roman Iron Age (0-400 cal AD), Middle Iron Age (400-800 cal AD), Late Iron Age (800-1200 cal AD), and medieval period (1200-1600 cal AD). Subneolithic and Neolithic periods are marked by the presence of pottery and domesticated animals respectively.

rivers. As a result, rivers that have provided very rich aquatic food resources, especially migratory fish, remain understudied. Thirdly, today, Bronze and Iron Ages fish weirs are known only from riverine sites in Lithuania, all at Kaltanėnai. If they had not been studied, the role of fishing in some regions would undoubtedly remain underestimated. Finally, urgent excavations at riverine underwater sites are often required due to complicated preservation. Riverine sites are extremely vulnerable to erosion and may be destroyed by the flow of a river over the course of several years. Such vulnerability of riverine sites may be among the main reasons why they are much less numerous compared to lacustrine ones throughout the eastern Baltic (although see Kriiska and Roio, 2011; Bērziņš et al., 2016; Piličiauskas et al., 2020a; 2020b).

Scientific research at Kaltanėnai became possible due to the fruitful cooperation between professional archaeologists and a highly enthusiastic diver and amateur archaeologist Aldas Matiukas (hereafter AM). Cooperation continued after the Kaltanėnai investigations and in 2021 a field survey was initiated at another underwater site on the same river – Garnys. Garnys is a small village located 14 km downstream from Kaltanėnai (Fig. 1). Here, between 2017 and 2020 AM collected hundreds of Mesolithic-Neolithic finds made of bone, antler, stone, and ceramic during multiple diving expeditions. In 2021, with the involvement of professional archaeologists, an archaeological survey, including small-scale excavations, were launched at Garnys with the aim to learn more about the stratigraphy and the site's formation, chronology, and functions.

Our investigations at Garnys were based solely on volunteers without external funding. Initially, only a couple of divers and archaeologists were involved, while additional specialists joined the project during the post-excavation analyses. During the research Garnys' extremely important role in the Neolithisation process, as well as its importance for prehistoric fishing, became apparent. Today, it seems that underwater archaeological sites such as Garnys and Kaltanėnai are so rare, so rich, and so important on a European scale that they deserve to be published individually, which is the focus of this article.

Materials and Methods

Field research

We started our fieldwork by a series of aerial photos taken from a drone (DJI Mavic 2 Pro) at a height of 50 m, which were later combined into a 2D orthomosaic with a resolution of 1.1 cm per pixel. The orthomosaic was used as a base layer for mapping wooden structures observed during underwater survey and measured with a total station (Fig. 2). Underwater visual survey of the riverbed was carried out along a 360 m length segment of the river. In addition, 23 boreholes were drilled with a hand auger measuring 3 cm in diameter to a depth of 1-3 m, either from a boat or on the riverbanks. Finally, we excavated six test-pits (in total 10 m^2) on the banks of the Žeimena River and a single test-pit No. 5 (2.2 m^2) on the riverbed. Underwater excavation was carried out manually with the aid of a water pump (Figs. 3-4). Archaeological finds were removed from arbitrary c. 5 cm thick layers. In addition, a 5- and 2-mm sieves were used for separating tiny artefacts sucked in accidently from the water and the sediment.

Radiocarbon (^{14}C) dating

We dated charcoal from underwater test-pit No. 5, bone tools from find areas V3 and V4, and wooden poles from each of the aggregations. To determine the chronology of the archaeological layer in test-pit No. 5, we attempted to date animal, mostly red deer, remains. However, due to degraded collagen, it was unsuccessful. Therefore, we targeted wood charcoal samples, which are less reliable due to higher chances of re-deposition as well as the old wood effect. Whenever possible, we chose charcoal from relatively short-lived trees, such as alder, rather than pine, to minimise the old wood effect as much as possible. In the case of wooden poles, the samples for dating were broken off from their upper ends.

AMS (^{14}C) was undertaken at two laboratories: the Centre for Physical Sciences and Technology in Vilnius (Lithuania) and the Poznań Radiocarbon Laboratory (Poland). In addition, the ^{14}C content in two wooden samples was measured by liquid scintillation counting (LSC) methods at the Laboratory of Nuclear Geophysics and Radioecology, Nature Research Centre in Vilnius (Lithuania). The standard acid-alkali-acid (AAA) pre-treatment was applied to the wood and charcoal samples by all laboratories. In Vilnius, collagen extraction was performed using an AAA procedure followed by gelatinisation (Molnár et al., 2013). In Poznań, collagen extraction was performed using the procedures originally described by Longin (1971), with further modifications (Piotrowska and Goslar, 2002). In this study, all radiocarbon dates were calibrated using the OxCal 4.4 software and IntCal20 atmospheric curve (Bronk Ramsey, 2009; Reimer et al., 2020). Calibrated dates are presented at 95.4% probability.

Zooarchaeology

The analysis of mammal, fish and reptile remains was carried out in the Zooarchaeology Laboratory of Vilnius University using a comparative collection of modern animals. The avian bones were identified using the recent comparative bird bone collection of the Hungarian Natural History Museum and manuals, including osteological descriptions and measurements (e.g. Bacher, 1967; Woelfle, 1967). The minimum number of individuals (MNI) was calculated using the methodology of White (1953). The epiphyseal fusion and teeth eruption time defined by Silver (1969) were used. The age of the horses was estimated by the height of the premolars and molars (Levine, 1982). Measurements according to von den Driesch (1976) were made using an electronic calliper with an accuracy of 0.01 cm. The analysed animal remains are stored in the Zooarchaeological Repository of Vilnius University, Faculty of History.

Samples of subfossil molluscs were taken during the investigations of the archaeological layer in test-pit No. 5. They were identified by the naked eye and through comparison with catalogues of Lithuanian molluscs (Šivickis, 1960; Gurskas, 2010).

Wood sampling and species determination

Wood samples were collected for species determination from *in situ* standing poles and several horizontally lying sticks. The upper parts of the poles were sawed off by a diver. The wood taxa were identified by the analysis of thin sections with the aid of a bright-field microscope (Optica B-193) between 40 and 1000x magnification. The analysis of wood anatomical features and identification of taxa was based on Schoch et al. (2004) and Wheeler (2011).

Traceological analyses of flint and osseous tools

The traceological analyses were performed using two microscopes. Studies on the state of preservation of artefacts and initial analysis of the technological and use-wear traces were made using a Nikon SMZ-745T microscope (up to 65x magnification) fitted with a Delta Pix Invenio 6EIII camera. Observations of polish were performed using a Zeiss Axioscope 5 Vario microscope fitted with an Axiocam 208 camera.

The terminology applied in the traceological studies was based on the published conceptual system (e.g. Vaughan, 1985; van Gijn, 1989; Sidera, 1993; Juel Jensen, 1994; Legrand, 2007; Osipowicz, 2010; Buc, 2011), which was adjusted to the needs and requirements of the present analysis.

All osseous artefacts (n = 11) and selected flint products (all morphological tools and selected blades and flakes, a total of 76 products) were subjected to traceological analysis. The analysis of flint products was hindered mainly by the strong patination on most of the products. In many cases, this and other types of post-depositional damage prevented an assessment concerning potential function of these artefacts. Similarly complex was the analysis of the osseous products, whose surfaces were usually eroded.

Results and interpretation

Geological profile

From the nine-drilled boreholes and two test-pits (Nos. 4 and 5), a 187 m long geological profile was compiled, which cuts the Žeimena River valley perpendicularly (Fig. 2 and 5). The alluvium of the Žeimena riverbed was only found in a 50-60 m wide part of the valley, meaning that the river was flowing in around the same place throughout the Holocene, with little change in the position of its bed. The riverbed's alluvium consisted mainly of organic-rich silty fine to medium sand, except for the lowermost horizon. This was only 15-20 cm thick and consisted of coarse sand with abundant mollusc shell debris and archaeological finds (Fig. 6). At the deepest point of the current riverbed, at a depth of 2.35 m, the riverbed alluvium has been eroded down to the top of the glacial or periglacial deposits consisting of fine sand, silt or clay (Fig. 5). The geological section has shown that there was no lake in the Žeimena valley at Garnys. Furthermore, the river has always flowed along the right slope of the valley. Consequently, most human onshore activities during all phases of occupation at the site were on the higher right bank instead of the lower and wet left bank (Fig. 5).

Distribution of artefacts

During the underwater and onshore surface surveys between 2017 and 2021 as well as the small-scale excavations of 2021, a total of 1,292 artefacts were collected at Garnys. These were obtained from adjacent fields, the riverbed, and two of the seven test-pits (Nos. 1 and 5). The archaeological finds were found within a 360 m long section of the river, though not continuous, in eight separate accumulations (Table 1; Fig. 2). Most of the finds were collected at the edge of a low sandy dune (100 x 25 m) on the right bank of the river (find area S2), and from a 130 m section of the riverbed, 100 m downstream from the dune (find areas V2-5).

Ceramics (n = 614) and flint tools/processing waste (n = 564) were most numerous both on the right bank as well as the riverbed. Bone artefacts (n = 11) were found only in V3 and V4. Submerged areas V1 and V5 contained only flint finds, so it is likely that the river is eroding an *in situ* archaeological layer on the right bank, resulting in the movement of flint artefacts into the riverbed. In general, organic remains are not preserved in dry sandy soils.

Table 1. Artefact distributions at Garnys. There were no archaeological finds recovered from the other test-pits except Nos. 1 and 5.

<table>
<tr><th colspan="2">Place</th><th>Ceramics</th><th>Flint artefacts</th><th>Bone and antler tools</th><th>Animal remains</th><th>Stone tools</th></tr>
<tr><th rowspan="4">Right bank</th><th>S1</th><td>27</td><td>76</td><td>-</td><td>-</td><td>-</td></tr>
<tr><th>S2</th><td>217</td><td>246</td><td>-</td><td>-</td><td>-</td></tr>
<tr><th>S3</th><td>0</td><td>8</td><td>-</td><td>-</td><td>-</td></tr>
<tr><th>Test-pit No. 1</th><td>66</td><td>29</td><td>-</td><td>38 (all burnt)</td><td>-</td></tr>
<tr><th rowspan="6">Riverbed</th><th>V1</th><td>-</td><td>4</td><td>-</td><td>-</td><td>-</td></tr>
<tr><th>V2</th><td>11</td><td>-</td><td>-</td><td rowspan="2">234</td><td>-</td></tr>
<tr><th>V3</th><td>92</td><td>6</td><td>11</td><td>3</td></tr>
<tr><th>V4</th><td>60</td><td>40</td><td>2</td><td>126</td><td>-</td></tr>
<tr><th>V5</th><td>-</td><td>93</td><td>-</td><td>-</td><td>-</td></tr>
<tr><th>Test-pit No. 5</th><td>140</td><td>62</td><td>-</td><td>389</td><td>-</td></tr>
</table>

Pottery

Judging from the clay's temper, surface treatment, vessel forms and ornamentation, most of the potsherds found in Garnys (586/614 or 95%) were classified as Porous Ware, which was widely used during the Subneolithic and Neolithic in Latvia and Lithuania (Loze, 1979; Piličiauskas, 2016). Shell and sometimes plant temper, pit and notch ornamentation as well as forms of vessel rims are characteristic for the Subneolithic (Fig. 7). Most of the vessels were thin-walled (6-8 cm) and had smooth or striated surfaces, although pseudo-textile impressions were also present (13%). Only horizontal cord impressions on the upper part of some vessels are reminiscent of Neolithic ceramics, such as CWC and GAC. In some other Neolithic East Baltic sites (e.g. Kretuonas 1C and Abora 1) flat bottomed ceramic vessels are another clear sign of the Neolithic Porous Ware contrary to the pointed bottoms of the Subneolithic. However, the absence of any base fragments among the Porous Ware assemblage at Garnys argues more for the use of pointed- or rounded-bottom vessels since these produce much less identifiable potsherds when fragmentary compared to flat bases. Only 11 potsherds from Garnys (find area V2) were attributed to the Iron Age, or more precisely to the Late Brushed Ware dating from c. 300 cal BC – 200 cal AD. The other potsherds were difficult to classify, often due to their small size.

Porous Ware ceramics were clearly dominant in both the river (find areas V3 and V4) and on the right bank (find area S2 and test-pit No. 1). Neolithic Porous Ware sherds were recovered from test-pit No. 5 and were assigned based on four AMS ^{14}C dates that were made on wood charcoal collected at different depths. When calibrated, they all fall within the range of the Neolithic, i.e. 2900-1800 cal BC (see dates Nos. 11-14 in Table 2). However, the formation of the Neolithic layer may have been much shorter. The oldest ^{14}C date from test-pit No. 5 was made on pine charcoal — 4277 ± 31 BP (FTMC-UJ17-19); 3008-2778 cal BC. It is, however, older by c. 300-700 years than three dates obtained from underlying alder charcoal and a pine trunk (Fig. 6; Table 2). It is therefore reasonable to assume that the dated pine charcoal was re-deposited, and its date does not correspond to the formation of the archaeological layer. Furthermore, the date of a pine trunk (3984 ± 29 BP; FTMC-UJ17-18; 2578-2456 cal BC) is not related to the archaeological layer since it was found below it (Fig. 6). Therefore, only two alder charcoal dates (3568 ± 29 (FTMC-UJ17-20) and 3665 ± 31 BP (FTMC-DY55-2)) indicate the time of formation of the layer of test-pit No. 5 and they narrow that process to the very end of the Neolithic — c. 2100-1800 cal BC.

Table 2. Radiocarbon dates obtained on wooden structures, artefacts and ecofacts from Garnys.

No.	**Description, ID, find area or test-pit No.**	**Lab code**	**Date BP**	**Cal BC/AD (95.4%)**
1	Human bone, ID 1, pelvis, female 30-45 (V3)	FTMC-UU26-24	4359 ± 26	3076-2906 BC
2	Single-row barbed bone point, ID 1 (V3)	Poz-130204	8340 ± 50	7531-7192 BC
3	Spruce pole, ID 33 (V3-1)	FTMC-UJ17-6	2241 ± 28	381-204 BC
4	Pine pole, ID 40 (V2-4)	FTMC-UJ17-7	2668 ± 28	900-794 BC
5	Hazel pole, ID 58 (V3-2)	FTMC-UJ17-8	5258 ± 30	4229-3983 BC
6	Pine pole, ID 86 (V2-3)	FTMC-UJ17-9	2710 ± 28	908-808 BC
7	Maple pole, ID 22 (V3-1)	FTMC-SJ39-13	2271 ± 30	398-208 BC
8	Pine pole, ID 71 (V3-2)	FTMC-SJ39-14	1363 ± 29	606-774 AD
9	Uniserial bone harpoon, ID 252 (V3)	FTMC-UJ17-22	8610 ± 38	7733-7580 BC
10	Bone spearhead with thickened middle part, ID 235 (V3)	FTMC-UJ17-23	5129 ± 31	4036-3803 BC
11	Pine charcoal (test-pit No. 5, square A1, horizon L1)	FTMC-UJ17-19	4277 ± 31	3008-2778 BC
12	Alder charcoal (test-pit No. 5, square A1, horizon L2)	FTMC-UJ17-20	3568 ± 29	2021-1778 BC
13	Alder charcoal (test-pit No. 5, square A2, horizon L4)	FTMC-DY55-2	3665 ± 31	2140-1947 BC

14	Pine trunk, ID 150-151 (test-pit No. 5, square A1, horizon L5)	FTMC-UJ17-18	3984 ± 29	2578-2456 BC
15	Birch pole, ID 60 (V3-2)	Vs-3170	5675 ± 60	4679-4363 BC
16	Hazel pole, ID 63 (V3-2)	Vs-3171	4665 ± 65	3634-3196 BC
	Biserial bone harpoon, ID 251 (V3)	Poor collagen content		
	Bone spearhead with triangular cross-section and short tang, ID 239 (V3)	Poor collagen content		
	Human bone, ID 2, skull (V3)	Poor collagen content		
	Red deer tibia bone, ID 103 (test-pit No. 5)	Poor collagen content		
	Small ungulate bone (test-pit No. 5, square A1, horizon L1)	Poor collagen content		
	Red deer tibia (test-pit No. 5, square A1, horizon L2)	Poor collagen content		
	Red deer tibia (test-pit No. 5, square A1, horizon L3)	Poor collagen content		
	Red deer cranium (test-pit No. 5, square A1, horizon L4)	Poor collagen content		

Bone and antler tools

We studied all 13 bone and antler tools that were recovered from the riverbed, mostly V3 (Table 1). In contrast to the rather narrow chronology of finds from test-pit No. 5 (c. 2100-1800 cal BC), typology and AMS dating of bone and antler tools which had been washed out of the river bottom sediments at find areas V3 and V4, moved the lower boundary of the site chronology well into the Mesolithic. For instance, two uniserial barbed points were dated to 7733-7580 and 7531-7192 cal BC (Fig. 8: 3 and 7; Table 2). Although a large spearhead that had a triangular cross-section and a short tang failed to be dated due to a poor collagen yield, it is analogous with an example from Lake Niegocin in north-eastern Poland, which was dated to 8810-8496 cal BC (Orłowska and Osipowicz, 2022). Some forms of biserial barbed points found at Garnys are likely Subneolithic (e.g. Fig. 8:2 and 5) as has been evidenced by the AMS ^{14}C date of a similar tool from Kaltanėnai — 4251–3997 cal BC (Piličiauskas et al., 2020a). Another Subneolithic form is a long spearhead with a thickened middle portion that was dated to 4036-3803 cal BC (Fig. 8:10).

The presence of Mesolithic and Subneolithic osseous tools at Garnys raises the question why only a Neolithic layer was found in test-pit No. 5. And the possible answer comes from the different preservation of bones. Bones from the submerged test-pit No. 5 were light-coloured, very fragile when dried and had poorly preserved collagen. However, among the bone finds collected during surface survey in the riverbed, many were darker and remained hard even when dried. Intriguingly, after AMS ^{14}C dating these better-preserved bone tools appeared to be Mesolithic and Subneolithic, i.e. older than the poorer preserved Neolithic finds. Consequently, patches of organic-rich alluvium which accumulated during the Mesolithic and Subneolithic containing well-preserved osseous remains may have survived at Garnys.

Technological traces observed on the surfaces of the osseous artefacts mainly result from scraping and planing. One of the barbed points also bears traces of grinding/polishing. The barbs were usually created by planing, only in one case was sawing identified.

None of the osseous artefacts from Garnys, which for morphological reasons are attributed to the function of projectile weapon inserts, bore typical impact traces. However, on the tip of the only point where use-wear traces are preserved (Fig. 8:11), a linear smoothing of homogeneous micro-topography and regular micro-relief with slightly rounded highest points is visible (Fig. 9 :18). These traces are legible at about 4 cm, and then they disappear (giving way to technological traces). On the tang of this artefact, a polish with a different characteristic was discovered (Fig. 9:19). It is a result of rubbing between the point and the shaft.

Bending fractures visible at the bases of two of the discovered barbed points (Fig. 9:20) may be of post-impact origin, but one cannot be sure. However, on three out of four analysed points of this type, a well-developed linear usage polish was observed, analogous to the one described in the case of points (Fig. 9:21, 22). It concentrates on the tips of the first few barbs and the points' ends.

Only on one of the two biconical points analysed micro traces were observed that can be associated with use (Fig. 8:4). It consists of polish and linear traces with characteristics quite analogous to those described in the case of points and barbed points. In addition, in various parts of this artefact (but mainly on its tip), interesting perpendicularly oriented polishing and linear traces were discovered (Fig. 9:23, 24). Their origin can therefore be both related to production and/or use.

The only antler axe in the collection (Fig. 8:9) was hafted and probably used for processing soft plant material.

Flint artefacts

Since the Žeimena fluvioglacial valley lacks flint raw material, non-local flint varieties were utilised at the site. The predominant raw material was Cretaceous flint, which may have been imported from southern Lithuania or western Belarus. However, and uncommon for Lithuania, coarse opaque black flint was also in use although less frequent (c. 20/564; e.g. Fig. 10:16). This variety may originate from carboniferous deposits in north-western Russia (Zhilin, 2006).

From a typological point of view, the flint artefacts collected in Garnys (n = 564) are of a varied chronology. Unfortunately, in many cases dating remains uncertain as most of them were found either re-deposited by river erosion or from the non-stratified multi-period sandy layer on the right bank of the river (n = 502). Only a small portion of flints (n = 62) was collected from the well-dated Neolithic layer in test-pit No. 5. However, among the latter there were almost no formal tools except for two side scrapers (Fig. 10:4). The Kunda point from find area V5 (Fig. 10:16) and the arch-backed piece from S2 (Fig. 10:10) are associated with Mesolithic. Trapezes from S1 and S2 (Fig. 10:11, 12) can be also connected to this period. At S1 and S2 laurel leaf bifacial projectile points were discovered (Fig. 10:15, 17, 18) and are associated with the Subneolithic phase of settlement, while heart-shaped bifacial projectile points from S2, V1 and V5 (Fig. 10:19-21), a tanged bifacial projectile point from V3 (Fig. 10:22), and a polished flint axe from V5 are dated to the Neolithic and Early Bronze Age.

Traceological analysis included: six end scrapers (Fig. 10:1-3), two truncated blades, 11 scrapers (Fig. 10:4), four burins (Fig. 10:5-7), three borers/perforators (Fig. 10:8, 9), seven retouched blades and flakes, including a flake from a polished axe (Fig. 10:23-25), 13 items traditionally classified as inserts of projectile weapons (three laurel leaf bifacial projectile points - Fig. 10:15, 17-18; three heart-shaped bifacial projectile points - Fig. 10:19-21; a tanged bifacial projectile point - Fig. 10:22; two trapezes - Fig. 10:11, 12; an arch-backed piece - Fig. 10:10; a Kunda point and two fragments of the willow leaf points of an unknown type (Fig. 10:13-14, 16), 26 blades (Fig. 10:26-28), three flakes and a core from a damaged, polished flint axe.

Among the flint products subjected to analysis, there were 27 unused/with illegible traces of use, 13 that had probably been used and three whose use was confirmed, but the traces observed did not allow us to make any suggestions about their function. The remaining 33 artefacts bore use-wear traces allowing for the interpretation of their probable functions. Detailed results of their analysis are presented in Table 3.

Table 3. Results of the traceological analysis conducted on the flint artefacts with use-wear traces.

No.	ID	Morphological description	Functional interpretation	Comments	Figure
1	166	Endscraper	Wood scraping	-	Fig. 10:1
2	213	Endscraper	Hide scraping	-	Fig. 10:2
3	271	Endscraper	Hide cutting	The use of the endscraper front is unclear	Fig. 10:3; Use-wear: Fig. 9:1
4	255	Scraper	Soft wood scraping	-	Fig. 10:4
5	172	Burin on a break	Carving in wood	Two working edges	Fig. 10:6; Use-wear: Fig. 9:2
6	205	Single blow burin	Cutting/splitting plants with soft (wet?) non-woody stems	-	Fig. 10:5
7	297	Burin on a break	Carving in shell (?)	Traces are quite typical, but changed post-depositionally (strong patina). Functional interpretation uncertain	Fig. 10:7; Use-wear: Fig. 9:3
8	201	Perforator	Perforating the hide	Weakly developed use-wear traces	Fig. 10:8
9	108	Perforator	Carving in wood	Weakly developed use-wear traces	Fig. 10:9
10	196	Arch-backed piece	Arrowhead or side insert of arrow/slotted point	Post-impact linear abrasion - Fig. 10.4	Fig. 10:10; Use-wear: Fig. 9:4
11	160	Trapeze	Arrowhead or side insert of arrow/slotted point	-	Fig. 10:11
12	215	Trapeze	Arrowhead or side insert of arrow/slotted point	-	Fig. 10:12
13	31	Willow leaf point (?)	Arrowhead	Fragment of a tool	Fig. 10:13
14	162	Willow leaf point (?)	Arrowhead (?)	Fragment of a tool. Hafting traces – Fig. 10:5. Function uncertain due to the lack of the tip	Fig. 10:14; Use-wear: Fig. 9:5
15	170	Laurel leaf bifacial projectile point	Arrowhead	Traces of carrying in a leather container (quiver?) – Fig. 10:6	Fig. 10:15; Use-wear: Fig. 9:6
16	208	Laurel leaf bifacial projectile point	Arrowhead	-	Fig. 10:17
17	207	Laurel leaf bifacial projectile point	Arrowhead	-	Fig. 10:18
18	209	Heart-shaped bifacial projectile point	Arrowhead	-	Fig. 10:19
19	27	Heart-shaped bifacial projectile point	Arrowhead	The hide-origin smoothing on the tip of the specimen – Fig. 10:7	Fig. 10:20; Use-wear: Fig. 9:7
20	32	Heart-shaped bifacial projectile point	Arrowhead	The hide-origin polish and smoothing on the end of the arrowhead's wings (Fig. 10:9). Abrasion polish resulting from rubbing of the point's tip against a hard material, most likely bone (base of the quiver?)– Fig. 10:8.	Fig. 10:21; Use-wear: Fig. 9:8, 9
21	23	Retouched blade	Soft wood sawing	-	Fig. 10:23
22	269	Retouched blade	Splitting the silica plants	-	Fig. 10:24; Use-wear: Fig. 9:10

No.	ID	Morphological description	Functional interpretation	Comments	Figure
23	61	Retouched secondary crested blade	Drilling (widening by drilling/scraping) holes in amber (?)	Two working edges. Specific matting and rounding/polishing of the working edges – Fig. 10:11. Residues – Fig. 10:12	Fig. 10:25; Use-wear: Fig. 9:11, 12
24	161	Blade	Wood scraping	-	-
25	171	Blade	Hide cutting	-	-
26	318	Blade	Hide cutting	Two working edges	Fig. 10:26; Use-wear: Fig. 9:13
27	36	Blade	Hide cutting	-	-
28	204	Blade	Meat cutting	-	-
29	284	Blade	Meat cutting	-	-
30	35	Blade	Cutting/splitting siliceous plants (perhaps very soft and wet wood)	-	-
31	146	Overpassed blade from single platform core	Cutting/splitting siliceous plants (perhaps very soft and wet wood)	-	Fig. 10:27; Use-wear: Fig. 9:14, 15
32	55	Blade	Plants processing (?)	Untypical use-wear traces. Contact side: invasive linear polish with domed topography and smooth texture. Single perpendicular dark striations (Fig. 10:16). Non-contact side: polish with less intrusion and varied topography (Fig. 10:17). Residues: resinous substance and plant remains? (seeds?)	Fig. 10:28; Use-wear: Fig. 9:16, 17
33	34	Flint axe, ground, reused as a core	-	Before reuse, used according to its morphology	-

Six tools related to hide processing and two used for cutting meat were identified. Among the hide-processing specimens, one artefact was used to scrape (Fig. 10:2) and one to perforate (Fig. 10:8). Traces related to cutting were observed in four cases (Fig. 10:3, 26). Most hide-cutting tools bear well-developed use-wear traces (Fig. 9:1, 13).

In the case of tools used for wood processing (n = 6), scraping was confirmed in three cases (Fig. 10:1, 4), sawing in one case (Fig. 10:23), and carving in two cases (Fig. 10:6, 9). An example of the use-wear recorded on the burins is shown in Fig. 9:2.

In addition to the tools related to woodworking, five artefacts were used for processing plants with non-woody stems, including siliceous ones. One of these (Fig. 10:24) was used for splitting this raw material (obtaining fibres?), which is indicated by the use-wear traces registered on its working edge (Fig. 9:10). The following three tools (Fig. 10:5, 27) were similarly used as well as for cutting (Fig. 9:14, 15). The last artefact included in this group (Fig. 10:28) bears untypical traces of use and organic residues (Fig. 9:16, 17). Its precise function is unclear.

The group of projectile weapon inserts is the most numerous among all distinguished functional groups (n = 11). Two retouched blades, probably fragments of the Mesolithic willow leaf points (Fig. 10:13, 14), as well as all the Subneolithic-Neolithic laurel leaf (Fig. 10:15, 17-18) and heart-shaped bifacial projectile points (Fig. 10:18-20) served as arrowheads. In the case of Mesolithic trapezes (Fig. 10:11, 12) and the arch-backed piece (Fig. 10:10), only a general suggestion about their function was possible (head or side insert). The laurel leaf and heart-shaped bifacial projectile points from Garnys, apart from the typical impact (Fig. 9:4) and hafting (Fig. 9:5) traces, had evident damage resulting from transport in a leather container (Figs. 9:6, 7, 9). Their bottoms, in some cases, could have been made of bone (Fig. 9:8).

A burin was also identified in the collection, probably used for engraving mollusc shell (Figs. 10:7 and 9:3). Also, one of the tools may have been used to widen perforations in an unspecified material (Fig. 10:25). The use-wear traces observed on this artefact are specific (Fig. 9:11). Both of its working edges are covered with large amounts of yellow and orange dusty residues (Fig. 9:12).

Animal remains

A total of 787 animal bones, teeth, antlers and their fragments were collected from Garnys. A part of the assemblage (NISP 114) was recovered from the non-stratified multi-period sandy layer in test-pit No. 1 and the upper deposits in test-pit No. 5. These are mixed materials from different periods, including a few modern finds which are excluded from further study. The remaining 673 specimens were divided into two partly overlapping chronological groups: Mesolithic–Neolithic (c. 8000-1800 cal BC) and Neolithic (c. 2900-1800 cal BC). The former finds were collected during the underwater survey in find areas V3 and V4 (Fig. 1) while the latter in the archaeological layer of test-pit No. 5 (Fig. 6). The chronology of the zooarchaeological material was based on the archaeological artefacts, their ^{14}C dates, as well as the charcoal ^{14}C dates from test-pit No. 5 (Table 2).

Out of the 360 (8490 g) specimens in the Mesolithic-Neolithic group, 352 (97.8%) came from mammals, five (1.4%) from birds, a single tooth was attributed to a pike, and two peripheral plates of the European pond turtle carapace were also identified. The remains from a total of 203 mammal, four birds, two reptiles, and one fish were identified to the family or species level (Table 4). Many of the bones had butchering marks, which were not reliably identifiable on their eroded surfaces. The mammalian remains in this group represented at least 12 species. If the horse remains belonged to the wild congener (see below), which cannot be unequivocally proven morphologically, a minimum of 198 (97.5%) of the identified specimens belonged to wild animals. Remains of large ungulates such as elk (32%), red deer (19.4%) horse (8.3%), and auroch/bison (7.3%) predominated the assemblage. Beaver bones were also numerous (7.3%), while the remains of wild boar, roe deer, bear, fox, otter and marten were present in far smaller quantities. The only definitely domestic animal found was a small – medium sized dog, whose humerus and pelvic fragments were identified. Meanwhile, it was not possible to say whether the lower third premolar (P_3) fragment belonged to cattle, auroch or bison, while the two teeth (fragments of developing incisor (I) and lower first molar (M_1) are derived from a young boar or pig. Three of the four avian remains represented rather well-preserved skeletal parts from the shoulder girdle and the limbs. The scapula belonged to a mute swan. The humerus belonged to a red-breasted merganser, most possibly a female specimen according to the measurements of the bone. The tarsometatarsus belonged to a western capercaillie, most possibly a male specimen, also according to the size. Finally, the diaphysis fragment from the radius was assigned to a golden eagle.

Table 4. Taxonomic distribution of animal remains from Garnys. NISP – number of identified specimens, MNI – minimum number of individuals.

Species	**Mesolithic-Neolithic**			**Neolithic**		
	NISP	% NISP	MNI	NISP	% NISP	MNI
Horse (*Equus ferus ferus/E. f. caballus*)	17	8.1	2	1	2.4	1
Dog (*Canis lupus familiaris*)	2	1.0	1			
Auroch (*Bos primigenius*)	8	3.8	2	1	2.4	1

Auroch/bison (*Bos primigenius/Bison bonasus*)	7	3.3		-	-	-
Auroch/bison/cattle (*Bos* sp.)	1	0.5	1	-	-	-
Elk (*Alces alces*)	66	31.4	4	12	28.6	2
Red deer (*Cervus elaphus*)	40	19.0	4	9	21.4	1
Elk/red deer (Cervids)	14	6.7		1	2.4	
Roe deer (*Capreolus capreolus*)	9	4.3	2	1	2.4	1
Boar (*Sus scrofa scrofa*)	12	5.7	3	7	16.7	1
Boar/pig (*S. s. scrofa/S. s. domesticus*)	2	1.0	1	1	2.4	1
Beaver (*Castor fiber*)	15	7.1	6	4	9.5	1
Bear (*Ursus arctos*)	7	3.3	2	-	-	
Fox (*Vulpes vulpes*)	1	0.5	1	-	-	
Eurasian otter (*Lutra lutra*)	1	0.5	1	-	-	
European pine marten (*Martes martes*)	1	0.5	1	1	2.4	1
Mute swan (*Cygnus olor*)	1	0.5	1			
Mallard (*Anas platyrhynchos*)		-	-	1	2.4	1
Red-breasted merganser (*Mergus serrator*)	1	0.5	1	-	-	
Golden eagle (*Aquila chrysaetos*)	1	0.5	1	-	-	
Western capercaillie (*Tetrao urogallus*)	1	0.5	1	-	-	
European pond turtle (*Emys orbicularis*)	2	1.0	1	2	4.8	1
Northern pike (*Esox lucius*)	1	0.5	1	1	2.4	
Total	**210**	**100.0**	**37**	**42**	**100.0**	**11**

A total of 313 (728 g) specimens were recovered from the Neolithic layer of test-pit No. 5 and 41 (13.1%) of them were identified to the family or species level. Except an ulna from a (likely female) mallard and two plates of a European pond turtle carapace, the remainder of the specimens were mammal remains, representing at least eight wild game species. The most abundant remains were those of elk (30.0%), red deer (22.5%), boar (17.5%) and beaver (10%). Horse, auroch, roe deer, and marten were represented by a single specimen or a few bones (Table 4). It is however not clear whether the single *Sus scrofa* incisor fragment belonged to a domestic pig or a wild boar.

The faunal remains of both groups are generally similar in their species composition. Bones of wild animals, mainly large ungulates, predominated in both groups, accounting for 75-80% of the total faunal remains, with a significant proportion of beavers (7-10%). Such a species composition is typical for Subneolithic to Early Bronze Age hunter-gatherer-fisher sites in eastern Lithuania, e.g., Kretuonas 1C, and 1D, Žemaitiškė 1, and 3B, Kaltanėnai (Daugnora and Girininkas, 2004, Tab. 18; Piličiauskas et al., 2020). During the Late Bronze Age (1100-500 cal BC), domestic animal remains typically predominate the faunal assemblages from eastern Lithuania, accounting for 90-93% of the identified specimens. In comparison, wild animals are infrequent, though the remains of small game such as hare, marten, and fox predominate (Luik et al., 2022).

Fragments of horse skull and mandibles, teeth, and lower limb bones such as talus, metacarpal and metatarsal bones, as well as phalanges were found at Garnys. Most of the horse bones had butchery marks while the individuals were of different ages: 3-4 (MNI = 1), 7-9 (MNI = 2) and 10-14 years (MNI = 1). The bones were fragmented, so only a few measurements were available (see Table 5).

Table 5. Horse bone measurements from Garnys.

ID	Bone	Bp, mm	SD, mm	Bd, mm	Dd, mm
69	Metacarpus	45.0	-	-	-
47	Metatarsus	-	~35.0	52.0	36.9
99	Metatarsus	-	-	42.1	32.3
46	Phalanx 1	52.5	35.0	-	-

When studying horse remains from Neolithic and later eastern Baltic archaeological sites it is difficult to attribute them to either the domestic or wild congener. The latter lived in the territory of Lithuania until the 17th-18th c AD (Paaver, 1965 and authors mentioned therein; Bliujienė et al., 2017). The earliest known horse remains (3900-3700 cal BC, NISP = 14) in Lithuania come from the Šventoji 43 site, where they accounted for 2.1% of all identified mammals (Piličiauskas et al., 2019). In general, horse remains are scarce in Lithuanian Subneolithic settlements, e.g., Šventoji 23; Žemaitiškė 1, and 3B (Daugnora and Girininkas, 2004). During the Neolithic, domestic animals arrived in Lithuania together with the incoming CWC pastoralists and presumably domestic horses also appeared in this period (Piličiauskas et al., 2017a; Piličiauskas, 2018). However, horse remains are still very sparse in the Neolithic and Early Bronze Age (e.g. Kretuonas 1C, and 1D, and Žemaitiškė 2) accounting for only 0.4-0.7% of all mammals (Daugnora and Girininkas, 2004). Similarly low numbers of horse remains are found throughout the whole eastern Baltic (Paaver, 1965; Maldre and Luik, 2009). In contrast, horse remains are present in much higher frequencies from the Late Bronze Age – e.g., 1.3 - 5.3% in eastern Lithuania (Garniai 1, Narkūnai, and Mineikiškės) and as much as 30% in western Lithuania (Kukuliškiai) (Luchtan, 1986; Luik et al., 2022). To summarise, horse bones from Garnys are few and varied in size and bear similarities with both domestic and wild horses. However, since no other remains of domestic animals (except of dog) were found in Garnys we might assume that all horse bones most likely belong to hunted wild animals.

Detailed information regarding the exploitation of birds during prehistory in Lithuania is rather scarce due to a lack of specialists and incomplete comparative collections (Piličiauskienė and Micelicaitė, 2020). Despite this, one study on bird remains from 10 Subneolithic to Early Bronze Age sites, includes no less than 28 different species (Daugnora et al., 2002). The list of Subneolithic – Early Bronze Age fowl includes a wide range of ducks and other birds living in aquatic environments, comprising most of the species identified from Garnys. Mallard and red-breasted merganser was identified at nine sites (Šventoji 1B, 2B, 4, and 23, Daktariškė 5, Kretuonas 1B, and 1C, Šarnelė and Žemaitiškė 2). Western capercaillie was identified from only three sites (Šventoji 3B, Žemaitiškė 2, and Šarnelė). Although mute swan was identified from Garnys, only the whooper swan is known from three Subneolithic sites (all at Šventoji). Finally, three different birds of prey from the family of Accipitridae were identified from a total of four Subneolithic – Early Bronze Age sites – golden eagle was not present (Daugnora et al., 2002). This species has only been described from two late medieval castles in Lithuania (Ehrlich et al., 2021). The small avian assemblage from Garnys likely indicates that fowling was opportunistic. It is also possible that bird hunting was seasonally practiced. The four middle to large-sized aquatic and terrestrial species (swan, ducks, and capercaillie) were possibly slaughtered for both their nutritional value and feathers, while the radius from the golden eagle may represent an individual that was procured for its wing or feathers rather than for its meat. Interestingly, only the wing bones from the golden eagle were present in the Early and Late Neolithic assemblages at the site of Alsónyék-Bátaszék in southern Hungary. Two ulnae in the Late Neolithic material of this site also had cut marks. Moreover, only the leg bones (most probably from the same individual) are known from the Early Neolithic site of Foeni – Cimitirul Ortodox in western Romania (Gál et al., 2021). Elsewhere, a radius from a young *Aquila* specimen was identified from the Early Neolithic site of Starčevo in Serbia (Clason, 1980), while a single golden eagle bone (unknown element) is known from the Mesolithic campsite of Mount Sandel in Northern Ireland, which was found in a pit together with the remains of red-throated diver, grouse, and wild boar (Holmes, 2018).

A less common animal in Lithuanian zooarchaeological material is the freshwater turtle. They are very infrequent within faunal assemblages and were likely not a significant part of the human diet. Few turtle plates have been found in Subneolithic - Early Bronze sites (Nida, Žemaitiškė 1, and 2, Kaltanėnai, and Šventoji 4) (Rimantienė, 1996, Tab. IX, XII; Daugnora and Girininkas, 2004; Piličiauskas et al., 2020; unpublished data by GP).

One pike bone was found at Garnys. However, this likely does not reflect the importance of fish to the diets of the peoples at the site, as the carbon and nitrogen stable isotope analysis of a single human individual confirms (see below). This is a situation analogous to the Kaltanėnai site where lightweight fish bones may have been transported by the flow of water downstream (Piličiauskas et al., 2020). This is probably also a contributing factor to explain the very scarce number of bones of birds and small mammals among the faunal remains coupled with the hand collection strategy on the riverbed.

For mollusc species identification only the largest shell fragments from the Neolithic layer of test-pit No. 5 were collected. Therefore, unsurprisingly they all belonged to a single species — freshwater pearl mussel (*Margaritifera margaritifera*). Today this species is already extinct in Lithuania, although still present in Latvia (Cuttelod et al., 2011). It lives in rivers and streams with clear and fast running water and sandy and rocky bottoms (Skinner et al., 2003). Its presence in the Neolithic layer confirms the fluvial environment. Freshwater pearl mussel may have been consumed by Neolithic people as food and/or for shell temper when making ceramic vessels. Although we cannot prove for certain, the gathering and consumption of this large (up to 10 to 13 cm in length) freshwater mollusc during the Stone Age seems highly probable. For instance, in Latvia during the Subneolithic, *Unio* sp. was harvested in great quantities for human consumption and other means (Brinker et al., 2020).

Human remains

Among the osteological material from Garnys, six human bone fragments were identified from find areas V3-V4 and test-pit No. 5: four skull fragments, one femur and one pelvic bone. The pelvic bone from V3 belonged to a 30-45 year-old woman. Furthermore, the femur bone from V4 belonged to a subadult individual. Since it was impossible to determine the age and sex for the skull fragments, the isolated human bones from Garnys likely belonged to at least two individuals.

We attempted to date the skull and pelvis bones (Fig. 1). However, collagen was poorly preserved in the chosen skull fragment. The pelvic bone had well-preserved collagen and its date (4359 ± 26 BP; FTMC-UU26-24; 3076-2906 cal BC), without correction for the freshwater reservoir effect (FRE; see more Piličiauskas and Heron, 2015), points to the very end of the Subneolithic. Recently published carbon and nitrogen isotope data (δ^{13}C = -24.5‰ and δ^{15}N = 11.1‰) of the same bone indicates the consumption of freshwater foods — the measured δ^{13}C value of -24.5‰ is the lowest among an extensive dataset of hunter-gatherer-fisher individuals from Lithuania (Simčenka et al., 2022). Therefore, it is very likely that the ^{14}C date of the Garnys woman was affected by a currently unknown FRE. As a result, some or even all the isolated human bones at Garnys likely belong to the Neolithic (2900-1800 cal BC). Isolated human bones, very often skulls and their fragments, is a wide-spread phenomenon at hunter-gatherer-fisher dwelling sites and fishing stations throughout the circum-Baltic region. They were probably circulated among the living as symbolic and ritual objects or perhaps entered water bodies from disturbed open air-graves rather than from formal burials (see Piličiauskas et al., 2017b and cited references therein).

Fish weirs

During the underwater survey of 2021, 76 wooden poles driven into the riverbed were recorded. By removing soft sediments by hand, we reached only the topmost and usually eroded parts of poles, thus it was not always possible to measure their original thickness (Table 6). In addition, it was unclear whether the lower ends had been sharpened and the techniques used. Furthermore, not all poles were standing vertically; some were heavily inclined towards the river flow. Therefore, the mapping of the poles' upper ends represents their approximate original distribution (Fig. 2). Despite this, some trends regarding their spatial arrangement became obvious. Firstly, the wooden constructions were installed, preserved and partly uncovered by erosion close to the left bank and only within a 60 m segment of the river (Fig. 2). The measured poles form four distinct aggregations; only two poles were positioned further away. In three of the four aggregations (V3-1, V3-2, and V3-3) wooden poles were arranged in c. 4 m long lines with distances of 0.1-0.5 m between individual poles oriented perpendicular to the riverbed (Fig. 2). Therefore, they are very likely the remains of fish weirs that were widely used in Lithuanian rivers from prehistory until World War II (Piškinaitė-Kazlauskienė, 1998; Piličiauskas et al., 2020a).

Table 6. Wood taxa determinations of the wooden poles.

No.	ID	Find area	Common name	Binomial nomenclature	Ø cm
1	35	V2-3	Pine	*Pinus sylvestris*	5
2	36	V2-3	Pine	*Pinus sylvestris*	>2.5
3	73	V2-3	Pine	*Pinus sylvestris*	>3
4	74	V2-3	Maple	*Acer platanoides*	>8.5
5	75	V2-3	Pine	*Pinus sylvestris*	>10
6	76	V2-3	Alder	*Alnus* sp.	4.5
7	77	V2-3	Hazel	*Corylus avellana*	2.4
8	78	V2-3	Pine	*Pinus sylvestris*	3.5
9	79	V2-3	Spruce	*Picea abies*	>3
10	80	V2-3	Maple	*Acer platanoides*	3
11	81	V2-3	Pine	*Pinus sylvestris*	>3
12	82	V2-3	Ash	*Fraxinus excelsior*	8
13	83	V2-3	Pine	*Pinus sylvestris*	3.2
14	84	V2-3	Pine	*Pinus sylvestris*	>5
15	85	V2-3	Pine	*Pinus sylvestris*	4
16	86	V2-3	Pine	*Pinus sylvestris*	>5.5
17	87	V2-3	Pine	*Pinus sylvestris*	4
18	88	V2-3	Ash	*Fraxinus excelsior*	>5.5
19	89	V2-3	Pine	*Pinus sylvestris*	5
20	90	V2-3	Pine	*Pinus sylvestris*	6
21	91	V2-3	Ash	*Fraxinus excelsior*	>5
22	92	V2-3	Pine	*Pinus sylvestris*	6.5
23	93	V2-3	Pine	*Pinus sylvestris*	6
24	94	V2-3	Pine	*Pinus sylvestris*	6
25	95	V2-3	Pine	*Pinus sylvestris*	3.5
26	96	V2-3	Pine	*Pinus sylvestris*	>7
27	97	V2-3	Pine	*Pinus sylvestris*	>3.5
28	98	V2-3	Pine	*Pinus sylvestris*	>4.5
29	99	V2-3	Ash	*Fraxinus excelsior*	5.5
30	37	V2-4	Pine	*Pinus sylvestris*	>1.8

31	38	V2-4	Ash	*Fraxinus excelsior*	>7
32	39	V2-4	Pine	*Pinus sylvestris*	4
33	40	V2-4	Pine	*Pinus sylvestris*	5
34	41	V2-4	Pine	*Pinus sylvestris*	4
35	42	V2-4	Pine	*Pinus sylvestris*	-
36	43	V2-4	Pine	*Pinus sylvestris*	4
37	44	V2-4	Pine	*Pinus sylvestris*	5
38	45	V2-4	Pine	*Pinus sylvestris*	>2.5
39	46	V2-4	Pine	*Pinus sylvestris*	3
40	47	V2-4	Pine	*Pinus sylvestris*	3.5
41	48	V2-4	Pine	*Pinus sylvestris*	4
42	49	V2-4	Pine	*Pinus sylvestris*	>5
43	50	V2-4	Pine	*Pinus sylvestris*	3.5
44	51	V2-4	Pine	*Pinus sylvestris*	>4.5
45	52	V2-4	Pine	*Pinus sylvestris*	>4
46	20	V3	Pine	*Pinus sylvestris*	>3
47	21	V3	Spruce	*Picea abies*	2.8
48	22	V3-1	Maple	*Acer platanoides*	-
49	23	V3-1	Pine	*Pinus sylvestris*	-
50	24	V3-1	oak	*Quercus* sp.	4
51	26	V3-1	Pine	*Pinus sylvestris*	-
52	27	V3-1	Pine	*Pinus sylvestris*	>5.5
53	28	V3-1	Pine	*Pinus sylvestris*	>10
54	29	V3-1	Pine	*Pinus sylvestris*	>6
55	30	V3-1	Pine	*Pinus sylvestris*	-
56	31	V3-1	Alder	*Alnus* sp.	4.5
57	32	V3-1	Spruce	*Picea abies*	-
58	33	V3-1	Spruce	*Picea abies*	>2.5
59	34	V3-1	Spruce	*Picea abies*	2.4
60	57	V3-2	Pine	*Pinus sylvestris*	-
61	58	V3-2	Hazel	*Corylus avellana*	>4
62	59	V3-2	Pine	*Pinus sylvestris*	-
63	60	V3-2	Birch	*Betula* sp.	5.5
64	61	V3-2	Hazel	*Corylus avellana*	>5.5
65	62	V3-2	Birch	*Betula* sp.	7
66	63	V3-2	Hazel	*Corylus avellana*	5
67	64	V3-2	Maple	*Acer platanoides*	>5
68	65	V3-2	Pine	*Pinus sylvestris*	4.5
69	66	V3-2	Birch	*Betula* sp.	7.8
70	67	V3-2	Pine	*Pinus sylvestris*	>4
71	68	V3-2	Pine	*Pinus sylvestris*	4
72	69	V3-2	Birch	*Betula* sp.	9
73	70	V3-2	Elm	*Ulmus* sp.	6
74	71	V3-2	Pine	*Pinus sylvestris*	4.2
75	72	V3-2	Spruce	*Picea abies*	2.2

We ^{14}C dated eight wooden poles, between one and four from each aggregation (Fig. 2; Table 1). Two poles from the aggregation V3-1 were dated to the pre-Roman Iron Age — 381-204 BC and 398-208 cal BC. Therefore, these poles most likely belonged to a single fish weir, which was constructed from young pine (6/12) and spruce (3/12) tree trunks, 4-10 cm thick.

In comparison, the aggregation V3-2 consisted mostly of pine (6/16) and birch (4/16) trees, 4-10 cm thick. Hazel (3/16) was also present (Table 6). Two hazel poles (IDs 58 and 60) from V3-2 were ^{14}C dated to 4229-3983 BC and 3634-3196 cal BC respectively. These dates correspond well with other fish weirs throughout the southern Baltic region dating to the Mesolithic and Neolithic, which were similarly constructed from hazel (Fisher, 2007; Klooß, 2014; Piličiauskas et al., 2020a). A third date on a birch pole (ID 60) further confirmed a Subneolithic age for the fish weirs - 4679-4363 cal BC. However, the fourth date on a pine pole appeared to be from the Middle Iron Age — 606-774 cal AD (Fig. 2; Table 1). The dating proved that the wooden poles at V3-2 (Fig. 11) belonged to multiple fish weirs, built mostly during the Subneolithic.

The last two pole aggregations V2-3 and V2-4, were completely adjacent to each other (Fig. 2) and their ^{14}C dates are almost identical - 908-808 cal BC and 900-794 cal BC (Table 2). Thus, they probably belonged to the same Late Bronze Age fishing structure. Pine wood was clearly the favoured raw material with 20/29 and 15/16 poles made of their trunks respectively. The poles' thickness varied from 3 to 10 cm. The weir was built and used during the Late Bronze Age despite the very few finds dating to the period. Only two polished stone axe fragments and a bifacial triangular tanged flint arrowhead, all from V3, may typologically date to this period. Furthermore, the preferable use of pine wood for riverine fish weirs during the Late Bronze Age is evident (Table 6). Young pine trees have soft wood and are thus easy to cut down and process. In addition, they have few branches and straight trunks. And finally, pine was a dominant tree species at the Žeimena fluvioglacial plain with sandy soils prevailing during the Holocene as well as today.

Weirs made of densely placed roundwood (e.g. V3-1, V3-2 and V3-3 at Garnys) were in use in the Žeimena River for a prolonged period of time, starting as early as the Subneolithic until the medieval period (Fig. 1; Piličiauskas et al. 2020a). However, at the nearby site of Kaltanėnai a riverine fish weir of a different and more complex construction is known, which was made of large pine laths and likely used in conjunction with a fyke net. It was dated to the pre-Roman and Roman Iron Age boundary (Piličiauskas et al., 2020a, fig. 15). It is interesting to note that only one similar pine lath was noted at Garnys, at pole aggregation V3-3 (Fig. 12). However, it has not yet been dated and we cannot be sure that it belongs to the Bronze Age fish weir, like most of the other poles from that aggregation likely do.

Another very important question is what was in-between the individual roundwood poles at the Garnys weirs. Since the remains of stationary fishing constructions in riverine settings from the Stone Age are extremely scarce in the Baltic region, we may draw on the numerous remains of stationary fishing gear recovered from lacustrine, lagoonal/estuarine, and coastal Stone Age sites around the Baltic as well as ethnographic parellels. During the Subneolithic in the eastern and northern Baltic, the fish weirs in lakes and lagoons were made from narrow (1-5 cm wide) pine laths bound together with lime or birch bark fibres and supported by sparsely distributed wooden poles (Bērziņš, 2008; Koivisto and Nurminen, 2015; Piličiauskas, 2016). Pine lath fences, if not removed by their users, would be inevitably dismantled and carried away by the river flow leaving only a few standing poles. However, ethnographical records from Siberia show that weirs made of wooden poles and pine laths had also been used in rivers, sometimes reinforced against the flow with inclined poles (see Fig. 7 in Koivisto 2017). In the western Baltic, wickerwork panels made of hazel rods and attached to wooden poles are known since the Mesolithic (Fischer 2007). In addition, fences made of thin hazel sticks bound together with plant ropes or threads are known from the southern and eastern Baltic from the Neolithic (Leineweber et al. 2011; Piličiauskas et al. 2023). Stationary fishing structures are also known from North America (e.g. Stewart 2018), which bear similarities with those found at Garnys. Further research, however, is required to fully understand the techniques used in their construction.

Ethnographic records state that wooden fences, in conjunction with hoop nets or wooden traps, were used in Lithuanian rivers for catching migratory fish such as salmon, eel and vimba bream up until World War II (Piškinaitė-Kazlauskienė, 1998). At Garnys, the wooden weirs may have been used for trapping many freshwater species such as cyprinids, pike and perch. Migratory species may also have been important, especially European eel, which is still present within the region (Piličiauskas et al. 2020a). The European eel migrates across the Atlantic Ocean to the Sargasso Sea to spawn (Dainys et al. 2017; Wright et al. 2022). However, while in Europe, it can change habitat many times, especially during spring nights. Migrating salmonids were perhaps not as important when Garnys was in use. Today, Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta trutta*) enters the Žeimena River to spawn during the late summer and autumn (Kesminas et al. 2003). Although their spawning grounds are located further downstream and do not reach Garnys (AM observations), it is unknown whether this situation was the same in prehistory.

Neolithic hunter-gatherer-fishers withstand Neolithisation at Garnys

The faunal assemblage from Garnys indicates that the subsistence economy of the local Neolithic community was largely based on the hunting of large game, while fowling may have been of minor importance. Despite the small quantities of fish remains, fishing is likely to have been important and is likely underestimated due to post-depositional factors. Indeed, the limited carbon and nitrogen isotope data obtained from human remains also attests to the prolonged consumption of freshwater protein. In contrast, agriculture was not practised during the Neolithic at Garnys. This is perhaps not entirely surprising given the complete absence of domestic animal remains in the recovered assemblage as well as the general absence or scarcity at other Subneolithic-Neolithic sites in eastern Lithuania, e.g. Kretuonas 1C, and 1D, Žemaitiškė 2 (Daugnora and Girininkas, 2004, table 18). In comparison with the Lithuanian Neolithic settlements of the CWC, GAC and Rzucewo cultures, the subsistence economy was either based on animal husbandry or mixed. This was confirmed not only by zooarchaeological data but also by human bone collagen isotope compositions and the lipid residue analysis of ceramics (Piličiauskas et al., 2017; Robson et al., 2019; Simčenka et al., 2022). Since the Garnys individual is the only representative of the Neolithic Porous Ware which has been subjected to stable isotope analysis in Lithuania, the Abora I settlement in eastern Latvia provides a better insight into the Neolithic diet of the descendants of Subneolithic hunter-gatherers. Here, all Neolithic individuals (n = 7) had freshwater diets ($\delta^{13}C < -22‰$), which were very similar to those of the preceding Subneolithic (Legzdiņa and Zariņa, 2023).

The traceological research indicates that hunting and gathering, particularly of an aquatic environment was of great importance to the Stone Age people at Garnys, including the Neolithic. The importance of hunting is attested by the many osseous and flint projectile weapon elements and clear evidence for hide processing and meat cutting. What is striking here is the absence of impact traces (fractures) typical for tools of this functional group while, at the same time, excellent readability of usage polish that allowed us to analyse the penetration depth of the points. Traces with such characteristics prove, on the one hand, that the tools had been used for a very long time. On the other hand, they indicate hitting relatively "soft" and cushioning targets located in an "environment" that protects the point from breaking as a result of hitting a hard surface (even in the event of missing the target). It seems that an aquatic environment has such features. In turn, the gathering and great importance of raw materials of plant origin for the Mesolithic-Neolithic people inhabiting Garnys is evidenced by the large number of identified tools used for woodworking and plant processing (including siliceous ones). An interesting find here are also artefacts that may be related to the processing of shells, indicating the possible local production of ornaments.

Overall, the Garnys Neolithic inhabitants appear to have retained both a Mesolithic and Subneolithic economic way of life, including a pottery making tradition that was rooted into pre-Neolithic times. The Garnys site therefore appears to have withstood Neolithisation, which differs to other Lithuanian sites where Subneolithic pottery making traditions ceased to exist by the middle of the 3rd millennium cal BC (Piličiauskas, 2016; Piličiauskas, 2018). Similarly, the Garnys case differs from the Ostorf cemetery in northern Germany, where local hunter-gatherer-fishers continued to exploit wild resources during the Neolithic in a similar fashion to Garnys, but at the same time culturally assimilated the Neolithic Funnel Beaker style of pottery (Lübke et al., 2009). If we look to the east, to the northern Belarusian culture, these ceramics also show a much higher number of Neolithic elements than in Garnys although wild resources continued to be exploited there by means and weapons like those of the Subneolithic (Charniauski, 2016).

Highly forested and lacustrine regions offer rich and varied aquatic and forest resources but perhaps were not very attractive for the first farmers. There are only a few stylistic similarities between Late Porous Ware as well as CWC and/or GAC ceramics, while the continued exploitation of wild resources at Garnys and some other nearby sites (e.g. Kretuonas 1C and Žemaitiškė 2) show that in the Žeimena River basin local hunter-gatherer-fishers may have been living side by side with Neolithic newcomers autonomously and without a significant cultural and economic assimilation throughout the Neolithic. Although we still do not have any data on the diets of the GAC and CWC people from the Žeimena River basin, it may have been like that of the Porous Ware producers. For instance, it has recently been shown that GAC and CWC ceramic vessels at the Abora I and Tamula Neolithic sites in Latvia and Estonia were used mostly for processing aquatic foods (Piličiauskas et al. 2020a; Piličiauskas et al., 2023).

Conclusions

The 16 ^{14}C dates obtained as well as the broad typo-chronology of artefacts demonstrate a multiphase occupation at the riverine Garnys site in north-eastern Lithuania. Starting from the Early Mesolithic (c. 7700 cal BC) the site was intermittently used until the Middle Iron Age (c. 700 cal AD). The c. 360 m long segment of the Žeimena River was an important hunting, gathering, fishing and living place for many generations during various periods. Stone Age hunter-gatherer-fishers spent more time and conducted more varied activities on and near water's edge compared to the Bronze and Iron Age peoples. This resulted in losing (and ritual deposition?) hunting and fishing equipment as well as the accumulation of numerous animal remains, pottery and isolated human bones on the riverbed. The remains of Subneolithic fish weirs are also present. The single human pelvis bone found belonged to 30-45 years old woman, who was living during the Neolithic and, according to their isotope values, consumed large quantities of freshwater foods. In contrast, the zooarchaeological assemblage revealed that hunting was of great importance during the Mesolithic-Neolithic. Elk and red deer predominated, although boar and beaver were also sought-after. Mute swan and golden eagle have, for the first time, been identified from prehistoric Lithuania. It is suggested that the single wing bone with limited economic value from the latter species would indicate the use of feathers – or even the whole wing – of this large bird of prey.

Traceological research further confirmed the exploitation of a diverse range of wild resources from an aquatic environment during the Stone Age, including the Neolithic. The importance of hunting was confirmed by large numbers of osseous and flint projectile points, hide-processing and meat-cutting tools. Furthermore, the absence of impact fractures on throwing weapons and together with excellent readability of usage polish prove, that the tools may have been used for a very long time and in a "soft" environment. In addition to hunting, plant (including siliceous ones) and shell gathering and processing were attested by a range of tools.

Our research at Garnys demonstrates a distinctive cultural, economic and perhaps also demographic process in north-eastern Lithuania during the Neolithic. The potters of the time followed the preceding Subneolithic tradition, while the economy remained focussed on hunting, gathering and fishing. The forested and lacustrine Žeimena River basin offered rich and varied aquatic and forest resources but was perhaps not very attractive for the first farmers due to infertile sandy soils. The case of Garnys confirms that some local hunter-gatherer-fisher communities maintained their culture and way of life for almost a thousand years after the arrival of the first Neolithic pastoralists in the eastern Baltic region.

Contrary to the Stone Age, Garnys was used exclusively for stationary fishing with fish weirs during the Metal Ages. The almost complete absence of materials dating to this period from the riverbed as well as on its banks suggests, that dwelling zones of those people were located at some distance from the fishing stations.

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List of illustrations

Fig. 1. Location of the riverine site of Garnys and several other sites mentioned in the text.

Fig. 2. Extent of the investigations undertaken at Garnys. Black numbers show calibrated ^{14}C dates (medians) of wooden structures and artefacts. Note that the locations of ^{14}C dated wooden poles and charcoal from test-pit No. 5 are precise, while the locations of the three-dated bone points as well as the human pelvis bone (dates marked with *) are approximate.

Fig. 3. Drone photograph of the underwater excavation of test-pit No. 5.

Fig. 4. Closer view of the underwater excavation of test-pit No. 5.

Fig. 5. Geological profile of Garnys compiled from the data of 11 boreholes and underwater measurements and exaggerated vertically by a factor of five.

Fig. 6. Stratigraphy of the riverbed sediments in test-pit No. 5. The gradation of the scale is 20 cm. The Neolithic archaeological layer is composed of coarse sand with *Margaritifera magaritifera* shell

debris and is shown in the bottom part of the section. The approximate locations of the four charcoal and wood ^{14}C-dating samples are shown.

Fig. 7. Late Porous Ware from test-pit No. 5.

Fig. 8. Mesolithic and Subneolithic bone tools from find concentration V3.

Fig. 9. Examples of the use-wear traces and residues observed on the flint and osseous artefacts.

Fig. 10. Selection of flint artefacts from Garnys with marked edges bearing use-wear traces (dotted lines) and places where photomicrographs were taken (red squares).

Fig. 11. Remains of Subneolithic fish weirs at wooden pole aggregation V3-2.

Fig. 12. A wooden pole made from a large pine lath from pole aggregation V3-3.