Archaeobotanical analysis of the judgement samples from research of Stare gmajne, an Eneolithic pile-dwelling site: mosses, vessel contents and the analysis of the wooden artefacts

Arheobotanična analiza po presoji odvzetih vzorcev z eneolitskega kolišča Stare gmajne: mah, polnila posod in leseni artefakti

Tjaša TOLAR, Dolores MATIKA

Izvleček

Arheobotanično sta bila raziskana dva konteksta vzorcev s kolišča Stare gmajne: prepleti mahov in polnila posod. Opravljene so bile tudi lesnoanatomske analize nekaterih lesenih najdb in oglja. Poleg nabiranja gozdnega mahu dveh vrst, makroostanki rastlin v analiziranih vzorcih dokazujejo prehrano kot tudi okoljsko rastje v eneolitiku (3521−3366 cal BC). Ugotovljen je velik pomen nabiranja divjih rastlin in gojenja šest vrst kultivarijev. Rezultati, predstavljeni v pričujočem članku, kažejo pomembne razlike med obema izkopanima sondama kot tudi med različnimi stratigrafskimi enotami. Vprašanja, kot sta, ali lahko z rastlinskimi makroostanki dokažemo spremembe v nivoju vode in ali lahko ugotovimo, kje (npr. ob obali ali ne) so stala kolišča, bodo zagotovo predmet nadaljnjih arheobotaničnih raziskav tako stratigrafskih in profilnih stolpcev kot tudi sistematično odvzetih vzorcev sedimenta iz obeh sond (4 in 5). Lok, čeprav manjših dimenzij, je izdelan iz lesa tise. Leseni obročki so izdelani iz leske. Pomemben zaključek pričujoče študije je dokaz o dandanašnji izjemni ogroženosti arheoloških organskih ostankov v tleh Ljubljanskega barja.

Ključne besede: Slovenija; Ljubljansko barje; Eneolitik; arheobotanika; kolišča; mah; polnila posod; leseni izdelki

Abstract

The archaeobotanical research of the Stare Gmajne pile-dwelling site included analyses of samples taken from moss remains and vessel contents, as well as wood anatomical analyses of several wooden artefacts and charcoal pieces.The moss of two forest species and other macroremains provide evidences of human diet and gathering as well as surrounding vegetation in the Eneolithic (3521−3366 cal BC). The results show the inhabitants collected wild plants and cultivated crops, with six cultivars identified. For the wooden artefacts, they show the bow was made of yew and the rings of hazel. They also reveal significant differences between the two excavated trenches and between different stratigraphic units. Further research of the systematically sampled sediments will address questions concerning the possibility of detecting changes in water levels and the location of the Eneolithic settlement. What is already clear is that the organic remains in the present-day Ljubljansko barje soil are highly endangered.

Keywords: Slovenia; Ljubljansko barje; Eneolithic; archaeobotany; pile dwellings; mosses; vessel contents; wooden artefacts

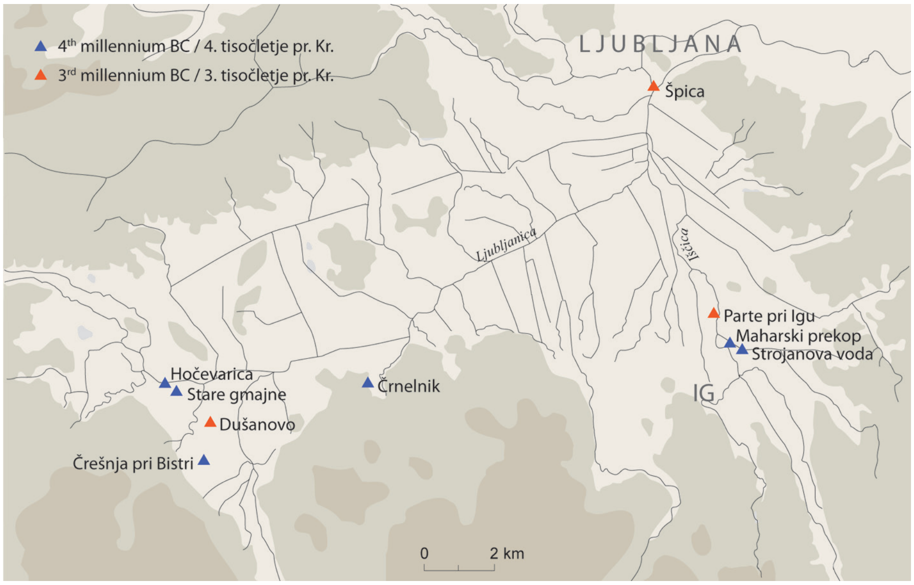

Fig. 1: Map of the Ljubljansko barje showing the main pile-dwelling sites from the 4th and 3rd millennia BC with archaeobotanical remains recovered.
Sl. 1: Zemljevid Ljubljanskega barja z najpomembnejšimi arheobotanično raziskanimi koliščí iz 4. in 3. tisočletja pr. Kr.

More than forty pile-dwelling sites from the 5th to the 3rd millennium BC have so far been documented in the marshy area of the Ljubljansko barje, central Slovenia (Velušček 2004a; 2014). Of those from the 4th millennium BC (*Fig. 1*), archaeobotanical investigations have been conducted at Hočevarica (Jeraj 2002; 2004; Jeraj, Velušček, Jacomet 2008), Stare gmajne (Tolar et al. 2010; 2011), Maharski prekop (Šercelj 1975; Šercelj 1981–1982; Culiberg, Šercelj 1991; Tolar 2018), Črešnja pri Bistri (Velušček et al. 2004), Strojanova voda (Tolar 2018) and Črnelnik (Velušček et al. 2018), of those from the 3rd millennium BC (*Fig. 1*) at Parte near Ig (Culiberg, Šercelj 1980; Šercelj, Culiberg 1980; Šercelj 1981–1982; Culiberg 1984; Culiberg 1999), Dušanovo (not published yet) and Špica (Andrič et al. 2017; archaeobotany not published yet).

We should first briefly discuss the archaeobotanical evidence (*Tab. 1*) from the pile-dwelling sites from the 4th millennium BC that are contemporaneous with Stare gmajne site.

The Hočevarica site is located in the southwestern Ljubljansko barje, near the present-day riverbed of the Ljubljanica, and dates to the mid-4th millennium BC (Velušček 2004b). It was discovered in 1992 by Andrej Šemrov from the National Museum of Slovenia. Six years later, ZRC SAZU, Institute of Archaeology[1] conducted a small-scale excavation (Velušček 2004c) that included sampling for archaeobotanical and palynological analyses. For the former, sediment samples were wet sieved using different mesh sizes (3, 1 and 0.5 mm) and then air-dried. The analysis revealed the remains of cultivated and gathered plants, as well as algae and mosses (Jeraj 2002; 2004; Jeraj, Velušček, Jacomet 2008; see *Tab. 1*). Particularly noteworthy is a large amount of grape seeds (*Vitis vinifera* ssp.). The radiocarbon date (3650–3380 cal BC (2 sigma); Jeraj 2004, 63) confirms the grapes were harvested by the inhabitants, and the morphological analyses of the seeds suggest a wild (*V. vinifera* ssp. *sylvestris*) rather than domesticated *Vitis* subspecies (i.e., *V. vinifera* ssp. *vinifera*) (Korenčič Tolar, Jakše, Korošec-Koruza 2008).

The Maharski prekop and Strojanova voda sites are located in the southeastern Ljubljansko barje and also date to the mid-4th millennium BC. The former was discovered in 1953 (Jesse 1954) and most extensively excavated in 1970–1977 (Bregant 1974a; 1974b; 1975; 1976; 1996; Šercelj 1975; 1981–1982; Culiberg, Šercelj 1991). Its investigations in 2005 included dendrochronological analyses of the vertical piles (Velušček, Čufar 2008). In addition, samples for archaeobotanical and archaeozoological analyses were systematically taken from the cultural layer in two test pits measuring 1 m² each. The samples were wet-sieved using mesh sizes of 3 and 1 mm and then air-dried (Tolar 2018, 465–466). The analysis revealed hard and

[1] Hereafter ZRC SAZU.

lignified plant macroremains such as fragments of hazelnuts (*Corylus avellana*), acorns (*Quercus* sp.) and blackberries (*Rubus* sp.), while fragile seeds/fruits such as flax (*Linum usitatissimum*) and poppy (*Papaver somniferum*) were completely absent, most likely destroyed during sieving and drying (Tolar 2018; see *Tab. 1*), which makes the archaeobotanical results unrepresentative and unrealistic. The Department of Archaeology, Faculty of Arts, University of Ljubljana, also studied the site, focusing on detecting the human activities in the Ljubljansko barje during the Holocene (Mlekuž, Budja, Ogrinc 2006; Mlekuž et al. 2012).

The artefacts from the Črešnja pri Bistri area were found randomly during infrastructure constructions such as a railway viaduct and water supply lines (Jesse 1975; Velušček 1997, 9; Velušček et al. 2004). In 2003, ZRC SAZU collected wood samples (i.e. of piles) in the drainage ditches at the site for the purposes of a dendrochronological analysis. The cultural layer was also sampled and wet sieved for possible small-sized artefacts. The site has been dated to the 36th century BC and the pottery has parallels with those from the Hočevarica site. The archaeobotanical remains included charcoal, as well as waterlogged and dried seeds/fruits of cultivated and gathered plants (see *Tab. 1;* Velušček et al. 2004).

The Strojanova voda site was discovered already in 1875 (Deschmann 1876), but only archaeologically excavated in 1953 (Jesse 1954) and again in 2012, the latter a rescue excavation while deepening the local drainage ditch. The main objective, as in 2005 at Maharski prekop, was to sample the vertical wooden piles for dendrochronological analyses (Čufar et al. 2015). At the same time, two profile columns of sediment samples were taken for archaeobotanical analysis. It was the first time this sampling method (i.e. profile or stratigraphic column samples) was used for analysing plant macroremains in Slovenia. Appropriate methods were used, i.e. fine wet sieving with half-flotation and keeping the plant macroremains waterlogged (Tolar 2018, 464). The investigation recovered a large amount of plant remains, mostly non-carbonised, that include flax, poppy seeds and cereal chaff (Tolar 2018, 466–472; see *Tab. 1*). Radiocarbon analyses of red dogwood (*Cornus sanguinea*) fruit remains and barley (*Hordeum vulgare*) rachis fragments from Strojanova voda yielded an approximate date of 3865–4196 cal BC (median values of six ^{14}C dates; Tolar 2018, 470). Of particular interest is the large quantity of fragmented red dogwood (*Cornus sanguinea*) fruits, as experimental work and chemical analyses confirm these unedible fruits may have been used to produce oil, possibly even for cleaning dishes and/or as soap (Tolar, Vovk, Jug 2021).

The Črnelnik archaeological site is located in the central Ljubljansko barje, near Kamnik pod Krimom. It was discovered during the 2014 archaeological monitoring in advance of constructing the village sewerage system. The site probably dates to the first half of the 4th millennium BC. Its cultural layer was sampled randomly. The sampled area was small and the sample volume low, but it nevertheless revealed several characteristic cultivated and gathered plant macroremains (see *Tab. 1*; Velušček et al. 2018, 22–25).

The samples and ecofacts from Črnelnik include a dog coprolite (Velušček et al. 2018; Tolar, Galik 2019), moss remain sand a fragment of a tree fungus. Two moss species were identified: *Neckera crispa* and *Anomodon viticulosus*. The tree or wood-decay fungus was identified as tinder fungus (*Fomes fomentarius*), which thrives on beech (*Fagus sylvatica*) (Velušček et al. 2018, 26). The macroanalysis of the prehistoric dog coprolite, performed for the first time in Slovenia, showed the diet of the Eneolithic dog and the season the dog defecated (Tolar, Galik 2018).

Stare gmajne lies at Verd, village near Vrhnika, not far from Hočevarica site (Velušček 2009a). It dates to the 4th millennium BC and was inhabited in two phases. Dendrochronological evidence shows a settlement gap of about 170 years between the early and late phases (Čufar et al. 2009; 2010; 2015). A team of ZRC SAZU discovered the site in 1992 and conducted archaeological surveys here in 2002, 2004, 2006, 2007 (Velušček 2009a) and most recently in July 2021.[2] Systematic archaeobotanical sampling was carried out in 2007. Samples were taken from three grid squares in Trench 3 (Velušček 2009a, 55, 62). Each grid square measured 1 m^2 and was systematically sampled from the beginning to the end of the cultural layer; i.e. from top to bottom. This was the first time that fine wet-sieving with half-flotation method and examination in wet conditions were performed in Slovenia (after Hosch, Zibulski 2003; Tolar et al. 2010). The newly applied methods led to

[2] Leghissa, Velušček, Tolar, Arheološke raziskave na najdišču Stare gmajne – prazgodovinsko kolišče. Prvo strokovno poročilo o raziskavi 21-0293, 2022 (unpublished report; kept in ZVKDS OE Ljubljana and ZRC SAZU).

the identification of 93 plant taxa. The cultivars included flax (*Linum usitatissimum*) remains and non-carbonised cereal chaff, found for the first time at archaeological sites in Slovenia (Tolar, Velušček 2009; Tolar et al. 2010; 2011). In addition to 6 cultivars, analysis revealed 16 gathered, 16 weed/ruderal and 28 lakeshore/aquatic plant taxa (Tolar et al. 2011; see *Tab. 1*).

A large loom weight was found during the excavations in 2006. It broke during lifting and revealed its unfired clay interior, which was removed and finely wet-sieved. A large amount of carbonised and half-carbonised cereal chaff of barley (*Hordeum vulgare*), emmer (*Triticum dicoccum*) and einkorn (*Triticum monococcum*) was collected in the 0.355 mm sieve fraction, which indicates not only the cultivation and processing techniques used in the Eneolithic agriculture, but also the use of by-products and waste material (Tolar, Jacomet, Velušček 2016).

Dog coprolites (16 pieces) were first found at Stare gmajne during the excavations in 2007, but did not raise much attention until the promising study of the Črnelnik dog coprolite (Tolar, Galik 2018). The uniform coprolites from Stare gmajne were stored in waterlogged conditions and analysed in 2019–2021 (Tolar et al. 2021). In addition to macro-analyses (of plant and animal remains), 6 items were also subjected to micro-analyses (i.e. palynology, palaeoparasitology and a-DNA extraction) (Tolar et al. 2021).

The great potential for recovering new coprolites and the wish for continuing research at Stare gmajne led to new archaeological investigations at the site in the summer of 2021 as part of the project "Dog or its master? The scientific study of human or canine coprolites from the prehistoric pile-dwelling site of Stare gmajne, Slovenia". Partners from foreign institutions (Austrian Academy of Sciences, Vienna University of Technology and University of Bourgogne Franche-Comte, France) were included to conduct new types of analyses (e.g. biochemical palaeoparasitological analyses) on potential new coprolite finds. Investigations did indeed unearth 9 new coprolites, which are undergoing analyses.[3] Other remains were judgement sampled and some interesting wooden artefacts were found that are discussed below. The term "judgement sampling", first used by Jones (1991) and others, means "human subjective" sampling of archaeological layers that are regarded as important and interesting or appear to be rich in plant macroremains and are of special interest to archaeologists (and archaeobotanists). Since then, the expression has become commonplaced in archaeobotanical literature (e.g. Jacomet, Kreuz 1999, 97; Campbell, Moffett, Straker 2011, 11, Tab. 4). Two types of judgement samples obntained in 2021 at Stare gmajne are presented here: moss remains and vessel contents. Moss may have been used for different purposes and the archaeobotanical analysis is the first step towards finding what those were. The samples taken from or around vessels provide direct evidence of the food prepared or stored in them.

The contribution presents the results of the archaeobotanical analyses conducted in 2021 at Stare gmajne, one of the most important pile-dwelling sites in Slovenia that already revealed dog coprolites in 2007 (Tolar et al. 2021). It focuses on the archaeobotanical analyses of the judgement sampled material (see above; Jones 1991, 55; Jacomet, Kreuz 1999, 97; Van der Veen 1987, Fig. 105) and on the wood anatomical analyses of three wooden rings and a small, probably child's bow.

The following questions will be addressed:

1 – can we ascertain the purposes of gathering moss, i.e. are there any coprolites or food/fodder/litter residues preserved in it or is its content similar to the sediment that we usually get in the cultural layer,

2 – are there any traces of prepared food surviving in or around the broken vessels, or are these merely filled with soil (i.e. cultural layer) and

3 – was the choice of wood for the bow and the three rings deliberate – what kind of wood was preferred and why?

MATERIALS AND METHODS

Excavation in 2021

Decades of research at Stare gmajne (see above) and especially the 16 dog coprolites found in 2007 (Trench 3) prompted new excavation in 2021 (Trenches 4, 5; see *Fig. 2*). Two trenches were excavated next to the spot where coprolites were found in 2007 (see *Fig. 2*).[4] Previous research has shown that the site consists of two spatially separate parts, the eastern and the western, which lie more than 100 m apart. Dendrochronological research has shown that the western part was inhabited twice, first in

[3] Tolar, Caf, Le Bailly, 2023.

[4] Leghissa, Velušček, Tolar 2022 (unpublished report).

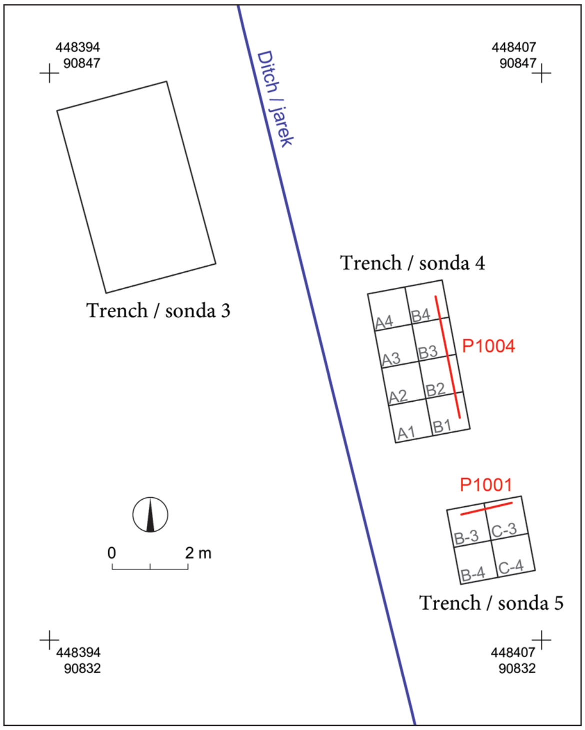

Fig. 2: Stare gmajne, Trench 3 excavated in 2007 and east of it Trenches 4 and 5 excavated in 2021 with their grid squares and Profiles P1001 and P1004.
Sl. 2: Stare gmajne, sonda 3, raziskana v letu 2007 ter sondi 4 in 5 iz leta 2021 z mrežami kvadratov in legami profilov P1001, P1004.
(coordinate system / koordinatni sistem: D48/GK)

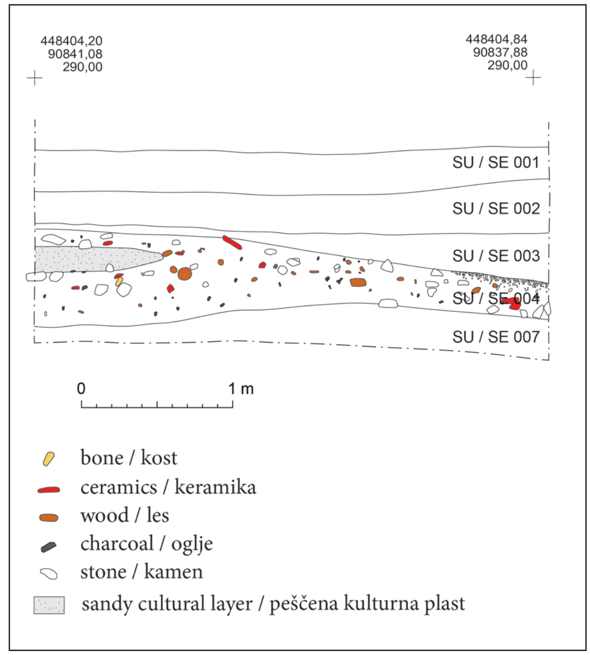

Fig. 3: Stare gmajne 2021, east profile of Trench 4 (P 1004). Scale = 1:20.
Sl. 3: Stare gmajne 2021, vzhodni profil sonde 4 (P 1004). M. = 1:20.

the 34th and then in the 32nd century BC. The eastern part held a much larger settlement, inhabited in the 32nd century BC and known for the discovery of a wooden wheel with an axle, two oak dugouts and other important finds. The western part is smaller and probably held a metallurgic workshop, as the 2007 excavation revealed (Velušček 2009a, 11; Čufar et al. 2009, 177).

In 2021, Trenches 4 and 5 were excavated east/southeast of Trench 3 from 2007 (*Fig. 2*). Only one cultural layer was documented in Trench 4, which the radiocarbon dating of a hazelnut shell showed to be dated to 3521–3366 cal BC.[5]

Archaeobotanical investigation involved systematic, profile and judgement sampling. The contribution presents the archaeobotanical remains (of seeds, fruits and charcoal) in the judgement sampled material (mosses remains, sediment in and around the fragmented vessels) and the analysis of several wooden artefacts from the cultural layer. Further analyses of the coprolites found in 2021 are in progess and will be published separately.

Trench 4 was 4 metres long, 2 metres wide and divided into eight grid squares (A1, B1, A2, B2, A3, B3, A4, B4). Two metres to the south was Trench 5, which was 2 m long, 2 m wide and divided into four grid squares (B-3, C-3, B-4, C-4) (*Fig. 2*).

The two trenches were systematically excavated according to stratigraphic units (SU), while the cultural layer was documented arbitrarily per 10 cm thick levels. Five stratigraphic units and 11 arbitrary levels were documented in Trench 4, 5 statigraphic units and 4 arbitrary levels in Trench 5 (*Fig. 3, 5*). Sediments in Trench 4 from SU 004 down were sampled for wet sieving.

The stratigraphy is simple. In Trench 4, turf (or grass; SU 001) and topsoil (SU 002) covered a greyish clay layer (SU 003), the lower part of which already contained remains of wood, in some places also charcoal. Its thickness varied (thicker towards the south; see *Fig. 3*). Beneath it, the cultural layer (SU 004) contained many stones and archaeological finds, and was dated to 3521–3366 cal BC (Velušček, Leghissa, Tolar 2021).[6] It was thickest in the north (see *Fig. 3*). It covered a layer of grey clay (SU 007) that contained the odd find in the upper

[5] Leghissa, Velušček, Tolar 2022, 32 (unpublished report).

[6] Leghissa, Velušček, Tolar 2022, 19, 32 (unpublished report).

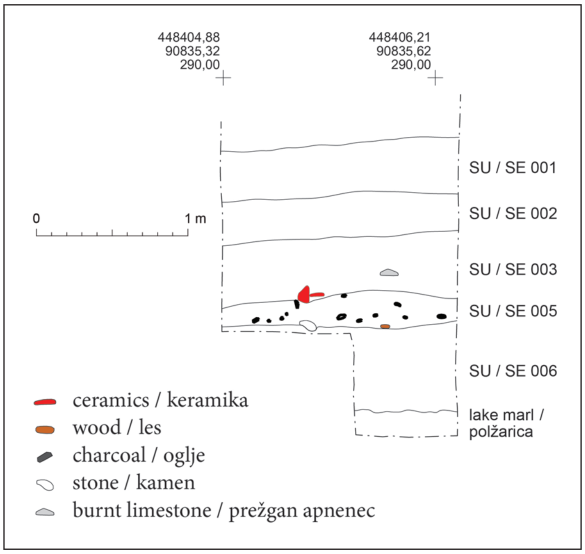

Fig. 4: Stare gmajne 2021, north profile of Trench 5 (P 1001). Scale = 1:20.
Sl. 4: Stare gmajne 2021, severni profil sonde 5 (P 1001). M. = 1:20.

Fig. 5: Stare gmajne 2021, stratigraphic sampling in Trench 4 with three 50 cm long plastic tubes with a diameter of 7 cm.
Sl. 5: Stare gmajne 2021, sonda 4: vzorčenje stratigrafskih stolpcev sedimenta s tremi 50 cm dolgimi plastičnimi cevmi premera 7 cm.

part, probably infiltrated from above. Under SU 007 was a lake sediment (lake marl, *polžarica*) (*Fig. 3*).

The cultural layer documented in Trench 4 was thinning out towards the south and was absent in Trench 5. The stratigraphy in Trench 5 consisted of the turf (SU 001), topsoil (SU 002), greyish clay layer (SU 003), layer with pottery, planks and other wooden objects (SU 005; same as SU 007 in Trench 4) and lake marl (SU 006, *polžarica*). The archaeological finds present in the upper part of SU 005 (*Fig. 4*) were probably infiltrated or deposited there as a result of changes in the water levels. The relativelly small sizes of the wooden piles in both trenches suggest we are not dealing with the remains of wooden houses on piles, but other elements, most likely used at the edge of the settlement.[7]

Archaeobotanical investigation in both trenches involved systematic surface sampling, stratigraphic (column and profile) sampling (e.g. *Fig. 5*) and judgement sampling.

Mosses and vessel contents were judgement sampled, wooden artefacts and coprolites were collected.

All together 26 archaeobotanical samples from both trenches consisted of 13 judgement samples, 4 samples for wood anatomical analysis and 9 coprolites (see *Tab. 2, 3*).

Materials

Trench 4

The cultural layer (SU 004) consisted of dark brown clayey silt with several patches of sand. It began about 60 cm below the current surface (*Fig. 3*). Most of the archeological finds (pottery, bioarchaeological, wood and stone) were found in this layer, as were vertical and horizontal piles and other remains of wood. The layer was thickest (64 cm) in the north and thinnest (24 cm) in the south. Under it, SU 007 of grey clay also contained pottery and wood. The vertical piles were also driven into the lowest layer, of lake marl.

Most archaeobotanical samples were collected from Trench 4. The 21 samples consist of 5 samples of moss remains, 4 samples of sediments in and around the fragmented vessels, 3 wooden artefacts (a bow and two rings) and 9 coprolites. 7 of the 9 dog/human coprolites were found while wet sieving the systematically taken samples (see *Tab. 2*).

[7] Leghissa, Veluščėk, Tolar 2022, 23 (unpublished report).

Seventeen of these samples derive from SU 004 and 4 from lower SU 007 (see *Tab. 2*).

Trench 5

This trench revealed no cultural layer, only some artefacts that were deposited (or infiltrated) in it.[8] Five archaeobotanical samples were collected: 4 sediment samples in and around fragmented vessels and one wooden ring. Two samples came from SU 003 and three from SU 005 (see *Tab. 3*).

The 2021 excavation at Stare gmajne yielded a total of 5 samples of moss remains, 8 sediment samples from vessel contents, a small but completely preserved bow, 3 wooden rings and 9 dog/human coprolites. The results of the archaeobotanical analyses presented here exclude the coprolites, which are studied separately using special (micro) methods.

Methods

The samples were stored in a refrigerator up to 4 degrees Celsius to prevent decay. In addition to wooden artefacts and coprolites, 13 samples (mosses and vessel contents) totalling 5,767 ml of sediment were collected for fine wet sieving in the archaeobotanical laboratory. The remains of seeds/fruits, wood, charcoal, mosses and fish remains were sorted out and analysed. The food remains detected on the walls of the broken pottery were carefully removed and sent for biochemical analysis. Wood and charcoal artefacts were anatomically examined and identified to the level of tree species or genus.

The judgement samples (*Tab. 2, 3*) were finely wet-sieved using the half-flotation method with 2 and 0.355 mm mesh sieves. For each sample, there is a worksheet with data on the location of the find (layer), the volume taken *in situ* and the volume after wet sieving (of 2 mm and of 0.355 mm fractions; data on sample size noted in *Tab. ESM 1, 2*).[9]

The organic samples from the 2 mm and 0.355 mm fractions were examined when still wet and sorted under a Leica MZ75 stereomicroscope at 6.3–50× magnification. The large fraction (2 mm) was examined on a whole, while the small fraction (0.355 mm) was subsampled. A subsample of 20 ml proved large enough for statistically reliable archaeobotanical results (Ven der Veen, Fieller 1982; Tolar et al. 2010). All recognizable organic remains larger than 0.355 mm were sorted out and divided into seeds and fruits, charcoal, small mammal (bones, teeth, coprolites) and fish finds (scales, teeth, bones).

Charcoal and animal remains (bones and teeth) were air dried, while the mostly waterlogged, fragile and thin seeds/fruits were stored in a special solution of methanol, glycerol, thymol and distilled water after identification to prevent microbial degradation. The same storage medium was used for fine and fragile fish scales preserved in waterlogged samples. Large (> 8 mm fragments) and small complete fish scales were stored separately. Coprolites and wooden artefacts were stored in wet and cold conditions.

Plant macroremains were identified using our own reference collections of seeds and fruits, charcoal and wood at ZRC SAZU, and with the help of specialised literature (e.g. Berggren 1981; Schweingruber 1990; Torelli 1991; Anderberg 1994; Gale, Cutler 2000; Cappers, Bekker, Jans 2006; Jacomet 2006a). Plant nomenclature follows Zohary, Hopf (2000) and Binz, Heitz (1990) for cultivated plants. Slovenian nomenclature and ecological characteristics of plants follow *Mala flora Slovenije* (Martinčič et al. 1999). We also used the commercial computer programme INTKEY for identifying deciduous wood (Richter, Dallwitz 2000).

After identification and quantification, the number of seeds/fruits was converted into concentrations per liter of sediment sample to facilitate comparison of results. Cereal chaff was converted into the number (MNI, minimum number of individuals) of cereal grains in such a way that 1 rachis fragment of barley (*Hordeum vulgare*) and 1 spikelet fork of glume wheat (*Triticum monococcum* and *T. dicoccum*) corresponded to 1 cereal grain, and 1 glume base of a glume wheat to half of a grain, while 2 glume bases represented 1 grain (for better understanding, see Andrič, Tolar, Toškan 2016, 51).

Because of fragmentation, only the bases of some seeds/fruits such as oak acorns (*Quercus* sp.) and hazel nuts (*Corylus avellana*) were counted (see e.g. Andrič, Tolar, Toškan 2016, 70). We counted the bases and tips of the fruits (nuts) of water chestnut (*Trapa natans*), the larger ends of capsules (with triangular tips) and whole seeds of flax (*Linum usitatissimum*), whole seeds and seed bases of apple and pear (*Malus/Pyrus* sp.), although

[8] Leghissa, Velušček, Tolar 2022, 23 (unpublished report).

[9] http://av.zrc-sazu.si/AV_75/Tolar_AV_75_2024_Tab_ESM1.xlsx; http://av.zrc-sazu.si/AV_75/Tolar_AV_75_2024_Tab_ESM2.xlsx

Fig. 6: Wood and charcoal samples prepared for identification.
Sl. 6: Primeri vzorcev lesa in oglja za identifikacijo.

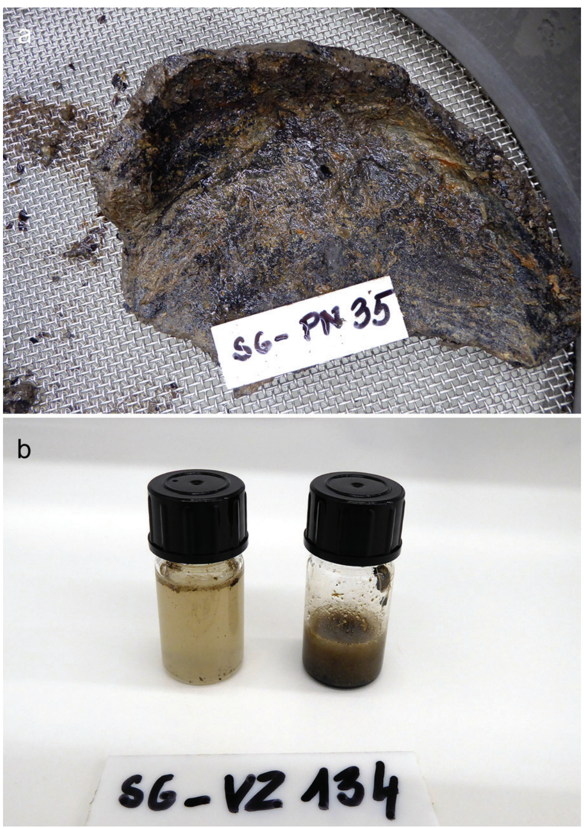

Fig. 7: Stare gmajne 2021, **a** – organic (possibly food) residues at the bottom of the fragmented vessel (PN 35), **b** – organic remains scraped from the vessel (VZ 134) and prepared for biochemical analysis.
Sl. 7: Stare gmajne 2021, **a** – organski ostanki (verjetno hrana) na dnu fragmentirane posode (PN 35), **b** – organski ostanki, postrgani iz posode (VZ 134), pripravljeni za biokemijske analize.

their pericarp fragments were also numerous (see *Tab. ESM 1, 2*).

Also analysed were 41 charcoal fragments (ranging in size from 0.2 to 8 cm) taken from 13 vessel and moss samples. As we are dealing with small-volume (25–200 ml for moss and 140–1200 ml for vessel samples; see *Tab. 5* and *7*) judgement samples, and as the main aim was to analyse (or identify) plant (and animal) macroremains (seeds, fruits) potentially used as food, the possible uses of mosses and traces of food in vessels were tried to figure out. The charcoal fragments, probably accidentally trapped in the samples, were not one of the major research objects. Therefore only one to six charcoal fragments (depending on sample size and the number of charcoal fragments surviving in it) were randomly selected from each sample. The main goal regarding charcoal was merely to determine whether the samples contained diverse charcoal taxa and whether some taxa dominated. Statistically reliable charcoal analysis will be done during the archaeobotanical analysis of the systematically taken samples. The identification of wood species was made with the help of transversal, tangential and radial wood anatomical sections. We manually broke a larger piece of charcoal to obtain three anatomical planes; for smaller pieces, we used a scalpel. The prepared charcoal sections were fixed in plasticine and/or sand for examination under stereo and light microscopes (*Fig. 6*).

To analyse the waterlogged artefacts (wooden rings and bow), we froze a sample of wet wood to facilitate cutting thin anatomical sections. Each wooden section was placed between two glasses and soaked in distilled water (*Fig. 6*) for examination under a light microscope with an up to 400× magnification. The sections were examined with a 6.3–50× Leica MZ75 stereomicroscope and a Nikon Eclipse ME 600 light microscope.

Seven samples (6 from Trench 4; *Tab. 4*) of possible food residues were collected from the vessels for biochemical analyses. They were scraped from the interior walls and bottoms of vessels (*Fig. 7*; *Tab. 4*). The samples were stored in distilled water in the refrigerator for further analysis, which will be carried out by Dr Erwin Rosenberg.[10]

Fish teeth, bones and scales were found in all judgement samples from Stare gmajne except in VZ 185, where only scales were found, probably due to the small volume (only 5 ml; see *Tab. 5*). Larger fish scales (fragment size over 8 mm) of larger fish species and well-preserved small scales of smaller species were sorted out and sent to Dr Alfred Galik[11] for further analysis.

[10] Institute of Chemical Technologies and Analytics at the Vienna University of Technology (TU Wien).

[11] Austrian Archaeological Institute of the Austrian Academy of Sciences (ÖAW).

Fig. 8: Stare gmajne 2021, most probably dog coprolite (VZ 182, Trench 4).
Sl. 8: Stare gmajne 2021, najverjetneje pasji koprolit (VZ 182, sonda 4).

Fig. 9: Stare gmajne 2021, moss remains from Trench 4.
Sl. 9: Stare gmajne 2021, primer prepleta mahu iz sonde 4.

The two coprolites (VZ 134 and VZ 182; *Fig. 8*) found in Trench 4 were carefully lifted and stored in cold waterlogged conditions. Further 7 coprolites recovered during later wet sieving of the systematically taken samples from Trench 4 (see *Tab. 2*) probably belong to either dogs or humans/ pigs. VZ 182 (*Fig. 8*) was found *in situ* and VZ 134 during fine wet sieving of the judgement sample from the vessel marked PN 35 (see *Tab. 2* and *4*). Six coprolites were separated into subsamples for palynological, palaeoparasitological and biochemical micro-analyses. The rest was fine wet-sieved for the identification of plant and animal macroremains. The remaining coprolites (3) are still stored in wet and cold conditions at ZRC SAZU for possible further analyses such as aDNA.

RESULTS

Moss samples

Five samples of moss remains were collected, all from Trench 4 (*Fig. 9*). They were taken from two SUs (004 and 007) and three grid squares (A4, B2 and B4; see *Tab. 2, 5; Fig. 2*).

Two moss species were identified: *Neckera crispa* and *Anomodon viticulosus*. Several plant and fish remains were caught in the moss. Two moss samples (VZ 84 and VZ 185) did not contain sufficient sediment or the sediment sample was not measured before sieving (see *Tab. 5*), making the identified macroremains from these two samples statistically unreliable (volumes < 5 ml). The discussion below thus only considers 3 samples (VZ 121, VZ 133 and VZ 184; *Tab. 5*).

Number of ID seeds/fruits in moss samples

A total of 769 seeds/fruits were identified in 3 moss samples, 96% of them are preserved in waterlogged, i.e. non-carbonised condition. Only some crop macroremains are carbonised (6%), mainly cereals (30%).

Crop macroremains predominate (371 ID seeds/ fruits; 48%) in all three samples, followed by weeds/ ruderal (193 ID seeds/fruits; 25%), gathered (106 ID seeds/fruits; 14%) and environmental (lakeshore and aquatic) plants (99 ID seeds/fruits; 13%) (*Fig. 10*).

Plant taxa in moss samples

We identified 27 taxa in all 3 samples. The gathered plant group predominates with 11 taxa (which is 41%), followed by cultivated and lakeshore/aquatic plants with 6 taxa (22%), while the weed/ruderal group is slightly less diverse (4 taxa; 15%) (*Fig. 11*).

Concentrations of ID seeds/fruits in individual moss samples

Interestingly, almost all ID taxa (26) come from the two samples from SU 004 (VZ 121 and VZ 133) while only 5 plant taxa were found in the VZ 184 sample from SU 007 despite being larger in volume (32 ml) than VZ 133 (25 ml; see *Tab. 5*).

Table 6 shows a slight dominance of *Triticum* over *Hordeum* in both moss samples from SU 004. *Papaver, Linum* and *Brassica* are fairly equally abundant in VZ 133, while *Papaver* is overrepresented in VZ 121. Among gathered plants, *Fragaria*, *Malus/ Pyrus*, *Rubus, Quercus* and *Abies* are represented

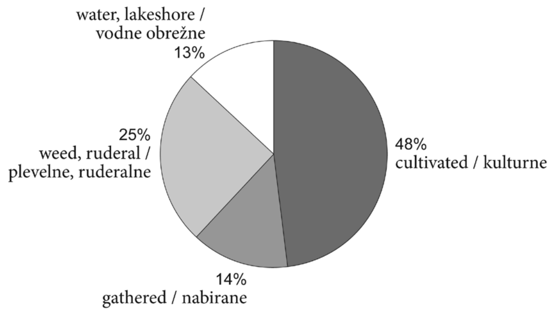

Fig. 10: Stare gmajne 2021, percentages of counted seeds/fruits by plant groups in three moss samples (VZ 121, 133, 184) from Trench 4. For taxa in each plant group, see *Tab. 6*.
Sl. 10: Stare gmajne 2021, odstotki preštetih semen/plodov po skupinah rastlin v treh vzorcih mahu (VZ 121, 133, 184) iz sonde 4. Za rastlinske taksone v posamezni skupini rastlin glej *Tab. 6*.

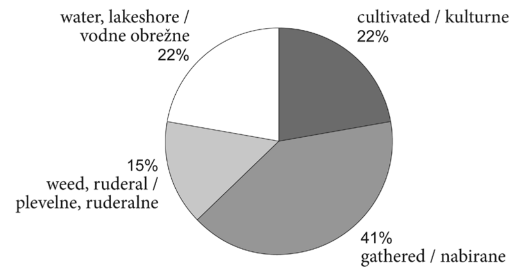

Fig. 11: Stare gmajne 2021, percentages of identified taxa by plant groups in three moss samples (VZ 121, 133, 184) from Trench 4. For taxa in each plant group, see *Tab. 6*.
Sl. 11: Stare gmajne 2021, odstotki identificiranih rastlinskih taksonov po skupinah rastlin v treh vzorcih mahu (VZ 121, 133, 184) iz sonde 4. Za rastlinske taksone v posamezni skupini rastlin glej *Tab. 6*.

in all samples, while *Physalis, Corylus, Trapa, Crataegus* and *Cornus* are only present in VZ 121; this is most likely the result of the sample's great volume (200 ml; see *Tab. 5*).

Vessel samples

The 8 sediment samples from broken vessels (*Fig. 12*) consist of 4 taken from Trench 4 and 4 from Trench 5. The former were taken from two SUs (004 and 007) and four grid squares (A2, A3, A2/B2, and B4), the latter from two SUs (003 and 005) and three grid squares (B-3, B-4, C-4; see *Tab. 7*).

With the exception of PN 51 and VZ 61, all samples contained sufficient plant macroremains (i.e. 384 seeds/fruits) for a statistically reliable archaeobotanical interpretation (after Van der Veen, Fieller 1982). The vessels revealed seeds/fruits larger than 0.355 mm, charcoal and some fish remains. Possible food residues were scraped and collected for biochemical analyses (see *Fig. 7*; *Tab. 4*).

Number of ID seeds/fruits in vessel samples

A total of 5,054 seeds/fruits were identified in the 8 samples, of which 96% survived in a waterlogged, i.e. non-carbonised condition. Only some macroremains of crops are carbonised (19%), mainly cereals (67%).

The remains of environmental (lakeshore and aquatic) plants predominate with 1,681 ID seeds/

Fig. 12: Stare gmajne 2021, broken vessels *in situ*.
Sl. 12: Stare gmajne 2021, ostanki posod *in situ*.

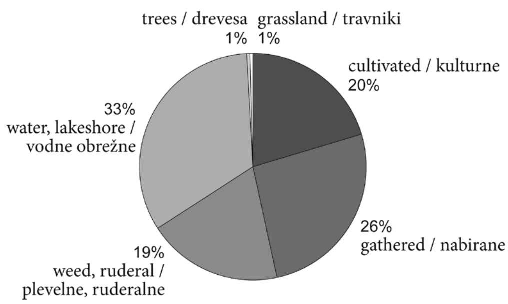

Fig. 13: Stare gmajne 2021, percentages of counted seeds/fruits by plant groups in eight vessel samples (VZ 12, 81, 134, 22, 61, 62 and PN 6, 51) from Trenches 4 and 5. For taxa in each plant group, see *Tab. 8* and *9*.
Sl. 13: Stare gmajne 2021, odstotki preštetih semen/plodov po skupinah rastlin v osmih vzorcih iz posod (VZ 12, 81, 134, 22, 61, 62 in PN 6, 51) iz obeh sond. Za rastlinske taksone v posamezni skupini rastlin glej *Tab. 8* in *9*.

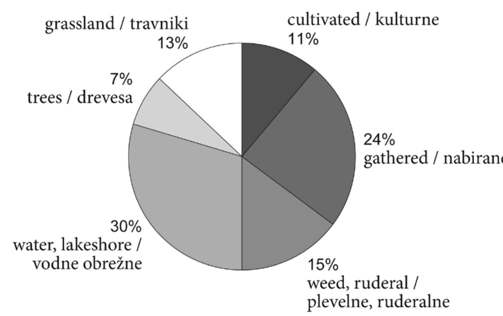

Fig. 14: Stare gmajne 2021, percentages of identified taxa by plant groups in eight vessel samples (VZ 12, 81, 134, 22, 61, 62 and PN 6, 51) from Trenches 4 and 5. For taxa in each plant group, see *Tab. 8* and *9*.
Sl. 14: Stare gmajne 2021, odstotki identificiranih rastlinskih taksonov po skupinah rastlin v osmih vzorcih iz posod (VZ 12, 81, 134, 22, 61, 62 in PN 6, 51) iz obeh sond. Za rastlinske taksone v posamezni skupini rastlin glej *Tab. 8* in *9*.

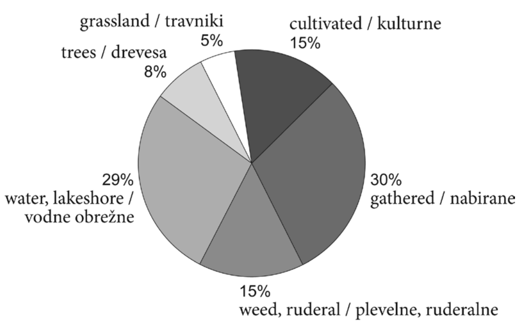

Fig. 15: Stare gmajne 2021, percentages of identified taxa by plant groups in four vessel samples (VZ 12, 81, 134 and PN 51) from Trench 4. For taxa in each plant group, see *Tab. 8*.
Sl. 15: Stare gmajne 2021, odstotki identificiranih rastlinskih taksonov po skupinah rastlin v štirih vzorcih iz posod (VZ 12, 81, 134 in PN 51) iz sonde 4. Za rastlinske taksone v posamezni skupini rastlin glej *Tab. 8*.

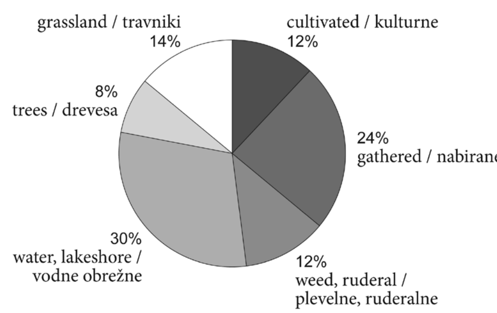

Fig. 16: Stare gmajne 2021, percentages of identified taxa by plant groups in four vessel samples (VZ 22, 61, 62 and PN 6) from Trench 5. For taxa in each plant group, see *Tab 9*.
Sl. 16: Stare gmajne 2021, odstotki identificiranih rastlinskih taksonov po skupinah rastlin v štirih vzorcih iz posod (VZ 22, 61, 62 in PN 6) iz sonde 5. Za rastlinske taksone v posamezni skupini rastlin glej *Tab. 9*.

fruits (33%). For nutritional plants, the gathered macroremains (with 1,325 ID seeds/fruits; 26%) dominate slightly over the cultivated plants (1,029 ID seeds/fruits; 20%). These are followed by fewer remains of weed/ruderal plants (975 ID seeds/fruits; 19%) and finally fewest grassland plants (21 ID seeds/fruits; 1%) and macroremains of trees with non-edible fruits such as birch, alder and maple (23 ID seeds/fruits; 1%; *Fig. 13*).

Plant taxa in the vessel samples

These samples revealed 54 taxa. The lakeshore/water plant group is the most diverse with 16 taxa (30%), followed by the gathered plants with 13 taxa (24%). The groups of cultivated plants (6 taxa; 11%) and non-nutritional trees (4 taxa; 7%) are the least diverse. The weed/ruderal (8 taxa; 15%) and grassland (7 taxa; 13%) groups show slightly greater diversity (*Fig. 14*).

Vessel samples from Trench 4

A total of 2,958 seeds/fruits were identified in the 4 samples from Trench 4. Except for PN 51 (from SU 7), all samples derive from SU 4 (see *Tab. 7*).

Forty taxa were identified (*Tab. 8*). The group of collected plants with 12 taxa (30%) and the group of lakeshore/water plants with 11 taxa (29%) are the most diverse. Cultivated and weed/ruderal plant groups, each with 6 taxa (15%), have a slightly lower diversity, while non-nutritional trees with 3 taxa (8%) and grassland plants with 2 taxa (5%) are least diverse (*Fig. 15*).

Vessel samples from Trench 5

A total of 2,096 seeds/fruits were identified in the 4 samples from Trench 5. Two samples (VZ 22 and PN 6) were from SU 003 and two from SU 005 (see *Tab. 7*).

Fifty plant taxa were identified (*Tab. 9*). The group of lakeshore/aquatic plants is slightly more diverse with 15 taxa (30%) than the group of gathered plants with 12 taxa (24%). This is followed by grassland plants with 7 taxa (14%). The cultivated and weed/ruderal plant groups are slightly less diverse (6 taxa; 12%), the non-nutritional trees are least diverse (4 taxa; 8%) (*Fig. 16*).

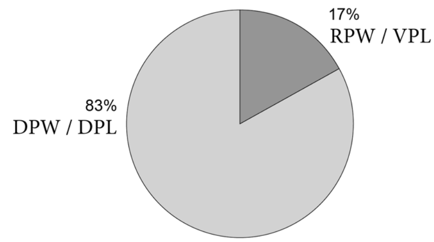

Fig. 17: Stare gmajne 2021, ratios of ring porous (RPW) and diffuse porous (DPW) charcoal fragments in moss and vessel samples in Trenches 4 and 5. For tree taxa in each group, see *Tab 10*.
Sl. 17: Stare gmajne 2021, deleža venčastoporoznih (VPL) in difuznoporoznih (DPL) odlomkov oglja v prepletih mahu in vzorcih iz posod v obeh sondah. Za drevesne taksone v posamezni skupini glej *Tab. 10*.

Charcoal

Charcoal analysis is less significant as we are dealing with extremely small judgement samples taken due to: 1 – remains of indicia of the use of mosses and 2 – possible food residues in the broken vessels. Charcoal was not abundant, but was present and should be mentioned. The analysis involved only 41 charcoal fragments from 13 judgement samples. Nine samples (with 29 ID charcoal fragments) were collected from Trench 4 and 4 (with 12 ID charcoal fragments) from Trench 5. All were of deciduous tree taxa (*Fig. 17*). Fragments of diffuse porous wood predominated with 83%. The most common species were *Corylus avellana* (hazel), Rosaceae (Rose fam.), *Alnus* sp. (alder), *Acer* sp. (maple), cf. *Carpinus betulus* (white hornbeam), *Fagus sylvatica* (common beech) and *Sorbus* sp. (service tree). Only 17% belong to ring-porous tree species, the most common being *Fraxinus* sp. (ash), *Quercus* sp. (oak), *Fraxinus* sp./*Castanea sativa* (ash or chestnut) (see *Tab. 10*).

Corylus wood is characterized by aggregate rays, scalariform perforation plates (with 5–10 bars) and heterogeneous rays (Schweingruber 1990, 92).

Rose family (or Rosaceae) includes e.g. *Crataegus* sp., *Rhamnus* sp., *Malus, Pyrus* etc., all with very similar wood anatomical characteristics, hence identification to the species level is often not possible. They are all diffuse porous, have simple and/or scalariform perforation plates and quite thin rays (i.e. bi- to tri-seriate rays in tangential section).

The exact wood species could not be identified in two examples (*Corylus avellana*/*Alnus* sp.; see *Tab. 10*) due to the small size of the charcoal pieces and very similar characteristics of the two species: diffuse porous wood with aggregate rays and scalariform perforation plates (Schweingruber 1990, 74, 92). *Castanea sativa/Fraxinus* sp. can also not always be distinguished, both are ring porous and have uni- to bi-seriate rays and simple perforation plates. The radial distribution of pores characteristic of *Castanea* is often not clearly recognizable (Schweingruber 1990, 86, 102).

Charcoal in Trench 4

The 29 randomly selected charcoal fragments in 9 samples (4 of vessel contents and 5 of mosses) from Trench 4 were wood anatomically analysed (*Tab. 11*). Wood of diffuse porous deciduous tree taxa predominated: *Corylus avellana* 11, Rosaceae 6, followed by *Alnus* sp. 3, *Sorbus* sp. 2, *Fagus sylvatica* 1, and cf. *Carpinus betulus* 1. Only 5 charcoal fragments were of ring-porous deciduous tree taxa: *Fraxinus* sp. (4 fragments) and *Quercus* sp. (1 fragment) (*Tab. 11*).

There is no significant difference in the taxa diversity between the samples from vessels and mosses. Both show 4 identical taxa (hazel, ash, Rose fam. and alder) and 2 other tree taxa in each (vessels: service tree and hornbeam; mosses: beech and oak). A total of 8 taxa of charcoal were determined in 9 samples from Trench 4.

Charcoal in Trench 5

In contrast, a smaller number of judgement (only vessel) samples was collected from Trench 5 (see section on Materials; *Tab. 3*) and only 12 charcoal fragments have been analysed. Diffuse porous deciduous wood predominates: *Corylus avellana* 5, followed by *Alnus* sp. 2, Rosaceae 1, *Acer* sp. 1, and *Corylus avellana/Alnus* sp. 1. Only two fragments

Fig. 18: Stare gmajne 2021, wooden artefacts: **a** – small bow and **b** – three wooden rings.
Sl. 18: Stare gmajne 2021, lesene najdbe: **a** – majhen lok in **b** – trije leseni obročki.

were found to be of ring porous wood: *Fraxinus* sp. and *Castanea sativa/Fraxinus* sp. (*Tab. 12*).

A total of 6 taxa were identified in Trench 5, which are identical to those from Trench 4 with the exception of maple (*Acer* sp.).

Wooden artefacts

The finds from the 2021 excavations at Stare gmajne included several wooden artefacts surviving in the waterlogged sediments, namely a bow, three wooden rings (*Fig. 18*) and two fragments of worked wood (with visible traces of cutting and/or chopping). The bow and two wooden rings (VZ 115, N 6 and NN) were found in Trench 4, SU 004, while the third wooden ring (VZ 61) came from Trench 5, SU 005. The worked wood fragments were found while wet sieving VZ 134 (sediment sample from a vessel from Trench 4, SU 004).

The wood anatomical examination of the bow shows it is made of conifer wood, more precisely yew (*Taxus baccata*). This wood is hard and elastic, devoid of resin canals (Schweingruber 1990, 66); it also has cupressoid pits and helical thickeninigs in the tracheid walls (Schweingruber 1990, 66; Čufar 2006, 23). All three wooden rings (VZ 61, N 6 and NN) are made of diffuse porous wood with aggregated rays, most probably hazel (*Corylus avellana*) or hazel/alder (*Corylus avellana/Alnus* sp.). The main characteristics of hazel and alder wood are aggregated rays and scalariform perforation plates. Hazel wood has 5–10 bars, while alder has 15–25 bars in the perforation. Because the perforations in VZ 61 and NN were destroyed or not sufficiently preserved, the ID remains unidentified for the two rings (*Corylus avellana* or *Alnus* sp.), while the N 6 ring is made of hazel.

Two pieces of wood and a bark with signs of working were found while wet sieving VZ 134 (judgement sample from a vessel from Trench 4). Both wood remains are of diffuse porous deciduous tree taxa, more specifically alder (*Alnus* sp.) with characteristically aggregated rays, scalariform perforation plates (with 15–25 bars) and homogeneous rays. The bark remain belongs to maple (*Acer* sp.), with characteristic broad rays (with up to 6 cells in width) and simple perforation plates.

DISCUSSION

The archaeobotanical material from the 2021 excavation at Stare gmajne originates from three types of remains: moss remains, vessel contents and wooden artefacts. It revealed three different types of plant macroremains: waterlogged mosses and seeds/fruits, waterlogged wood and charcoal. In addition to plant macroremains, analyses of pollen, palaeoparasites and biochemical analyses, as well as analyses of fish remains are in progress using some of the judgement samples.

The contribution presents the results of the archaeobotanical (i.e. plant macroremains) analyses of 13 judgement samples and the wood-anatomical analyses of 4 wooden artefacts unearthed in Trenches 4 and 5, both with a total surface of 12 m^2. Trench 4 was archaeobotanically richer, which is consistent with the archaeological findings.[12]

[12] Leghissa, Velušček, Tolar 2022, 5 (unpublished report).

Moss remains (interweavings or tangles of moss) were only found in the layers with archaeological finds, i.e. the cultural layer SU 004 and the clay layer SU 007 below it in Trench 4, which confirms that collecting moss was of importance to the inhabitants. The analysed mosses belong to two species, namely *Neckera crispa* and *Anomodon viticulosus*, which thrive in fir-beech forests and have already been detected at other pile-dwelling sites such as Črnelnik (Velušček et al. 2018, 51) and Hočevarica (Jeraj 2004, 60–61; Jeraj, Velušček, Jacomet 2008; *Tab. 1*). The inhabitants intentionally gathered moss and brought it to the settlement (Velušček et al. 2018, 58–59). It may have been used for different purposes, e.g., as raw material for fillings, making soles, cleaning dishes, wrapping food, hygiene (instead of toilet paper) etc. (Velušček et al. 2018, 58–59 with references). Found inside the moss were plant macroremains (seeds, fruits, charcoal) and fish remains. Analyses confirm the moss was part of the cultural remains, while the observed (identified) plant macroremains entangled into the moss are all usually found also in the cultural layers of the pile-dwelling settlements in the Ljubljansko barje (e.g. Jeraj, Velušček, Jacomet 2008; Tolar et al. 2011; Tolar 2018; see *Tab. 1*). The recovered remains of gathered, cultivated, weed/ruderal and lakeshore/aquatic plant taxa are all typical of the Eneolithic pile-dwellings in Slovenia. As at other European sites, the results from Slovenia confirm the early farmers consumed a variety of plants that included cultivated cereals, legumes and oil plants, as well as various gathered resources depending on environmental conditions (e.g. Antolin et al. 2021). The moss samples from Stare gmajne revealed 6 cultivated crop taxa: two glume wheats, i.e. einkorn (*Triticum monococcum*) and emmer (*Triticum dicoccum*), as well as barley (*Hordeum vulgare*), flax (*Linum usitatissimum*), poppy (*Papaver somniferum*) and possibly cultivated turnip (*Brassica rapa*). Only one taxon, i.e. pea (*Pisum sativum*), characteristic but rarely found at waterlogged sites due to taphonomy (Jacomet 2006b, 2009), is absent in the analysed moss samples from Stare gmajne. The reason for this absence may be non-carbonised preservation and small sediment samples (25–200 ml) (Tolar et al. 2010; Antolin et al. 2021). The same is true of the gathered plant taxa. Although 11 taxa (*Fragaria vesca, Abies alba, Rubus fruticosus*, *Malus/Pyrus* sp., *Corylus avellana, Physalis alkekengi, Trapa natans, Cornus sanguinea* etc.; see *Tab. 6*) were noted in the moss entangles, some plant remains otherwise common in the Slovenian pile-dwelling settlements from the 4th millennium BC are absent here (e.g. *Viscum album, Solanum nigrum, Prunus spinosa, Rosa* sp., *Sambucus* sp., *Fagus sylvatica, Vitis vin. sylvestris*; see *Tab. 1*), which is most likely due to the small volume judgement samples. The remains of natural, environmental plant taxa, considered non-nutritional, have also become entangled in the mosses. They prove the existence of a shallow lake or slow-flowing river and marshy or lakeshore habitats (e.g. *Mentha aquatica, Oenanthe aquatica, Schoenoplectus lacustris* etc.; see *Tab. 6*), as well as an antropogenic environment, i.e. weeds/ruderals or plants characteristic of the surroundings of settlements, paths and fields. *Tab. 6* shows that the mosses from SU 004 in Trench 4 contained much more plant macroremains than from SU 007 that stretched some 30 cm under SU 004, proving that the cultural layer in the deeper SU 007 was thinning out and mostly contained only infiltrated finds. Surprisingly, no plant macroremains of lakeshore and aquatic vegetation were found in the mosses from SU 007. Could this be an indication of changes in the water level? This will certainly be the subject of further archaeobotanical investigation, while the small-volume judgement samples presented here (i.e. only 32 ml of sediment for VZ 184/SU 007; *Tab. 5*) are not sufficiently representative for such a conclusion.

Two archaeobotanically richest moss samples (VZ 121 and VZ 133) are from SU 004, from conjoining grid squares A4 and B4. They yielded quite similar archaeobotanical finds, with some minor differences such as VZ 121 (grid square A4) containing much more *Papaver* seeds and VZ 133 (grid square B4) containing slightly more *Chenopodium* seeds and gathered plant macroremains (*Fragaria, Quercus*, *Malus/Pyrus* sp. and *Rubus*). On the other hand, the diversity of gathered plants is higher in VZ 121 (with 11 taxa compared to 5 taxa in VZ 133; see *Tab. 6*). Could this indicate two sites within 2 m^2 with different food preparation activities? Again, this is a subject for future archaeobotanical study of larger-volume systematic surface, stratigraphic profile and column samples. For the time being, we may suggest the difference is the consequence of the insufficient volumes of the sediment samples collected from the field along with the judgement sampled mosses (VZ 121 of 200 ml was by far the largest , and VZ 133 only contained 25 ml of sediment; see *Tab. 5*). The fact that both moss samples (VZ 121 and VZ 133), despite their small volume, contained 6 cultivated plant taxa, with *Papaver*

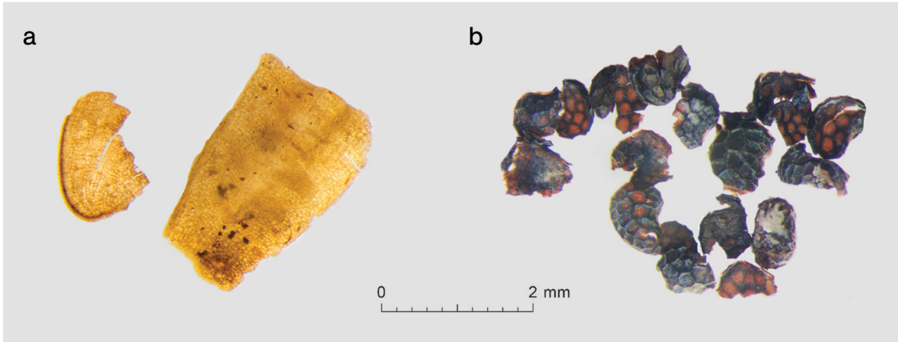

Fig. 19: Stare gmajne 2021, **a** – flax (*Linum usitatissimum*) and **b** – poppy (*Papaver somniferum*) macroremains in poor condition.
Sl. 19: Stare gmajne 2021: **a** – lan (*Linum usitatissimum*) in **b** – mak (*Papaver somniferum*) makroostanki v slabem stanju.

seeds standing out, as well as quite diverse remains of gathered plant taxa (fruits/seeds of *Fragaria, Rubus* and Maloideae), with the needles of *Abies* standing out (see *Tab. 6*), proves that we are dealing with an archaeobotanically rich Eneolithic cultural layer with good research opportunities. Unfortunately, the use of the mosses from Stare gmajne remains unclear, as we found no traces of fodder, litter, food, coprolites or anything else that would provide indications to that effect. Moss was most probably collected in the nearest fir-beech forest and deposited in the settlement, ready for use. The very usual plant remains caught in it were probably just sedimented in the aggregates of mosses and deposited there.

The samples of vessel contents (in and around the fragmented vessels) were larger, i.e. 600–1000 ml, and are therefore more representative. Six of them contained more than 384 ID seeds/fruits, which gives them statistical reliability (Ven der Veen, Fieller 1982). Half (i.e. 4) of the samples derive from Trench 4 (SU 004 and SU 007) and the other half from Trench 5 (SU 003 and SU 005). Considering the seed/fruit remains from both trenches, the lakeshore and aquatic plant group is the most diverse (16 plant taxa) and numerous (1,681 ID seeds/fruits), followed by the gathered (13 taxa and 1,325 ID seeds/fruits) and cultivated (6 taxa and 1,029 ID seeds/fruits) plants. The weeds and ruderals group (8 taxa and 975 ID seeds/fruits) is also close. Plant spectra more or less common in the Slovenian Eneolithic pile-dwelling sites were found in both trenches (Tolar et al. 2011; Tolar 2018). As in the moss samples, the judgement samples from the broken vessels indicate we are dealing with the common sediment deposits from the time of the settlement and not with a rare find such as the remains of prepared food in the vessels; further biochemical analyses (see *Tab. 4*) will confirm or reject this conclusion. As in the moss samples, the vessel samples are missing one cultivated taxon (*Pisum sativum*) and some gathered plants (Tolar et al. 2011). The importance of legumes (i.e. *Pisum*) and possibly additional wheat taxa (i.e. new glume wheat and tetraploid naked wheat), which were occasionally found at Neolithic sites in the western Mediterranean and northern Italy (see e.g. Antolin et al. 2021), but not yet in Slovenia, will be reconsidered and better demonstrated in future archaeobotanical studies on larger-volumed, systematically collected sediment samples from Stare gmajne. The gathered plants include one taxon identified in the vessel samples (namely wild grapevine, *Vitis vinifera* ssp. *sylvestris*) that is absent in the moss samples. There are minor differences in plant diversity and number of seeds/fruits identified in vessels between Trench 4 (2,958 seeds/fruits; 40 plant taxa) and Trench 5 (2,096 seeds/fruits; 50 plant taxa). In both trenches, the remains of 6 cultivars and 12 gathered fruits/nuts/needles were identified (see *Tab. 8* and *9*). In Trench 4, the gathered plant group (12 taxa) slightly outnumbers the lakeshore/water plant group (11 taxa), while in Trench 5, the lakeshore/water plant group (15 taxa) outnumbers the gathered plant group (12 taxa). The differences in **identified plant taxa** are minor, especially when considering nutritional plant taxa, whereas there are clear differences between the trenches in the **concentrations of seeds/fruits** (*Tab. 13*): 5,737 crop plant seeds/fruits per litre of sediment sample were identified in Trench 4 versus 1,592 in Trench 5, 4,279 seeds/fruits of gathered plants in Trench 4 versus 781 in Trench 5, 5,237 weed/ruderal seeds/fruits in Trench 4 versus 1,754 in Trench 5, 5,628 seeds/fruits of lakeshore/water plants in Trench 5 compared to 2,049 in Trench 4, 77 seeds/fruits of non-edible trees/shurbs in

Trench 5 compared to 31 in Trench 4, 577 seeds/fruits of grassland plants in Trench 5 compared to 19 in Trench 4 (see *Tab. 13*).

It is quite clear that the macroremains of cultivated, gathered and weed/ruderal plant groups are significantly more numerous in Trench 4 compared to Trench 5. Conversely, the numbers of remains from the ecological (environmental, i.e. lakeshore/water, trees/shurbs and grassland) plant groups are higher in Trench 5. This corroborates the observation in Leghissa, Velušček, Tolar[13] regarding "not documenting a cultural layer in Trench 5". There are indications of anthropogenic influence (i.e. crops and weeds remains) in Trench 5, but considerably fewer compared with Trench 4; this is logical given that the two trenches are only two meters apart from each other (see *Fig. 2*) and anthropogenic remains do not end abruptly, but rather gradually decrease in number. They show that we were likely excavating at the edge of the settlement. Further analyses of the systematically taken sediment samples will certainly provide additional evidence.

The vessel content samples from Trench 4 were mainly taken from SU 004, only one from SU 007, which had the least botanical macroremains of both nutritional and environmental plant groups (*Tab. 7, 8*); the same is true of the moss samples. SU 007 lies under SU 004, suggesting the former is not a cultural layer (or just the beginning of it), though some anthropogenic influences travelled down the wet and clayey soils of the Ljubljansko barje. Two samples of vessel contents in Trench 5 were taken from SU 003 and two from SU 005; no characteristic differences in plant diversity were found between them (*Tab. 9*).

The contribution of Leghissa, Velušček, Tolar[14] correlates SU 005 in Trench 5 with SU 007 in Trench 4. Let us take a look at the archaeobotanical evidence for this correlation. The average concentration of ID seeds/fruits in SU 007 of Trench 4 is 1,094, while it is 1,883 in SU 005 of Trench 5. SU 007 (Trench 4) revealed slightly more remains of cultivated plants and weeds/ruderals, but fewer remains of gathered plants and significantly fewer remains of the environmental plant groups (lakeshore/water plants, grassland plants and non-nutritional trees/shrubs) compared to SU 005 (Trench 5). The same was observed for the moss samples from Trench 4 (SU 004 vs. SU 007; *Tab. 6*) and when comparing the concentrations of seeds/fruits of different plant groups in the vessel contents from Trench 4 and Trench 5 (*Tab. 13*). This is evidence of different environmental conditions (or water levels) in the different SUs and trenches. It suggests the existence of a lake or slow flowing river in close proximity to Trench 5, SU 005. These and other similar questions, such as whether the equation of SU 005 in Trench 5 and SU 007 in Trench 4 is correct, will certainly be the subject of discussion in further archaeobotanical, palynological, geological and archaeological studies. One of the probable explanations is that we are dealing with an area that was either not settled or lay at the edge of the settlement (i.e. Trench 5 and SU 007 in Trench 4), where the water level changes were quite frequent. In general, Trench 5 contained more remains of a diverse coastal vegetation with water-tolerant, moisture-loving trees and shrubs (such as *Salix, Betula*, etc.) and grassland plants (such as *Ranunculus, Rumex*, etc.), as well as lakeshore/water plants compared with Trench 4 (see *Tab. 13*).

The abundance of edible plant taxa stands out in both moss and vessel samples, especially in SU 004 of Trench 4. Most evident is the abundance of *Papaver, Fragaria, Rubus*, *Malus/Pyrus*, *Chenopodium* seeds/fruits and of *Abies* needles. While the first five, including the *Chenopodium* weed (e.g. Schlichterle 1981; Brombacher 1997), are important gathered and/or possibly cultivated plants, the evergreen fir (*Abies*) twigs are important winter fodder and bedding for livestock (e.g., Jacomet, Leuzinger, and Schibler 2004, 400). In permanent settlements, the gathered wild plants play an important role, especially those that can be dried or otherwise stored for winter and/or collected in winter/spring, for example charred apple halves, fir needles, eagle fern (*Pteridium*) leaves and others. Opium poppy (*Papaver*) was an integral part of the Neolithic diet as well, although it is not clear whether it was the cultivated or wild form (Tolar et al. 2011; Antolin et al. 2021). Further study of systematically collected archaeobotanical samples is needed to calibrate the role of wild plants in the diet of the Stare gmajne pile-dwellers. This contribution only offers a preliminary insight, albeit through small-volume judgement samples. We have found most of the cultivated and gathered plant macroremains common for the Eneolithic pile-dwelling sites in the Ljubljansko barje with the exception of *Pisum sativum*, *Prunus spinosa*, *Rosa* sp. and *Sambucus* sp. (see *Tab. 1*).

[13] Leghissa, Velušček, Tolar 2022, 23 (unpublished report).

[14] Leghissa, Velušček, Tolar 2022, 23 (unpublished report).

An important result of this study is also the alarming condition of the remains surviving in the soils of the Ljubljansko barje, the pile-dwelling sites of which were included in the UNESCO World Heritage List in 2011. The plant macroremains and dog/human/pig coprolites from the 2021 excavation at Stare gmajne are significantly less well preserved than those from the 2007 excavations (see *Fig. 8* and *19*; Tolar et al. 2011, Fig. 6; Tolar et al. 2021, Fig. 2b; Velušček, Leghissa, Tolar 2021).

In addition to seeds/fruits, some **charcoal fragments** were also trapped in the mosses and sediments in and around vessel fragments. As charcoal analysis was not the focus of the study, only 41 largest pieces of charcoal were analysed to offer a rough picture of whether they represented deliberately (1–2 taxa) or randomly selected tree taxa. Charcoal was mainly found in the samples from Trench 4 (29 ID specimens) and only pointed to deciduous tree taxa (mainly diffuse porous wood). *Corylus avellana* is the most common species, identified with 39% (representing 16 of the 41 analysed charcoal pieces). The second most frequently identified wood is from the rose family (Rosaceae) with 7 specimens, representing 17%. *Fraxinus* sp. and *Alnus* sp. were identified in 5 specimens (12% each). All other taxa (*Sorbus* sp., *Quercus* sp., *Fagus sylvatica, Acer* sp., cf. *Carpinus betulus*) were identified in single specimens (2.5% each). The charcoal spectrum is similar to that from Hočevarica, a neighbouring pile-dwelling site from the 4th millennium (ca. 3600) BC (see above; *Fig. 1*). In Hočevarica, *Corylus* and *Alnus* predominate with 25% each. The remaining 50% are represented by *Fraxinus, Fagus, Quercus, Acer, Sorbus, Pyrus/Malus, Prunus, Populus, Betula, Crataegus* and other, mostly shrub species (Jeraj 2004, 60). Unlike the charcoal remains from Stare gmajne, Hočevarica also revealed coniferous wood (*Abies, Juniperus, Taxus* and *Pinus*), albeit in a smaller share (Jeraj 2004, 60). The large number of firewood species at Hočevarica is most likely the result of larger, systematically collected sediment samples as well as a larger excavation area: 580 charcoal fragments (Jeraj 2004, 60) identified at Hočevarica compared to 41 pieces at Stare gmajne. The charcoal analysis for the pile-dwelling site at Črešnja pri Bistri (36th century BC) identified 155 fragments (Velušček at el. 2004, 45) of a broader wood spectrum (13 taxa, compared to 10 taxa in Stare gmajne 2021); *Alnus* and *Corylus* predominate, *Fraxinus* and *Quercus* are also common, while the shares of the other 9 shrub taxa are much lower at Črešnja pri Bistri. Charcoal from conifers was found neither at Črešnja nor at Stare gmajne 2021. Although the number of charcoal samples analysed at Stare gmajne 2021 is low, it shows together with the results for Hočevarica and Črešnja pri Bistri that the inhabitants of the Ljubljansko barje practiced non-specific collection of firewood. Hazel, alder and species from the Rose family are present with a higher percentage, in contrast to larger tree species like fir, beech and maple, which were obviously not the first choice for fire-making. We can conclude that selection was governed by accessibility of smaller growing trees and bushes rather than by the type of wood (that burns longer or gives more heat, e.g. beech, oak or hornbeam). Oak and ash may occur among the charcoal remains also as the remnant of wood used in pile constructions. Further wood anatomical analysis of the charcoal surviving in the larger systematically collected archaeobotanical samples (not yet studied) is necessary for a more representative discussion on fire management at Stare gmajne. It has already been shown that the wood for artefacts (equipment and tools) was specifically and carefully selected (e.g. Tolar, Zupančič 2009; Velušček, Čufar, Zupančič 2009; Tolar, Velušček, Čufar 2012; see below), and was very likely not the same species as used for firewood. Apparently, taxa (especially shrub species) of poorer wood properties, but more easily accessible were used for fire making (also Velušček et al. 2004, 44).

The **wooden artefacts** unearthed during the excavation in 2021 include a bow (small, measuring 37 cm in length; see *Fig. 18a*) made of yew (*Taxus baccata*), a common and very likely highly suitable wood species for the purpose (Velušček, Čufar 2001; Tolar, Zupančič 2009, 241). Another two bows had come to light at Ljubljansko barje pile dwellings, both of yew wood (Velušček 2004c, 41–44; Velušček 2009b, 72; Tolar, Zupančič 2009, 241–242). The bow from Hočevarica (122.3 cm long) is believed to have been used by adolescents, while another one from Stare gmajne is shorter (64.4 cm) and has been ascribed to children. Even though the latter is short and probably intended for very young children to play with, it is still made of the best wood material.

The three rings of unknown use were most likely all made of *Corylus* wood, which was useful as firewood (see above), but is also flexible and easily split, thus suitable for wickerwork such as baskets and wattle-and-daub. It is possible that the high percentage of hazel in the charcoal assemblage is also due to common and varied use of hazel wood including fire making.

The archaeobotanical remains recovered from the Stare gmajne judgement samples provide information on the dietary habits and gathering economy (e.g. moss and firewood), but also on the environmental conditions at and around the site. As common for cultural layers, the remains of weeds/ruderals are the most numerous among the non-nutritional plant taxa (*Fig. 10, 13*). Plants from this group are usually multiseeded and thrive in places where people are active, which explains why their seeds are so numerous in the cultural layer. In second place in terms of the number of identified seeds/fruits, but in first place regarding their diversity (16 ID plant taxa; *Fig. 14, 15, 16*) is the group of lakeshore/water plants, which confirms the settlement was located near a slow-flowing river or most likely shallow lake (Velušček, Čufar, Zupančič 2009; Tolar 2018; Velušček et al. 2018; Tolar et al. 2011). These two nutritionally less important plant groups (excluded *Chenopodium*), identified from the moss and vessel samples, predominate alongside the few remains of grassland plants (e.g. *Hypericum perforatum*, *Ranunculus acris*, *Rumex* sp.) and non-edible trees/shrubs (such as *Acer, Betula, Alnus, Salix*), and indicate the main environmental conditions at the site during the habitation period. The charcoal assemblages confirm a mixed deciduous forest and forest edges, similar to today, which was easily accessible. Numerous records of *Corylus*, Rosaceae fam., *Alnus* and *Fraxinus* charcoal indicate an open and moist landscape at the edge of the lake and on the other side at the forest edge.

CONCLUSION

The judgement sampled archaeobotanical material presented in this study comes from two types of contexts: moss remains and vessel contents taken from the cultural layer excavated at the Stare gmajne pile-dwelling site in 2021 (Trenches 4 and 5). The wooden artefacts from the same cultural layer are presented as well. Three types of archaeobotanical remains were analysed: 1 – waterlogged remains of moss and seeds/fruits, 2 – waterlogged wood and 3 – charcoal remains. Collecting moss from the forest was again proved to be an important task of the Eneolithic pile-dwellers. The remains of nutritional plant taxa (cultivated and gathered) and weeds/ruderals confirm the economy of the Eneolithic Stare gmajne pile-dwellers. The identified cultivated plants comprise *Triticum monococcum, T. dicoccum, Horedum vulgare, Papaver somniferum, Linum usitatissimum* and *Brassica rapa*. The identified gathered plants show a great importance of *Fragaria, Rubus*, *Malus/Pyrus, Physalis, Quercus, Corylus* and *Abies*. The role of wild plants in the diet, the importance of legumes (e.g. *Pisum sativum*) and possibly additional wheat taxa (e.g. new glume wheat and tetraploid naked wheat) occasionally found at other European Neolithic sites can better be assessed when examining larger, systematically collected archaeobotanical samples. Further study is therefore needed to better substantiate or confirm the list of food taxa established in the small-volume judgement samples.

The most common firewood identified in this study was *Corylus*, Rosaceae*, Alnus* and *Fraxinus*. More easily accessible taxa were apparently used for fire making. The wooden artefacts included a bow made from *Taxus* and rings from *Corylus* wood.

The distribution and diversity of macroremains of non-nutritional (i.e. environmental) plant taxa differ to some extent between the two excavated trenches and their stratigraphic units. The difference pertains not to the spectra of cultivated and gathered plants (6 cultivars and 12 gathered plant taxa found in both), but to the diversity of other plant group taxa, i.e. the lakeshore/water, grassland and non-edible tree/shrub (50; 32 non-nutritional in Trench 5 versus 40; 22 non-nutritional in Trench 4).

The current results raise many questions for further archaeobotanical study of the systematically collected sediment samples and stratigraphic columns, such as what happened within a distance of just a few metres and when (e.g. change in water level, food preparation in specific places, edge of the settlement). Can plant macroremains show evidences of changes in water level or clues as to where (e.g. near the shore or not) dwellings were constructed? The samples (systematically and stratigraphically taken) from Trench 5 are particularly promising, as the current results indicate more natural vegetation and less human influence.

In addition to plant macroremains, analyses of pollen, palaeoparasites and biochemical analyses, as well as analyses of fish remains will be conducted on the judgement samples (e.g. food remains from vessels) and dog coprolites excavated at Stare gmajne in 2021.

The study also discloses the extremely poor state of preservation of the cultural remains at

Stare gmajne and alerts to the danger of destroying the World Heritage sites that have survived well preserved for more than 5,000 years in the water-saturated deposits of the Ljubljansko barje. Continuous drying and climate warming are visibly destroying the invaluable plant history at all the pile-dwelling sites in Slovenia. There is an urgent need for a rescue programme.

Acknowledgments

Dolores Matika from the University of Zadar was financially supported as part of the Erasmus+ programme (project 2020-1-HR01-KA103-077099). Many thanks to Dr Anton Velušček, head of the 2021 excavation at Stare gmajne, and to Dr Elena Leghissa, Dr Primož Pavlin, Dr Matija Turk, Dr Borut Toškan, Dr Nina Caf, Lucija Lavrenčič, Tilen Podobnik, Dragutin Valoh and Tamara Korošec, all ZRC SAZU, who participated in the excavation. Dragutin Valoh and Elena Leghissa prepared the illustrations and photographs. Special thanks to Elena Leghissa for the archaeological data and the discussions necessary for the archaeobotanical interpretation.

ANDERBERG, A.-L. 1994, *Atlas of Seeds and small fruits of Northwest-European plant species (Sweden, Norway, Denmark, East Fennoscandia, and Iceland) with morphological descriptions* 4. *Resedaceae-Umbelliferae.* – Uddevalla.

ANDRIČ, M., T. TOLAR, B. TOŠKAN 2016, *Okoljska arheologija in paleoekologija: palinologija, arheobotanika in arheozoologija*. – Ljubljana. https://doi.org/10.3986/9789610503484

ANDRIČ et al. 2017 = M. Andrič, T. Verbič, J. Lomax, T. Tolar 2017, Človekov vpliv na okolje v prazgodovini: primer z obrežja Ljubljanice pri Špici (Ljubljana) / Embankment of the Ljubljanica River at Špica (Ljubljana) and human impact on the environment in late prehistory. – *Arheološki vestnik* 68, 479–498.

ANTOLIN et al. 2021 = F. Antolin, L. Bouby, L. Martin, M. Rottoli, A. Jesus 2021, Archaeobotanical Evidence of Plant Food Consumption among Early Farmers (5700–4500 BC) in the Western Mediterranean Region. – *Food & History* 19/1-2, 235–253. https://doi.org/10.1484/J.FOOD.5.126406

BERGGREN, G. 1981, *Atlas of Seeds and small fruits of Northwest-European plant species (Sweden, Norway, Denmark, East Fennoscandia and Iceland) with morphological descriptions* 3. *Saliacaceae – Cruciferae.* – Stockholm.

BINZ, A., C. HEITZ 1990, *Schul- und Exkursionsflore für die Schweiz, mit Berücksichtigung angrenzender Gebiete.* – Basel.

BREGANT, T. 1974a, Kolišče ob Maharskem prekopu pri Igu – raziskovanja leta 1970 (Der Pfahlbau am Maharski-Kanal bei Ig – Untersuchungen aus dem Jahre 1970). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 3, 7–36.

BREGANT, T. 1974b, Kolišče ob Maharskem prekopu pri Igu – raziskovanja leta 1972 (Der Pfahlbau am Maharski-Kanal bei Ig – Untersuchungen aus dem Jahre 1972). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 3, 39–68.

BREGANT, T. 1975, Kolišče ob Maharskem prekopu pri Igu – raziskovanja 1973. in 1974. leta (Der Pfahlbau am Maharski-Kanal – Forschungen aus dem Jahren 1973 und 1974). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 4, 7–114.

BREGANT, T. 1976, Prispevek biološko-tehničnih disciplin k proučevanju kulture Ljubljanskega barja. – *Godišnjak. Centar za balkanološka ispitivanja* 13, 85–96.

BREGANT, T. 1996, Starejša, srednja in mlajša kamena doba ter bakrena doba / Early, Middle and Late Stone Ages, Copper Age. – In: B. Dirjec, N. Pirnat-Spahič, L. Plesničar-Gec, J. Rebolj, I. Sivec (eds.), *Pozdravljeni prednamci! Ljubljana od prazgodovine do srednjega veka / Ancestral ecounters. Ljubljana from prehistory to the Middle Ages,* 18–45. – Ljubljana.

BROMBACHER, C. 1997, Archaeobotanical investigations of Late Neolithic lakeshore settlements (Lake Biel, Switzerland). – *Vegetation History and Archaeobotany* 6, 167–186. https://doi.org/10.1007/BF01372569

CAMPBELL, G., L. MOFFETT, V. STRAKER 2011, *Environmental Archaeology: A guide to the theory and practice of methods from sampling and recovery to post-excavation*. –Swindon.

CAPPERS, R., R. M. BEKKER, J. E. A. JANS 2006, *Digitale Zadenatlas van Nederland (Digital Seed Atlas of the Netherlands).* – Groningen Archaeological Studies 4.

CULIBERG, M. 1984, Karpološke in ksilotomske raziskave kolišča na Partih, izkopavanja 1981 (Karpologische und Xylotomische Forschungen im Pfahlbau auf Parti – Ausgrabungen 1981). – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 12, 91–100.

CULIBERG, M. 1999, Palaeobotany in Slovene Archaeology / Paleobotanika v slovenski arheologiji. – *Arheološki vestnik* 50, 323–331.

CULIBERG, M., A. ŠERCELJ 1980, Pelodne, ksilotomske in karpološke analize s kolišča na Partih, izkopavanja 1979 (Palynologische, Xsylotome und Karpologische Analysen aus dem Pfahlbau uaf Parti – Ausgrabungen 1979). – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* VIII, 89–94.

CULIBERG, M., A. ŠERCELJ 1991, Razlike v rezultatih makroskopskih rastlinskih ostankov s kolišč na Ljubljanskem barju in pelodnih analiz – dokaz človekovega vpliva na gozd (Die Unterschiede zwischen den Resultaten der Untersuchungen der makroskopischen Reste aus den Pfahlbauten und den Pollenanalysen – ein Beweis für den Einfluss des Menschen). – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* XIX, 249–256.

ČUFAR, K. 2006, *Anatomija lesa*. – Ljubljana. https://repozitorij.uni-lj.si/Dokument.php?id=136023&lang=slv

ČUFAR et al. 2009 = K. Čufar, A. Velušček, T. Tolar, B. Komer 2009, Dendrokronološke raziskave na koliščarskih naselbinah Stare gmajne in Blatna Brezovica / Dendrochronological research at the Pile-Dwelling settlements Stare gmajne and Blatna Brezovica. – In: A. Velušček (ed.), 2009a, 117–197. https://doi.org/10.3986/9789612545611

ČUFAR et al. 2010 = K. Čufar, B. Kromer, T. Tolar, A. Velušček 2010, Dating of 4th millennium BC pile dwellings on Ljubljansko barje, Slovenia. – *Journal of Archaeological Science* 37, 2031–2039. https://doi.org/10.1016/j.jas.2010.03.008

ČUFAR et al. 2015 = K. Čufar, W. Tegel, M. Merela, B. Kromer, A. Velušček 2015, Eneolithic pile dwellings south of the Alps precisely dated with tree-ring chronologies from the north. – *Dendrochronologia* 35, 91–98.

DESCHMANN, K. 1876, Bericht über die Pfahlbautenaufdeckungen im Laibacher Moore im Jahre 1876. – *Sitzungsberichte der phil.-hist. Classe der kaiserlichen Akademie der Wissenschaften* 84, 471–484.

GALE, R., D. CUTLER 2000, *Plants in Archaeology. Identification manual of artefacts of plant origin from Europa and the Mediterranean*. – Kew.

HOSCH, S., P. ZIBULSKI 2003, The influence of inconsistent wet-sieving procedures on the macroremains concentration in waterlogged sediments. – *Journal of Archaeological Science* 30, 849–857. https://doi.org/10.1016/S0305-4403(02)00263-7

JACOMET, S. 2006a, *Bestimmung von Getreidefunden aus archäologischen Ausgrabungen*. https://ipna.duw.unibas.ch/fileadmin/user_upload/ipna_duw/PDF_s/AB_PDF/Getreidebestimmung_D.pdf

JACOMET, S. 2006b, Plant economy of the northern Alpine lake dwelling area – 3500–2400 cal. BC.– *Environmental Archaeology* 11/1, 65–85. https://doi.org/10.1179/174963106x97061

JACOMET, S. 2009, Plant economies and village life in Neolithic lake dwellings at the time of the Alpine Iceman. – *Vegetation History and Archaeobotany* 18, 47–59. https://doi.org/10.1007/s00334-007-0138-2

JACOMET, S., A. KREUZ 1999, *Archäobotanik*. – Stuttgart.

JACOMET, S., U. LEUZINGER, J. SCHIBLER 2004, *Die jungsteinzeitliche Seeufersiedlung Arbon. Bleiche 3. Umwelt und Wirtschaft*. – Archäologie im Thurgau 12.

JERAJ, M. 2002, Archaeobotanical evidence for early agriculture at Ljubljansko barje (Ljubljana Moor), central Slovenia. – *Vegetation History and Archaeobotany* 11, 277–288. https://doi.org/10.1007/s003340200040

JERAJ, M. 2004, Paleobotanične raziskave na kolišču Hočevarica / Paleobotanical analyses of the Hočevarica pille dwelling. – In: A. Velušček (ed.), 2004b, 56–64. https://doi.org/10.3986/9789612545055

JERAJ, M., A. VELUŠČEK, S. JACOMET 2008, The diet of Eneolithic (Copper Age, Fourth millennium cal B.C.) pile dwellers and the early formation of the cultural landscape south of the Alps: a case study from Slovenia. – *Vegetation History and Archaeobotany* 18/1, 75–89. https://doi.org/10.1007/s00334-008-0144-z

JESSE, S. 1954, Poročilo o sondiranju v okolici Iga pri Ljubljani (Rapport sur les sondages faits à Ig près Ljubljana). – *Arheološki vestnik* 5, 95–111.

JESSE, S. 1975, Borovnica. – In: *Arheološka najdišča Slovenije*, 175.

JONES, M. 1991, Sampling in Palaeoethnobotany. –In: W. van Zeist, K. Wasylikowa, K.-E. Behre (eds.), *Progress in Old World Palaeoethnobotany. A retrospective view on the occasion of 20 years of the International Work Group for Palaeoethnobotany,* 53–63. – Rotterdam.

KORENČIČ TOLAR, T., J. JAKŠE, Z. KOROŠEC-KORUZA 2008, The oldest macroremains of *Vitis* from Slovenia. – *Vegetation History and Archaeobotany* 17, 93–102. https://doi.org/10.1007/s00334-008-0192-4.

MARTINČIČ et al. 1999 = A. Martinčič, T. Wraber, N. Jogan, V. Ravnik, A. Podobnik, B. Turk, B. Vreš 1999, *Mala flora Slovenije. Ključ za določanje praprotnic in semenk*. – Ljubljana.

MLEKUŽ, D., M. BUDJA, N. OGRINC 2006, Complex settlement and the landscape dynamic of the Iščica floodplain (Ljubljana Marshes, Slovenia). – *Documenta Praehistorica* 33, 253–271.

MLEKUŽ et al. 2012 = D. Mlekuž, A. Žibrat Gašparič, M. Horvat, M. Budja 2012, Houses, pots and food: the pottery from Maharski prekop in context. – *Documenta Praehistorica* 39, 325–338.

RICHTER, H. G., M. J. DALLWITZ 2000, *Commercial timbers: descriptions, illustrations, identification, and information retrieval*. https://www.delta-intkey.com/wood/index.htm

SCHWEINGRUBER, F. H. 1990, *Mikroskopische Holzanatomie*. – Birmensdorf.

SCHLICHTHERLE, H. 1981, Cruciferen als nutzpflanzen in neolithischen ufersiedlungen Sudwestdeutschlands und der Schweiz. – *Zeitschrift für Archaologie* 15, 113–124.

ŠERCELJ, A. 1975, Analize makroskopskih in mikroskopskih rastlinskih ostankov s kolišča ob Maharskem prekopu, izkopavanja leta 1973 in 1974 (Die Analysen der Pflanzlichen Makro- und Mikroreste vom Pfahlbau Maharski-kanal, Grabung 1973 und 1974.) – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* IV, 115–123.

ŠERCELJ, A. 1981–82, Pomen botaničnih raziskav na koliščih Ljubljanskega barja. – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* IX–X, 101–106.

ŠERCELJ, A., M. CULIBERG 1980, Paleobotanične raziskave kolišča na Partih. Izkopavanja 1978. – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* VIII, 83–87.

TOLAR, T. 2018, Primerjava različnih metod vzorčenja in priprave arheobotaničnih vzorcev z eneolitskih kolišč Strojanova voda in Maharski prekop na Ljubljanskem barju / Comparison of different sampling and treatment methods in order to reconstruct plant economies at the Eneolithic pile-dwellings of Strojanova voda and Maharski prekop at Ljubljansko barje. – *Arheološki vestnik* 69, 461–498. https://ojs.zrc-sazu.si/av/article/view/7758/7268

TOLAR, T., A. VELUŠČEK 2009, Discovery of flax (*Linum usitatissimum*) at Ljubljansko barje, Slovenia. – *Histria Antiqua* 18, 187–194.

TOLAR, T., M. ZUPANČIČ 2009, Novoodkrite lesene najdbe s Starih gmajn pri Verdu / Newly discovered wooden finds from Stare gmajne at the Ljubljansko barje. – In: A. Velušček (ed.), 2009a, 235–245. https://doi.org/10.3986/9789612545611

TOLAR, T., A. GALIK 2019, A Study of Dog Coprolite from Late Neolithic Pile-Dwelling Site in Slovenija. – *Archaeological Discovery* 7, 20–29. https://www.scirp.org/pdf/AD_2019011416233715.pdf

TOLAR, T., A. VELUŠČEK, K. ČUFAR 2012, Arheobotanične raziskave na kolišču Stare gmajne, datiranem na osnovi raziskav lesa. – *Les/Wood* 64/5, 106–115.

TOLAR, T., S. JACOMET, A. VELUŠČEK 2016, Cereal chaff used as temper in loom-weights: new evidence from a Slovenian Eneolithic pile-dwelling site (ca. 3100 cal BC). – *Vegetation History and Archaeobotany* 25, 291–301. https://doi.org/10.1007/s00334-015-0549-4

TOLAR, T., I. VOVK, U. JUG 2021, The use of *Cornus sanguinea L.* (dogwood) fruits in the Late Neolithic. – *Vegetation History and Archaeobotany* 30/3, 347–361. https://doi.org/10.1007/s00334-020-00788-w

TOLAR, T., N. CAF, M. LE BAILLY 2023, The dog or its master? Interdisciplinary study on coprolite from the Pile-Dwelling Site Stare Gmajne. – V: V. Koprivnik, D. Salecl (ed.), Srečanja tisočletij. Zbornik mednarodnega simpozija 19.–21. 10. 2023 / The convergence of millennia. The collected volume of the symposium 19.–21. 10. 2023, *Museoeurope* 8, 78–91. https://museum-mb.si/wp-content/uploads/2023/10/MuseoEurope_2023.pdf

TOLAR et al. 2010 = T. Tolar, S. Jacomet, A. Velušček, K. Čufar 2010, Recovery techniques for waterlogged archaeological sediments: a comparison of different treatment methods for samples from Neolithic lake shore settlements. – *Vegetation History and Archaeobotany* 19, 53–67. https://doi.org/10.1007/s00334-009-0221-y

TOLAR et al. 2011 = T. Tolar, S. Jacomet, A. Velušček, K. Čufar 2011, Plant economy at the late Neolithic lake dwelling site in Slovenia at the time of the Alpine Iceman. – *Vegetation History and Archaeobotany* 20, 207–222. https://doi.org/10.1007/s00334-010-0280-0

TOLAR et al. 2021 = T. Tolar, A. Galik, M. Le Bailly, B. Dufour, N. Caf, B. Toškan, E. Bužan, L. Zver, F. Janžekovič, A. Velušček 2021b, Multi-proxy analysis of waterlogged preserved Late Neolithic canine excrements. – *Vegetation History and Archaeobotany* 30, 107–118. https://doi.org/10.1007/s00334-020-00805-y

TORELLI, N. 1991, *Makroskopska in mikroskopska identifikacija lesa (ključi).* Ljubljana.

VAN DER VEEN, M. 1987, The plant remains. – In: D. H. Heslop (ed.), *The excavation of an Iron Age settlement at Thorpe Thewles*, CBA Research Reports 65, 93–99.

VAN DER VEEN, M., N. FIELLER 1982, Sampling seeds. – *Journal of Archaeological Science* 9, 287–298. https://doi.org/10.1016/0305-4403(82)90024-3

VELUŠČEK, A. 1997, *Metodologija naselbinskih raziskovanj na barjanskih tleh*, 1. del. –

Unpublished Master's thesis / Neobjavljeno magistrsko delo, Oddelek za arheologijo, Filozofska fakulteta Univerze v Ljubljani.

VELUŠČEK, A. 2004a, Past and present lake-dwelling studies in Slovenia, Ljubljansko barje (the Ljubljana Marsh). – In: F. Menotti (ed.), *Living on the lake in prehistoric Europe, 150 years of lake dwelling research*, 69–82. – London.

VELUŠČEK, A. (ed.) 2004b, *Hočevarica. Eneolitsko kolišče na Ljubljanskem barju / Hočevarica. An Eneolithic pile dwelling in the Ljubljansko barje.* – Opera Instituti Archaeologici Sloveniae 8. https://doi.org/10.3986/9789612545055

VELUŠČEK, A. 2004c, Terenske raziskave, stratigrafija in najdbe / Field research, stratigraphy and the material finds. – In: A. Velušček (ed.), 2004b, 33–55. https://doi.org/10.3986/9789612545055

VELUŠČEK, A. (ed.) 2009a, *Koliščarska naselbina Stare gmajne in njen* čas. *Ljubljansko barje v 2. polovici 4. tisočletja pr. Kr. / Stare Gmajne pile-dwelling settlement and its era. The Ljubljansko barje in the 2nd half of the 4th millennium BC*, Opera Instituti Archaeologici Sloveniae 16. https://doi.org/10.3986/9789612545611

VELUŠČEK, A. 2009b, Koliščarska naselbina Stare gmajne pri Verdu / Stare gmajne pile-dwelling settlement near Verd. – In: A. Velušček (ed.), 2009a, 49–121. https://doi.org/10.3986/9789612545611

VELUŠČEK, A. 2014, Absolutna kronologija slovenskega neo- in eneolitika – prispevek za razpravo / Absolute chronology of the Slovenian Neo- and Eneolithic – contribution to discussion. - In: B. Teržan, M. Črešnar (eds.), *Absolutno datiranje bronaste in železne dobe na Slovenskem / Absolute dating of Bronze and Iron Ages in Slovenia*. - Katalogi in monografije 40, 629-644.

VELUŠČEK, A., K. ČUFAR 2001, 5600 let star lok z Ljubljanskega barja. – *Gea*, 11/1, 48–49.

VELUŠČEK, A., K. ČUFAR 2008, Novoopredeljeni najdišči keramike z brazdastim vrezom na Ljubljanskem barju / Newly determined sites with pottery with furrowed incisions from the Ljubljansko barje. – *Arheološki vestnik* 59, 31–48.

VELUŠČEK A., K. ČUFAR, M. ZUPANČIČ 2009, Prazgodovinsko leseno kolo z osjo s kolišča Stare gmajne na Ljubljanskem barju / Prehistoric wooden wheel with an axle from the pile-dwelling Stare gmajne at the Ljubljansko barje. – In: A. Velušček (ed.), 2009a, 197–222. https://doi.org/10.3986/9789612545611

VELUŠČEK, A., E. LEGHISSA, T. TOLAR 2021, Stare gmajne pri Verdu. Arheološko najdišče presežkov (Stare gmajne near Verd – An archaeological site of superlatives). – *Palafittes. Pfahlbauten. Palafitte. Kolišča. Pile Dwellings. News* 21, 100–105.

VELUŠČEK et al. 2004 = A. Velušček, K. Čufar, M. Culiberg, B. Toškan, J. Dirjec, V. Malez, F. Janžekovič, M. Govedič 2004, Črešnja pri Bistri, novoodkrito kolišče na Ljubljanskem barju (Črešnja pri Bistri. A newly discovered pile-dwelling settlement in the Ljubljansko barje). – *Arheološki vestnik* 55, 39–54.

VELUŠČEK et al. 2018 = A. Velušček, B. Podpečan, T. Tolar, B. Toškan, J. Turk, M. Merela, K. Čufar 2018, Črnelnik in Devce, novoodkriti najdišči iz bakrene dobe na Ljubljanskem barju / Črnelnik and Devce, Newly discovered Copper Age sites at Ljubljansko barje. – *Arheološki vestnik* 69, 9–68.

ZOHARY, D., M. HOPF 2000, *Domestication of plants in the Old World.* – Oxford.w

Arheobotanična analiza po presoji odvzetih vzorcev z eneolitskega kolišča Stare gmajne: mah, polnila posod in leseni artefakti

Povzetek

V uvodnem delu je na kratko predstavljeno stanje arheobotaničnih raziskav na barjanskih koliščih iz 4. tisočletja pr. n. št. (*sl. 1*; *tab. 1*). Pregled zgodovine raziskav se zaključi z eneolitskim koliščem Stare gmajne, ki je tudi predmet tega prispevka. Kolišče naj bi bilo poseljeno dvakrat, prvič v 34. stoletju in drugič v 32. stoletju pr. n. št., z vmesno približno 170-letno prekinitvijo (Čufar et al. 2009; 2010; 2015).

Kolišče je bilo odkrito leta 1992, raziskave so se izvajale v letih 2002, 2004, 2006 in 2007 (Velušček 2009a), tokrat pa predstavljamo rezultate iz leta 2021.[1] Leta 2007 je bila izkopana in raziskana sonda 3 (Velušček 2009a, 54–55), iz katere so bili prvič v zgodovini slovenske arheobotanike posebej odvzeti vzorci sedimenta za arheobotanične raziskave in obdelani v laboratoriju (Tolar et al. 2010; 2011). V tej sondi so bili odkriti in prepoznani tudi dokaj številni in zelo dobro ohranjeni domnevno pasji koproliti (tj. fosilizirani iztrebki). Prve raziskave teh so bile izvedene šele v letih 2019–2021 (Tolar et al. 2021). Velik raziskovalni potencial koprolitov tako na kolišču Črnelnik (Velušček et al. 2018; Tolar, Galik 2019) kot tudi na Starih gmajnah (Tolar et al. 2021) je botroval k novim raziskavam v letih 2021–2023. V začetku poletja leta 2021 sta bili v neposredni bližini sonde 3 iz leta 2007 izkopani novi sondi (sondi 4 in 5) (*sl. 2*). Med sondiranjem so bile izvedene tudi arheobiološke raziskave in sistematično iskanje koprolitov (npr. *sl. 8;* glej tudi *tab. 2*). Po izkopavanjih je bilo ugotovljeno, da obe novi sondi zajemata le starejšo fazo poselitve.[2] Po trenutni interpretaciji je kulturna plast ohranjena samo v sondi 4, medtem ko so bili v sondi 5 odkriti zgolj posamični artefakti, ki naj bi se tja infiltrirali ali sekundarno deponirali.[3]

Za arheobotaniko so bili sistematično odvzeti površinski vzorci sedimenta iz posameznih poglobitev znotraj različnih SE (npr. *sl. 3–4*), več profilnih stolpcev iz obeh sond, pet stratigrafskih stebričkov sedimenta iz sredine obeh sond (npr. *sl. 5*) in v tem prispevku predstavljeni arheobotanični vzorci, odvzeti z vzorčenjem po presoji (*tab. 2–3; tab. ESM*[4] *1–2*). Gre za tri kontekste vzorcev: prepleti mahov (npr. *sl. 9–11; tab. 5–6; tab. ESM 1*), polnila posod (npr. *sl. 12–16*; *tab. 7–9; tab. ESM 2*) in leseni artefakti (*sl. 18*). Vsi vzorci so bili obdelani v arheobotaničnem laboratoriju po ustaljenih metodah dela (npr. Tolar et al. 2010). Vrstno determinirani so bili vsi rastlinski makroostanki, večji od 0,355 mm (semena, plodovi, iglice, mahovi, les), iz skupno 17 po presoji odvzetih vzorcev: 5 prepletov mahov, 8 polnil posod, 3 leseni obročki in 1 lok (*tab. 2–3*). Poleg lesnoanatomskih analiz na artefaktih oz. izdelkih (*sl. 18*; *tab. 2–3*) so bili naključno odbrani in pregledani tudi nekateri odlomki oglja (*sl. 6; 17; tab. 10–12*). Pri delu so bili poleg stereomikroskopa in svetlobnega mikroskopa uporabljeni lastna referenčna zbirka rastlinskih delov (semen, plodov, lesa in oglja) ter slikovni določevalni ključi, npr. Cappers, Bekker, Jans (2006), Schweingruber (1990) in drugi.

Ob koncu izkopavanj in mokrega sejanja vzorcev sedimenta je bilo skupno najdenih 9 pasjih oz. človeških koprolitov (*sl. 8*; *tab. 2*), ti so še v analizi (npr. Tolar, Caf, Le Bailly 2023). Poleg tega so bili med čiščenjem keramike skrbno vzorčeni tudi domnevni ostanki hrane iz sedmih posod (*sl. 7*; *tab. 4*) za biokemijske analize, ki so prav tako v teku.

Rezultati in zaključki

Radiokarbonska datacija ostanka lešnikove lupine, ki je izvirala iz drugega nivoja kulturne plasti SE 4 v sondi 4, je pri kalibraciji *2 σ* pokazala razpon 3521–3366 cal BC (95,4 %).[5] Odkriti prepleti mahov dokazujejo nabiranje gozdnega mahu dveh vrst, *Neckera crispa* in *Anomodon viticulosus*. Makroostanki

[1] Leghissa, Velušček, Tolar, Arheološke raziskave na najdišču Stare gmajne – prazgodovinsko kolišče. Prvo strokovno poročilo o raziskavi 21-0293, 2022 (neobjavljeno poročilo; hranita ZVKDS OE Ljubljana in ZRC SAZU).

[2] Leghissa, Velušček, Tolar 2022 (neobjavljeno poročilo).

[3] Leghissa, Velušček, Tolar 2022, 23 (neobjavljeno poročilo).

[4] http://av.zrc-sazu.si/AV_75/Tolar_AV_75_2024_Tab_ESM1.xlsx; http://av.zrc-sazu.si/AV_75/Tolar_AV_75_2024_Tab_ESM2.xlsx

[5] Leghissa, Velušček, Tolar 2022, 6 (neobjavljeno poročilo).

rastlin (semena/plodovi in oglje; *tab. ESM 1–2; tab. 10*), ujeti v mahovne preplete, in tudi tisti iz vzorcev posod dokazujejo tako uporabo prehranskih kot tudi obstoj okoljskih rastlin na kolišču. Ponovno je bil ugotovljen velik pomen nabiranja divjih sadežev, oreškov in vej, kot so jagoda (*Fragaria vesca*), robida/malina (*Rubus* sp.), jabolko/hruška (Maloideae), volčje jabolko (*Physalis alkekengi*), hrast (*Quercus* sp.), leska (*Corylus avellana*) in jelka (*Abies alba*), ter gojenja dveh vrst pšenice (*Triticum monococcum*, *T. dicoccum*), ječmena (*Horedum vulgare*), maka (*Papaver somniferum*), lanu (*Linum usitatissimum*) in ogrščice (*Brassica rapa*) (*tab. 1, 6, 8–9*). Ugotovljeni taksoni dokazujejo, da imamo opravka z običajno kulturno plastjo kolišča iz 4. tisočletja pr. n. št. (prim. *tab 1*), in ne s posebnim arheobotaničnim kontekstom. V vzorcih iz posod smo pričakovali ohranjene ostanke kuhane (npr. kaše) ali skladiščene hrane (npr. pridelki, sadeži/oreški). Iz analize prepletov mahu pa smo si obetali ugotoviti pomen nabiranja mahu. Ta je namreč vsestransko uporaben, denimo za mašenje razpok v bivališčih, tudi drevakih, za celjenje ran, v izolacijske namene, za zavijanje in hrambo hrane, pa tudi v higienske namene, saj dobro vpija vodo.

Rezultati te študije dopolnjujejo nabor uporabnih rastlin in tudi okoljskega rastja na eneolitskih koliščih Ljubljanskega barja. Za ovrednotenje vlog divjih oz. udomačenih rastlin v njihovi prehrani in gospodarstvu bo potrebna študija sistematično zbranih arheobotaničnih vzorcev, ki bodo uporabni tudi pri analizi distribucije in raznolikosti okoljskega rastja, zlasti vodnih in obrežnih rastlin. Opozoriti namreč kaže na pomembne razlike v naboru in številčnosti posameznih taksonov, ugotovljene v okviru predstavljene arheobotanične raziskave. Opazne so tako med obema izkopanima sondama (4 in 5; torej horizontalno) kot tudi med različnimi stratigrafskimi enotami (vertikalno). Vprašanja, kot sta, ali lahko z rastlinskimi makroostanki dokažemo spremembe v nivoju vode in ali lahko ugotovimo, kje (npr. ob obali ali ne) so stala kolišča, bodo zagotovo predmet nadaljnjih arheobotaničnih raziskav tako stratigrafskih in profilnih stolpcev kot tudi sistematično odvzetih vzorcev sedimenta iz obeh sond (4 in 5). Trenutni rezultati, čeprav samo na podlagi po presoji odvzetih vzorcev, kažejo očitne razlike v prisotnosti semen/plodov okoljskega rastja v sondah 4 in 5 (*tab. 13*). V sondi 5 je bilo determiniranih 10 taksonov okoljskega rastja več kot v sondi 4; tudi koncentracije semen/plodov okoljskega rastja (tj. obrežnih, vodnih, traviščnih in drugih prehransko nepomembnih vrst, npr. lesno/grmovnih, kot sta jelša in breza) so višje v sondi 5. Po drugi strani pa je v sondi 4 zaznati višje vrednosti (tako v raznolikosti taksonov kot tudi v koncentracijah semen/plodov) gojenih in nabiranih rastlin ter plevelne vegetacije. Ta rezultat kaže, da so se na teh lokacijah (sonda 4 v primerjavi s sondo 5) dogajale različne aktivnosti (npr. v naselbini oz. zunaj nje) ali pa da so se na območju sonde 5 pogosto pojavljale poplave, morda celo odplavljanje kulturne plasti, česar na terenu ni bilo mogoče opaziti. Iskanje odgovorov na ta vprašanja bo nedvomno predmet prihodnjih raziskav, tudi na arheobotaničnih vzorcih, prepojenih z vodo, ki jih hranimo v hladilnici Inštituta za arheologijo ZRC SAZU. Nabirani mahovi in koproliti npr. niso bili ugotovljeni v sondi 5 (glej *tab. 5, 2*), medtem ko je bilo število fragmentiranih posod, katerih vsebino smo arheobotanično pregledali, v obeh sondah enako (glej *tab. 7*). V sondi 5 je bil odkrit le en izrezljan lesen obroček, v sondi 4 pa dva obročka in manjši lesen lok (glej *tab. 2–3; sl. 18*).

Trenutna analiza oglja – čeprav iz volumensko manjših, tj. po presoji odvzetih vzorcev mahu in vsebin iz posod – kaže na uporabo raznolikih predvsem difuzno poroznih drevesnih in grmovnih vrst, kot so leska (*Corylus avellana*), rožnice (Rosaceae), jelša (*Alnus glutinosa*) in jesena (*Fraxinus* sp.). Poleg naštetih smo identificirali še vsaj 6 lesnih vrst, ki so bile uporabljene za kurjavo (*tab. 10–12*). Vsi ugotovljeni taksoni so najverjetneje rasli v bližini kolišč na vlažnih in poplavnih tleh ter na obrobju gozda. Raznolik nabor lesnih vrst ter tudi ugotovljene prehranske rastline potrjujejo dosedanje raziskave oglja in drugih rastlinskih makroostankov na istodobnih koliščih z Ljubljanskega barja (*tab. 1*; npr. Šercelj 1975; Jeraj 2004; Tolar et al. 2011; Tolar 2018; Velušček et al. 2004; 2018). Tudi lok, čeprav manjših dimenzij, je bil izdelan iz lesa tise (*Taxus baccata*), kar se sklada z dosedanjimi analiziranimi primeri z Ljubljanskega barja (npr. Velušček, Čufar 2001; Tolar, Zupančič 2009). Vsi trije izrezljani leseni obročki so bili izdelani iz leske (*Corylus avellana*).

Pomemben zaključek opravljene študije je vsekakor tudi neposredna ogroženost arheoloških ostalin v tleh Ljubljanskega barja. Te so bile zelo dobro ohranjene več kot 5000 let v glinenih, anoksičnih in z vodo prepojenih tleh Ljubljanskega barja, danes pa so zaradi namernega izsuševanja tal, invazivnega kmetijstva in toplejšega podnebja žal v veliki nevarnosti pred propadom. Rastlinski makroostanki z izkopavanj v letu 2021 so namreč opazno slabše ohranjeni kot tisti, izkopani leta 2007 (*sl. 19*).

Tab. 1: Plant macroremains (of cultivated and gathered taxa) at Stare gmajne and contemporaneous 4th millennium BC pile-dwelling sites in the Ljubljansko barje. Cultivated taxa and mosses are shaded.
Tab. 1: Rastlinski ostanki (kulturnih in nabiranih taksonov) na Starih gmajnah in sočasnih koliščih iz 4. tisočletja pr. n. št. na Ljubljanskem barju. Gojeni taksoni in mahovi so osenčeni.

Pile-dwelling site / Kolišče *Plant taxon / Rastlinski takson*	**Hočevarica**	**Stare gmajne**	**Maharski prekop**	**Črešnja pri Bistri**	**Strojanova voda**	**Črnelnik**
Hordeum vulgare	×	×	×	×	×	×
Triticum sp.	×		×	×		
Triticum mono- and *dicoccum*		×			×	×
Linum usitatissimum		×			×	×
Papaver somniferum	×	×			×	
Pisum sativum		×	×			
Brassica rapa		×	×		×	×
Cornus mas/sanguinea	×	×	×	×	×	×
Corylus avellana	×	×	×	×	×	×
Crataegus monogyna		×			×	
Fragaria vesca	×	×	×		×	×
Malus/Pyrus sp.		×			×	
Prunus spinosa	×	×				
Physalis alkekengi		×	×		×	×
Rosa sp.		×				
Rubus idaeus/fruticosus	×	×	×	×	×	×
Quercus sp.	×	×	×	×	×	×
Sambucus ebulus	×	×	×		×	×
Trapa natans	×	×	×		×	×
Vitis vinifera sylvestris	×	×	×	×	×	×
Anomodon viticulosus (moss/mah)						×
Drepanocladaceae (moss/mah)	×					
Neckera crispa (moss/mah)	×	×				×
CHARCOAL/OGLJE (mainly/večinoma)	*Corylus, Alnus, Fraxinus*	n. d.	n. d.	*Alnus, Corylus, Fraxinus, Quercus*	n. d.	n. d.

n. d. – no data / ni podatka; × – present / prisotno

Tab. 2: Stare gmajne 2021, archaeobotanical samples from Trench 4.
Tab. 2: Stare gmajne 2021, arheobotanični vzorci iz sonde 4.

Sample / Vzorec	**Type of find / Tip najdbe**	**Grid square / Kvadrat**	**SU / SE**	**Altitude (m a.s.l.) / Višina (m n.m.)**
VZ 84	moss / mah	A4	004	n.d.
VZ 121	moss / mah	A4	004	288.64
VZ 133	moss / mah	B4	004	288.62
VZ 184	moss / mah	A4	007	288.37
VZ 185	moss / mah	B2	007	n. d.
VZ 12	vessel fillings of PN 2 / polnilo posode PN 2	B4	004	288.90
VZ 81	vessel fillings of PN 27 / polnilo posode PN 27	A2	004	288.54
VZ 134	vessel fillings of PN 35 / polnilo posode PN 35	A2/B2	004	288.60
PN 51	vessel fillings / polnila posod	A3	007	288.01
VZ 115	bow / lok	A3/A4	004	ca 288.70
N 6	wooden ring / lesen obroček	A4	004	n. d.
NN	wooden ring / lesen obroček	B1	004	ca 288.56
VZ 134	coprolite / koprolit	A2/B2	004	288.60
VZ 182	coprolite / koprolit	A4	007	288.39
SG MS 9	coprolite / koprolit	A1	004	288.53
SG MS 11	coprolite / koprolit	B4	004	288.90
SG MS 58	coprolite / koprolit	B4	004	288.90
SG MS 68	coprolite / koprolit	B4	004	288.90

SG MS 68	coprolite / koprolit	B4	004	288.90
SG MS 68	coprolite / koprolit	B4	004	288.90
SG MS 73	coprolite / koprolit	A4	004	n. d.

PN – special find / posebna najdba; n. d. – no data / ni podatka

Tab. 3: Stare gmajne 2021, archaeobotanical samples from Trench 5.
Tab. 3: Stare gmajne 2021, arheobotanični vzorci iz sonde 5.

Sample / Vzorec	**Type of find / Tip najdbe**	**Grid square / Kvadrat**	**SU / SE**	**Altitude (m a.s.l.) / Višina (m n.m.)**
VZ 22	vessel fillings of PN 4 / polnilo posode PN 4	B–4	003	288.75
VZ 61	vessel fillings of PN 23 / polnilo posode PN 23	B–3	005	288.46
VZ 62	vessel fillings of PN 25 / polnilo posode PN 25	C–4	005	288.47
PN 6	vessel fillings / polnila posod	B–3	003	288.61
VZ 61	wooden ring / lesen obroček	B–3	005	288.46

PN – special find / posebna najdba

Tab. 4: Stare gmajne 2021, list of samples for biochemical analyses of possible food remains from the rims, bodies and bottoms of ceramic vessels.
Tab. 4: Stare gmajne 2021, seznam vzorcev verjetnih ostankov hrane iz keramičnih posod (z ustij, ostenij in dna posod) za biokemijske analize.

Sample / Vzorec (Vessel find / Najdba posode)	**Trench / Sonda**	**SU / SE**	**Grid square / Kvadrat**	**Location of the org. remains in the vessel / Lega org. ost. v posodi**
VZ 12 (PN 2)	4	004	B4	bottom / dno
VZ 22 (PN 4)	5	003	B–4	body / ostenje
VZ 134 (PN 35)	4	004	A2/B2	bottom / dno
PN 37	4	004	B2	rim / ustje
PN 50	4	007	B3	bottom / dno
N 6	4	004	A4	vessel fragments / odlomki
N 94	4	007	A1	body / ostenje

PN – special find / posebna najdba; N – find / najdba

Tab. 5: Stare gmajne 2021, archaeobotanically analysed moss samples from Trench 4.
Tab. 5: Stare gmajne 2021, arheobotanično raziskani vzorci mahu iz sonde 4.

Sample / Vzorec	**VZ 84**	**VZ 121**	**VZ 133**	**VZ 184**	**VZ 185**
Trench / Sonda	4	4	4	4	4
SU / SE	004	004	004	007	007
Grid square / Kvadrat	A4	A4	B4	A4	B2
Volume of sediments before sieving / Volumen sedimenta pred spiranjem	n. d.	200 ml	25 ml	32 ml	n. d.
Volume of examined fraction / Volumen pregledane frakcije	n. d.	100 ml	15 ml	17ml	5 ml
No. ID seeds, fruits / Št. ID semen, plodov	129.5	644	118	7	4
No. ID taxa / Št. ID taksonov	18	26	17	5	5

n. d. – no data / ni podatka; No. ID / Št. ID – number of identified / število identificiranih

Tab. 6: Stare gmajne 2021, moss samples: concentrations of seeds/fruits (per litre of sediment) for individual taxa, listed in plant groups according to ecology and/or economy and sum of the concentrations for each plant group.
Tab. 6: Stare gmajne 2021, vzorci mahu: koncentracije semen/plodov (v litru sedimenta) posameznih rastlinskih taksonov po skupinah rastlin in vsota koncentracij vseh taksonov posamezne skupine rastlin.

	VZ 121 SE / SU 004	**VZ 133 SE / SU 004**	**VZ 184 SE / SU 007**
CULTIVATED PLANTS / KULTURNE RASTLINE	**4,173**	**1,160**	**125**
Cerealia (cereals / žita)			31
Hordeum vulgare (barley / ječmen)	210	200	
Triticum dicoccum (emmer / dvozrna pšenica)	78		
Triticum monococcum (einkorn / enozrna pšenica)	38		
T. mono/dicoccum (einkorn/emmer wheat / eno/dvozrna pšenica)	366	320	
Brassica rapa (turnip / ogrščica)	138	200	
Linum usitatissimum (flax / lan)	38	160	94
Papaver somniferum (poppy / mak)	3,305	280	
GATHERED PLANTS / NABIRANE RASTLINE	**702**	**800**	**62**
Abies alba (fir / jelka)	213	160	
Cornus mas (cornel / rumeni dren)	5		
Cornus sanguinea (dogwood / rdeči dren)	10		
Corylus avellana (hazel / leska)	20		
Crataegus sp. (hawthorn / glog)	5		
Fragaria vesca (wild strawberry / jagodnjak)	303	440	
Malus/Pyrus sp. (wild apple/pear / divje jabolko/hruška)	48	80	31
Physalis alkekengi (bladder cherry / volčje jabolko)	13		
Rubus fruticosus (blackberry / robida)	70	80	
Quercus sp. (acorn / želod, hrast)	5	40	31
Trapa natans (water chestnut / vodni orešek)	10		
WEED OR RUDERAL PLANTS / PLEVELNE OZ. RUDERALNE RASTLINE	**1,516**	**2,160**	**31**
Arenaria serpyllifolia (thyme-leaf sandwort / navadna peščenka)			31
Chenopodium album (goosefoot / bela metlika)	1,463	2,120	
Fallopia convolvulus (wild buckwheat / navadni slakovec)	15		
Urtica dioica (nettle / kopriva)	38	40	
LAKE-SHORE AND WATER PLANTS / VODNE IN OBREŽNE RASTLINE	**797**	**600**	**0**
Epilobium hirsutum (hairy willowherb / dlakavi vrbovec)	38		
Mentha aquatica (water mint / vodna meta)	163	120	
Oenanthe aquatica (water dropwort / vodni sovec)	295	120	
Ranunculus aquatilis (water-crowfoot / vodna zlatica)	118	160	
Schoenoplectus lacustris (lakeshore bulrush / jezerski biček)	178	200	
Sparganium sp. (bur-reed / ježek)	5		

Tab. 7: Stare gmajne 2021, archaeobotanically analysed samples from the vessels from Trenches 4 and 5.
Tab. 7: Stare gmajne 2021, arheobotanično analizirani vzorci iz posod iz sond 4 in 5.

Sample / Vzorec	**VZ 12**	**VZ 81**	**VZ 134**	**PN 51**	**VZ 22**	**PN 6**	**VZ 61**	**VZ 62**
Trench / Sonda	4	4	4	4	5	5	5	5
SU / SE	004	004	004	007	003	003	005	005
Grid square / Kvadrat	B4	A2	A2/B2	A3	B–4	B–3	B–3	C–4
V before sieving / V pred spiranjem	1,000 ml	700 ml	850 ml	140 ml	1,200 ml	330 ml	650 ml	640 ml
V of examined fraction / V pregledane frakcije	400 ml	220 ml	320 ml	35 ml	90 ml	50 ml	80 ml	50 ml
No. ID seeds; fruits / Št. ID semen; plodov	1,140	699	966	154	602	581	302	612
No. ID taxa / Št. ID taksonov	29	34	34	23	37	40	34	35

V – volume / volumen; No. ID / Št. ID – number of identified / število identificiranih

Tab. 8: Stare gmajne 2021, vessel samples from Trench 4: concentrations of seeds/fruits (per litre of sediment) for individual taxa, listed in plant groups and sum of concentrations for each plant group.
Tab. 8: Stare gmajne 2021, vzorci iz posod iz sonde 4: koncentracije semen/plodov (v litru sedimenta) posameznih rastlinskih taksonov po skupinah rastlin in vsota koncentracij vseh taksonov v posamezni skupini rastlin.

	VZ 12 SE / SU 004	**VZ 81 SE / SU 004**	**VZ 134 SE / SU 004**	**PN 51 SE / SU 007**
CULTIVATED PLANTS / KULTURNE RASTLINE	**3,771**	**851**	**805**	**310**
Cerealia (cereals / žita)	12	7	1	
Hordeum vulgare; 6-rowed hulled (glumed barley / ječmen s plevami)	70	104	20	
Hordeum vulgare; 6-rowed naked (naked barley / ječmen brez plev)	14		48	7
Triticum dicoccum (emmer / dvozrna pšenica)	87	13	11	
Triticum monococcum (einkorn / enozrna pšenica)	68	26	8	
T. mono/dicoccum (einkorn/emmer wheat / eno/dvozrna pšenica)	83	32	223	4
Brassica rapa (turnip / ogrščica)	11	51	137	21
Linum usitatissimum (flax / lan)	33	38	99	14
Papaver somniferum (poppy / mak)	3,393	580	258	264
GATHERED PLANTS / NABIRANE RASTLINE	**2,747**	**682**	**744**	**106**
Abies alba (fir / jelka)	46	64	329	7
Cornus mas (cornel / rumeni dren)	8	4		
Cornus sanguinea (dogwood / rdeči dren)	8	6	1	
Corylus avellana (hazel / leska)	52	7	2	
Crataegus sp. (hawthorn / glog)	2			
Fragaria vesca (wild strawberry / jagodnjak)	2,029	84	106	21
Malus/Pyrus sp. (wild apple/pear / divje jabolko/hruška)	35	45	232	7
Physalis alkekengi (bladder cherry / volčje jabolko)	92	32	5	14
Rubus fruticosus agg. (blackberry / robida)	417	416	49	43
Quercus sp. (acorn / želod, hrast)	42	6	18	7
Trapa natans (water chestnut / vodni orešek)	7	17	1	7
Vitis vinifera sylvestris (wild grape vine / divja vinska trta)	9	1	1	
WEED OR RUDERAL PLANTS / PLEVELNE OZ. RUDERALNE RASTLINE	**2,444**	**1,399**	**944**	**450**
Arenaria serpyllifolia (thyme-leaf sandwort / nav. peščenka)	11	6	9	14
Chenopodium album (goosefoot / bela metlika)	2,433	1,290	859	436
Fallopia sp. (wild buckwheat / slakovec)		13	1	
Plantago lanceolata (ribwort plantain / ozkolistni trpotec)			9	
Stachys sp. (hedge nettle / čišljak)		6		
Urtica dioica (nettle / kopriva)		84	66	
LAKE-SHORE AND WATER PLANTS / VODNE IN OBREŽNE RASTLINE	**319**	**872**	**630**	**228**
Cladium mariscus (swamp sawgrass / navadna rezika)	11	26	2	14
Epilobium hirsutum (hairy willowherb / dlakavi vrbovec)	11	19	9	7
Hippuris vulgaris (mare's-tail / navadna smrečica)			1	
Mentha aquatica (water mint / vodna meta)	55	206	115	29
Myriophyllum spicatum (Eurasian watermilfoil / klasasti rmanec)		6		
Nuphar luteum (yellow water-lily / rumeni blatnik)	1		1	
Oenanthe aquatica (water dropwort / vodni sovec)	97	204	221	14
Potamogeton sp. (pondweed / dristavec)	12	33	21	14
Ranunculus aquatilis (water-crowfoot / vodna zlatica)	44	175	29	29
Schoenoplectus lacustris (lakeshore bulrush / jezerski biček)	82	161	211	86
Sparganium sp. (bur-reed / ježek)	6	42	20	35
TREES, SHRUBS / DREVESA, GRMI		**12**	**19**	
Alnus sp. (alder / jelša)		6		
Betula pubescens (downy birch / puhasta breza)		6	19	
GRASSLAND PLANTS / TRAVIŠČNE RASTLINE		**1**	**18**	
Apiaceae (carrot fam. / kobulnice)			9	
Poaceae (grasses / trave)		1		
Rumex sp. (sorrels / kislice)			9	

Tab. 9: Stare gmajne 2021, vessel samples from Trench 5: concentrations of seeds/fruits (per litre of sediment) for individual taxa, grouped in plant groups and sum of concentrations for each plant group.
Tab. 9: Stare gmajne 2021, vzorci iz posod iz sonde 5: koncentracije semen/plodov (v litru sedimenta) posameznih rastlinskih taksonov po skupinah rastlin in vsota koncentracij vseh taksonov v posamezni skupini rastlin.

	VZ 22 SE / SU 003	**PN 6 SE / SU 003**	**VZ 61 SE / SU 005**	**VZ 62 SE / SU 005**
CULTIVATED PLANTS / KULTURNE RASTLINE	**276**	**852**	**275**	**189**
Cerealia (cerelas / žita)	2	3	5	6
Hordeum vulgare; 6-rowed hulled (glumed barley / ječmen s plevami)	13		48	76
Hordeum vulgare; 6-rowed naked (naked barley / ječmen brez plev)		76	2	
Triticum dicoccum (emmer / dvozrna pšenica)		8	47	4
Triticum monococcum (einkorn / enozrna pšenica)	4	15	22	12
T. mono/dicoccum (einkorn/emmer wheat / eno/dvozrna pšenica)	2	23		16
Brassica rapa (turnip / ogrščica)	4	30	32	16
Linum usitatissimum (flax / lan)	51	152	65	8
Papaver somniferum (poppy / mak)	200	545	54	51
GATHERED PLANTS / NABIRANE RASTLINE	**162**	**274**	**155**	**190**
Abies alba (fir / jelka)	41	15	70	90
Cornus mas (cornel / rumeni dren)		9		
Cornus sanguinea (dogwood / rdeči dren)	1	3	2	3
Corylus avellana (hazel / leska)	2	3	2	5
Fragaria vesca (wild strawberry / jagodnjak)	54	45	16	23
Malus/Pyrus (wild apple/pear / jabolko/hruška)	1	30	19	8
Physalis alkekengi (bladder cherry / volčje jabolko)	4	23		4
Rubus fruticosus agg. (blackberry / robida)		114		12
Rubus idaeus/fruticosus (raspberry/blackberry / malina/robida)	51	23	32	8
Quercus sp. (acorn / želod, hrast)	5	6	12	31
Trapa natans (water chestnut / vodni orešek)	1		2	4
Vitis vinifera sylvestris (wild grape vine / divja vinska trta)	2	3		2
WEED OR RUDERAL PLANTS / PLEVELNE OZ. RUDERALNE RASTLINE	**402**	**784**	**221**	**347**
Chenopodium album (goosefoot / bela metlika)	359	705	194	320
Fallopia sp. (wild buckwheat / slakovec)	1	26		4
Silene sp. (campion / slizek)	13	7	5	
Stachys sp. (hedge nettle / čišljak)		8		
Stellaria sp. (starwort / zvezdica)		8		
Urtica dioica (nettle / kopriva)	29	30	22	23
LAKE-SHORE AND WATER PLANTS / OBREŽNE IN VODNE RASTLINE	**1,472**	**1,881**	**783**	**1,492**
Alisma cf. *lanceolatum* (water plantain / suličastolistni porečnik)	38	23	43	12
Cladium mariscus (swamp sawgrass / navadna rezika)	58	106	22	225
Cyperaceae (sedges / ostričevke)	17	23	32	23
Epilobium hirsutum (hairy willowherb / dlakavi vrbovec)	13	106	16	12
Hippuris vulgaris (mare‘s-tail / navadna smrečica)				8
Lycopus europaeus (gypsywort / nav. regelj)	8	8		12
Mentha aquatica (water mint / vodna meta)	525	568	172	324
Najas marina (water nymph / vel. podvodnica)	4	8		
Nuphar luteum (yellow water-lily / rumeni blatnik)	1	8	5	3
Oenanthe aquatica (water dropwort / vodni sovec)	193	598	202	127
Polygonaceae (knotweed family / dresnovke)	13			
Potamogeton sp. (pondweed / dristavec)	6	17	11	34
Ranunculus aquatilis (water-crowfoot / vodna zlatica)	292		81	172
Schoenoplectus lacustris (lakeshore bulrush / jezerski biček)	263	348	194	522
Sparganium sp. (bur-reed / ježek)	41	68	5	18
TREES, SHRUBS / DREVESA, GRMI	**25**		**40**	**12**
Acer sp. (maple / javor)			2	
Alnus sp. (alder / jelša)	8			
Betula pubescens (downy birch / puhasta breza)			38	12

Salix sp. (willow / vrba)	17			
GRASSLAND PLANTS / TRAVIŠČNE RASTLINE	**8**	**509**	**37**	**23**
Apiaceae (carrot fam. / kobulnice)			5	
Asteraceae (composite family / košarnice)			16	
Hieracium sp. (hawkweed / škržolica)		8		
Hypericum perforatum (St. John's wort / šentjanževka)	8	8	11	23
Poaceae (grasses / trave)		15		
Ranunculus acris type (cf. meadow buttercup / ripeča zlatica)		470	5	
Rumex sp. (sorrels / kislice)		8		

Tab. 10: Stare gmajne 2021, counts (absolute number) and percentages of identified charcoal fragments from Trenches 4 and 5.
Tab. 10: Stare gmajne 2021, števila in odstotki identificiranih fragmentov oglja v obeh sondah.

Taxa / Takson	**Number / Število**	**%**
Corylus avellana (hazel / leska)	16	39
Rosaceae (Rose family / rožnice; *Crataegus, Rhamnus, Malus, Pyrus*)	7	17
Alnus sp. (alder / jelša)	5	12
Fraxinus sp. (ash / jesen)	5	12
Acer sp. (maple / javor)	1	2.5
cf. *Carpinus betulus* (hornbeam / nav. gaber)	1	2.5
Castanea sativa / Fraxinus sp. (chestnut/ash / kostanj/jesen)	1	2.5
Corylus avellana / Alnus sp. (hazel/alder / leska/jelša)	1	2.5
Fagus sylvatica (beech / bukev)	1	2.5
Quercus sp. (oak / hrast)	1	2.5
Sorbus sp. (service tree / jerebika)	1	2.5
cf. *Sorbus* sp. (cf. service tree / jerebika)	1	2.5

Tab. 11: Stare gmajne 2021, counts (absolute number) of identified charcoal fragments in individual sample from Trench 4.
Tab. 11: Stare gmajne 2021, števila identificiranih fragmentov oglja v posameznem vzorcu iz sonde 4.

	Sample / Vzorec	**Taxa / Takson**	**Number / Število**
vessel / posoda	**VZ 12**	*Corylus avellana* (hazel / leska)	3
		Fraxinus sp. (ash / jesen)	2
		Sorbus sp. (service tree / jerebika)	1
	VZ 81	*Fraxinus* sp. (ash / jesen)	1
		Rosaceae (Rose fam. / rožnice)	2
moss / mah	**VZ 84**	*Fagus sylvatica* (beech / bukev)	1
		Rosaceae (Rose fam. / rožnice)	1
	VZ 121	*Corylus avellana* (hazel / leska)	2
		Rosaceae (Rose fam. / rožnice)	1
	VZ 133	*Corylus avellana* (hazel / leska)	3
		Quercus sp. (oak / hrast)	1
vessel / posoda	**VZ 134**	*Alnus* sp. (alder / jelša)	1
		cf. *Carpinus betulus* (hornbeam / nav. gaber)	1
		Rosaceae (Rose fam. / rožnice)	1
		cf. *Sorbus* sp. (service tree / jerebika)	1
moss / mah	**VZ 184**	*Alnus* sp. (alder / jelša)	1
		Corylus avellana (hazel / leska)	1
		Fraxinus sp. (ash / jesen)	1
	VZ 185	*Corylus avellana* (hazel / leska)	1
vessel / posoda	**PN 51**	*Alnus* sp. (alder / jelša)	1
		Corylus avellana (hazel / leska)	1
		Rosaceae (Rose fam. / rožnice)	1

Tab. 12: Stare gmajne 2021, counts (absolute number) of identified charcoal fragments in individual sample from Trench 5.
Tab. 12: Stare gmajne 2021, števila identificiranih fragmentov oglja v posameznem vzorcu iz sonde 5.

	Sample / Vzorec	**Taxa / Takson**	**Number / Število**
vessel / posoda	**VZ 22**	*Alnus* sp. (alder / jelša)	2
		Corylus avellana (hazel / leska)	1
	VZ 61	*Corylus avellana* (hazel / leska)	2
		Rosaceae (Rose fam. / rožnice)	1
	VZ 62	Corylus avellana (hazel / leska)	1
		Corylus avellana / *Alnus* sp. (hazel/alder / leska/jelša)	1
		Fraxinus sp. (ash / jesen)	1
	PN 6	*Acer* sp. (maple / javor)	1
		Castanea sativa/*Fraxinus* sp. (chestnut/ash / kostanj/jesen)	1
		Corylus avellana (hazel / leska)	1

Tab. 13: Stare gmajne 2021, comparison of vessel contents from Trenches 4 and 5: average concentrations of seeds/fruits remains per litre of sediment samples for individual plant group.
Tab. 13: Stare gmajne 2021, primerjava vzorcev iz posod iz sond 4 in 5: povprečne koncentracije semen/plodov v litru sedimenta po posameznih skupinah rastlin.

	Trench 4 / Sonda 4	**Trench 5 / Sonda 5**
Cultivated plants / Kulturne rastline	1,434	398
Gathered plants / Nabirane rastline	1,070	195
Weeds, ruderals / Plevelne, ruderalne rastline	1,309	439
Lakeshore, water plants / Obrežne, vodne rastline	512	1,407
Non-edible trees, shrubs / Neprehranske drevesne, grmovne rastline	8	19
Grassland plants / Travišče rastline	5	144

Tjaša Tolar
ZRC SAZU, Inštitut za arheologijo
Novi trg 5
SI-1000 Ljubljana
tjasa.tolar@zrc-sazu.si
ID ORCID 0000-0003-2044-1025

Dolores Matika
Sandari 39
HR-52341 Žminj
dolores.matika@gmail.com

Tab. ESM 1–2:
http://av.zrc-sazu.si/AV_75/Tolar_AV_75_2024_Tab_ESM1.xlsx
http://av.zrc-sazu.si/AV_75/Tolar_AV_75_2024_Tab_ESM2.xlsx

Slikovno gradivo: Sl. 1, 6, 8–20 (Dragutin Valoh, ZRC SAZU). – *Sl. 2* (Elena Leghissa, ZRC SAZU; Dragutin Valoh, ZRC SAZU). – *Sl. 3, 4* (Tamara Korošec, ZRC SAZU; Elena Leghissa, ZRC SAZU; Dragutin Valoh, ZRC SAZU). – *Sl. 5* (Elena Leghissa, ZRC SAZU).
llustrations: Fig. 1, 6, 8–20 (Dragutin Valoh, ZRC SAZU). – *Fig. 2* (Elena Leghissa, ZRC SAZU ; Dragutin Valoh, ZRC SAZU). – *Fig. 3, 4* (Tamara Korošec, ZRC SAZU ; Elena Leghissa ZRC SAZU, Dragutin Valoh, ZRC SAZU). – *Fig. 5* (Elena Leghissa, ZRC SAZU).

The authors acknowledge the financial support of the Slovenian Research and Innovation Agency as a part of the Research programme P6-0064 and Research project J7-2598.
Članek je nastal v okviru raziskovalnega programa P6-0064 in raziskovalnega projekta J7-2598, ki ju sofinancira Javna agencija za znanstvenoraziskovalno in inovacijsko dejavnost Republike Slovenije.