Arheobotanička analiza „liburnske“ keramike s lokaliteta Nadin – Gradina

Knežić, Dolores; Šoštarić, Renata; Čelhar, Martina

Source / Izvornik: **Prilozi Instituta za arheologiju u Zagrebu, 2023, 40, 5 - 62**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.33254/piaz.40.2.1

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:291:651943

UDK 902
ISSN 1330-0644
Vol. 40/2
ZAGREB, 2023.

PRILOZI

Instituta za arheologiju u Zagrebu

Pril. Inst. arheol. Zagrebu
Str./Pages 1–186, Zagreb, 2023.

PRILOZI INSTITUTA ZA ARHEOLOGIJU
U ZAGREBU, 40/2/2023
STR./PAGES 1–186, ZAGREB, 2023.

Izdavač/Publisher
INSTITUT ZA ARHEOLOGIJU
INSTITUTE OF ARCHAEOLOGY

Adresa uredništva/
Address of the editor's office
Institut za arheologiju/Institute of archaeology
HR–10000 Zagreb, Jurjevska ulica 15
Hrvatska/Croatia
Telefon/Phone ++385/(0)1 61 50 250
Fax ++385(0)1 60 55 806
e-mail: urednistvo.prilozi@iarh.hr
http://www.iarh.hr

Glavni i odgovorni urednik/Editor in chief
Marko DIZDAR

Tehnički urednici/Technical editors
Marko DIZDAR
Katarina BOTIĆ

Prijevod na engleski/English translation
Tomislav BILIĆ, Sara ESSERT, Makso HERMAN, Tamara LEVAK POTREBICA, Marko MARAS

Prijevod na hrvatski / Croatian translation
Danijel DŽINO

Lektura/Language editor
Marko DIZDAR (hrvatski jezik/Croatian)
Marko MARAS (engleski jezik/English)

Korektura/Proofreads
Katarina BOTIĆ

Grafičko oblikovanje/Graphic design
Umjetnička organizacija OAZA

Računalni slog/Layout
Hrvoje JAMBREK

Tisak/Printed by
Sveučilišna tiskara d.o.o., Zagreb

Naklada/Issued
400 primjeraka/400 copies

Prilozi Instituta za arheologiju u Zagrebu indeksirani su u/
Prilozi Instituta za arheologiju u Zagrebu are indexed by:
DYABOLA – Sachkatalog der Bibliothek – Römisch-Germanische Kommission des Deutschen Archaeologischen Instituts, Frankfurt a. Main
Clarivate Analytics services – Web of Science Core Collection
CNRS/INIST – Centre National de la Recherche Scientifi que/L'Institut de l'Information Scientifi que et Technique, Vandoeuvre-lès-Nancy
EBSCO – Information servises, Ipswich
ERIH PLUS – European Reference Index for the Humanities and Social Sciences, Norwegian Directorate for Higher Education and Skills, Bergen
SciVerse Scopus – Elsevier, Amsterdam

E-izdanja. Publikacija je dostupna u digitalnom obliku i otvorenom pristupu na
https://hrcak.srce.hr/prilozi-iaz
E-edition. The publication is available in digital and open access form at
https://hrcak.srce.hr/prilozi-iaz?lang=en

DOI 10.33254

SADRŽAJ
CONTENTS

ARHEOBOTANIČKA ANALIZA „LIBURNSKE" KERAMIKE S LOKALITETA NADIN – GRADINA

ARCHAEOBOTANICAL ANALYSIS OF "LIBURNIAN" POTTERY FROM THE NADIN – GRADINA SITE

Izvorni znanstveni rad / prapovijesna arheologija
Original scientific paper / Prehistoric archaeology
UDK UDC 738:581.48(497.5 Nadin)''638.3''
Primljeno / Received: 13. 1. 2023. Prihvaćeno / Accepted: 13. 9. 2023. doi.org/10.33254/piaz.40.2.1

DOLORES KNEŽIĆ
Vinogradska ulica 8
HR–44000 Sisak
k.dolores23@gmail.com

RENATA ŠOŠTARIĆ
Botanički zavod, Biološki odsjek
Prirodoslovno-matematički fakultet
Marulićev trg 20/2, HR–10000 Zagreb
rsostar@biol.pmf.unizg.hr

MARTINA ČELHAR
Sveučilište u Zadru, Odjel za arheologiju
Obala kralja Petra Krešimira IV / 2
HR–23000 Zadar
mcelhar@unizd.hr

U radu su analizirani biljni makroostaci na glinenim ulomcima s organskim primjesama s nalazišta Nadin – Gradina u sjevernoj Dalmaciji. Ulomci keramičke posude većih dimenzija skladišne namjene potječu iz jednog zatvorenog naseobinskog konteksta (SJ 419) datiranog radiokarbonskom metodom u razdoblje starijeg željeznog doba, odnosno u vremenski okvir posljednje četvrtine 9. st. pr. Kr. do sredine 8. st. pr. Kr. Organske primjese korištene su od najranijih vremena u smjesi za izradu keramike kako bi se utjecalo na svojstva konačnog keramičkog produkta. Takvi sušeni ili pečeni keramički predmeti sadrže tragove korištenja biljnih primjesa u vidu otisaka i biljnih ostataka. Identificirani biljni ostaci većim dijelom potječu od ostataka vršidbe žitarica: pšeno, stabljike i listovi te pljeve i ostaci klasa. Na temelju analize otisaka i ostataka biljnih primjesa bilo je moguće determinirati krupnozrne žitarice: ječam (*Hordeum* sp.) i pšenicu (*Triticum* sp.) te sitnozrne: proso/muhar (*Panicum*/*Setaria* sp.). Od ostalih nalaza pronađeni su tragovi masline (*Olea europaea*) i drijena (cf. *Cornus mas*) te skupine trava (*Poaceae*). Otisci i ostaci biljnih primjesa u keramici često ostaju nezamijećeni, iako predstavljaju vrijednu dopunu klasičnoj analizi biljnih makrofosila, a time i dodatne podatke o gospodarskim strategijama i okolišu zajednice koja je keramiku proizvela.

KLJUČNE RIJEČI: biljni makroostaci, biljni otisci na keramici, Liburni, Nadin – Gradina, organske primjese, starije željezno doba, vršidba, žitarice

The paper analyses plant macroremains on clay sherds containing organic inclusions from the Nadin – Gradina site in northern Dalmatia. Sherds of a large pottery vessel intended for storage have been found in a closed settlement context (SU 419), dated using radiocarbon method to the Early Iron Age, that is, to the period between the last quarter of the 9th century BC and the middle of the 8th century BC. Organic inclusions in pottery pastes have been used since the earliest times with the intention of influencing the properties of the final ceramic product. Such dried or fired pottery contains traces of the plant temper employed, in the form of imprints and plant remains. The identified plant remains consist mainly of remains of cereal threshing: grains, stems and leaves, glumes and remains of ears. The analysis of the imprints and remains of plant temper allowed us to identify large-grained cereals – barley (*Hordeum* sp.) and wheat (*Triticum* sp.) – and small-grained cereals: broomcorn/foxtail millet (*Panicum*/*Setaria* sp.). Among other finds, there are traces of olive (*Olea europaea*) and cornelian cherry (cf. *Cornus mas*), and of grasses (*Poaceae*). The imprints and plant inclusions in pottery often remain unnoticed, but they are a valuable complement to the classical analysis of plant macrofossils, and provide additional information on the economic strategies and environment of the community which produced the pottery.

KEY WORDS: plant macroremains, plant imprints on pottery, Liburni, Nadin – Gradina, organic inclusions, Early Iron Age, threshing, cereals

UVOD

Glineni predmeti s primjesama i njihove karakteristike

Recentnim arheološkim istraživanjima dokazano je kako su najranije keramičke posude izrađivane već od strane lovačko-sakupljačkih zajednica na području Azije (Chi 2002; Kuzmin 2002; 2010; Bougard 2003; Keally et al. 2004; Kuzmin,Vetrov 2007; Boaretto et al. 2009; Wu et al. 2012; Craig et al. 2013; Budja 2016; Iizuka et al. 2022a; 2022b; Nakazawa et al. 2022). Analiza keramičkih posuda iz razdoblja samog kraja gornjeg paleolitika utvrdila je kako posude iz Japana i Rusije sadrže namjerno dodavane organske primjese, dok je u smjesi lončarije iz različitih dijelova Kine detektirana prisutnost kvarcita, pa čak iznimno i groga, odnosno usitnjene reciklirane keramike (Chi 2002: 32–33; Keally et al. 2004: 349).

Glinena smjesa koju koriste lončari sastoji se primarno od glinenog materijala (eng. *matrix*) i namjerno dodavanih raznovrsnih primjesa (eng. *temper*). Postupak izrade keramičkog predmeta započinje nabavom gline zadovoljavajuće kvalitete i sirovinskog materijala koji se koristi kao primjesa kako bi se povećala viskoznost smjese i modificirala svojstva gline. Najčešće primjese koje se dodaju glini su razne vrste pijeska, litoklasta (kvarcita, vapnenca, rožnjaka i sl.), groga i organskih dodataka (suha trava, pljeva, dlaka, suha balega, školjke, kosti i dr.), a koje utječu na oblikovanje, pečenje keramike, njezinu čvrstoću, termičku izdržljivost i poroznost. Njihov odabir često je povezan upravo s tim saznanjima, a nekada može biti uvjetovan tradicijom. Mehanizmi odabira sirovina za izradu lončarske smjese određeni su vanjskim faktorima zbog čega je za njihovo tumačenje potrebno razmotriti prirodno-geološke, tehnološke, morfološke i društvene aspekte (Kudelić 2017: 123–124).

Kao najčešća primjesa u glinenim predmetima javljaju se minerali među kojima dominiraju kvarc i kalcit koji se u smjesu najčešće dodaju u obliku pijeska. Oni doprinose snažnijem efektu zagrijavanja keramike što posljedično omogućava bržu pripremu hrane u usporedbi s keramikom koja sadrži organske primjese (Miloglav 2016: 32). No, dodavanje kalcita može imati i negativan efekt na keramičku posudu jer se on tijekom oksidacijskog pečenja na temperaturi iznad 600 do 870 °C pretvara u vapno koje

INTRODUCTION

Clay objects containing inclusions, and their characteristics

Recent archaeological research has demonstrated that the earliest pottery was already being produced by communities of hunter-gatherers in Asia (Chi 2002; Kuzmin 2002; 2010; Bougard 2003; Keally et al. 2004; Kuzmin, Vetrov 2007; Boaretto et al. 2009; Wu et al. 2012; Craig et al. 2013; Budja 2016; Iizuka et al. 2022a; 2022b; Nakazawa et al. 2022). Analysis of pottery dated to the very end of the Upper Palaeolithic has established that vessels discovered in Japan and Russia contain organic inclusions, deliberately added to the mixture, while the presence of quartzite – and occasionally also grog, or crushed recycled pottery – has been detected in pottery pastes from various parts of China (Chi 2002: 32–33; Keally et al. 2004: 349).

The clay mixture used by potters consists primarily of a clay matrix and diverse tempers deliberately added to it. The pottery production process begins with the procurement of clay of a sufficient quality and of raw material that will be used to temper the clay in order to increase the viscosity of the paste and modify the clay's properties. The most frequent tempers added to clay are various types of sand, lithoclasts (quartzite, limestone, chert and similar), grog and organic inclusions (dry grass, chaff, animal hair, dry dung, shells, bones etc.), which impact the shaping and firing of the pottery, its hardness, thermal resistance and porosity. Their selection is often linked to such awareness, but sometimes it may also be impacted by tradition. The selection mechanisms for pottery-mixture raw materials are determined by outside factors, and thus their interpretation requires consideration of natural/geological, technological, morphological and social aspects (Kudelić 2017: 123–124).

The most frequent tempers found in clay objects are minerals, primarily quartz and calcite, most frequently added to the paste in the form of sand. They contribute to a stronger pottery-heating effect, which consequently allows for quicker food preparation in comparison to pottery tempered with organic material (Miloglav 2016: 32). However, calcite temper can also affect the ceramic vessel negatively, since calcite turns into lime during oxidation firing at temperatures above 600 to 870° C, and the lime expands while cooling, causing the vessel to fragment. Nonetheless,

se za vrijeme hlađenja širi i tako uzrokuje fragmentaciju posude. Ipak, dodavanje manje količine (< 10 %) fino usitnjenog kvarca smanjit će mogućnost pucanja posude (Miloglav 2016: 39–40).

Organske primjese, baš kao i mineralne, običavale su se dodavati glini radi modifikacije svojstava smjese kao i svojstava konačnog produkta. Stavljanjem određenih dodataka u glinu poput sveprisutnih trava, slame, biljnih vlakana, pljeve ili balege postiže se lakša izrada i oblikovanje svježe smjese, brže sušenje, a samim time i brže pečenje, smanjenje sakupljanja i prevencija od pucanja tijekom pečenja te otpornost na termalni stres kao i čvrstoća nakon pečenja. Organski materijal tijekom pečenja najčešće izgori i nestane, a u strukturi keramike ostaju vidljive pore ili šupljine koje ocrtavaju izgled dijela ostatka u negativu (Rye 1976:115). Redukcijski način pečenja, bez prisustva kisika pretvara organske primjese u ugljen pa se tako lako može prepoznati udio organskih primjesa u smjesi, a pojedini nalazi u takvim uvjetima postaju karbonizirani i kao takvi se pronalaze. Veća količina usitnjenog organskog materijala u glinenoj smjesi očituje se tamnijim tonovima koji idu prema crnoj boji vidljivim u presjeku keramike, dok, s druge strane, sivkaste nijanse indiciraju manju količinu organskih primjesa. Jedan od nedostataka posuda s organskim primjesama je slabiji efekt zagrijavanja pa se pretpostavlja kako nisu korištene za klasično kuhanje na vatri već da se u njima kuhalo pomoću vrućega kamenja. S druge strane, njihova prednost počiva na manjoj težini koju su imale u usporedbi s posudama u kojima nema organskih primjesa ili imaju primjese drugih vrsta pa su time bile pogodnije za transport. Također, dodavanje organskih primjesa pridonosi većoj otpornosti na mehaničke udarce i lomljenje (Kudelić 2016: 209–210; 2017: 138; Miloglav 2016: 32–33). Skriveni potencijal organskih primjesa leži u njihova dva osovna aspekta – poljoprivrednom (ratarstvo) i tehnološkom (proizvodnja keramike) na lokalnoj razini (Dzhanfezova 2020: 61).

Bitno je točno odrediti pripadnost organskih primjesa u glini u različitim glinenim medijima, npr. radi li se o kultiviranim biljkama ili divljim biljkama te jesu li organske primjese namjerno dodane ili su orginalno bile dio gline koja je nabavljana za potrebe keramičarstva. Namjerno dodavane organske primjese mogu dati podatke o složenoj interakciji tehnoloških odluka

when used in small quantities (< 10%) and very fine-grained, quartz can make pottery less prone to cracking (Miloglav 2016: 39–40).

As with mineral inclusions, organic temper was added to the clay to modify the paste's properties and those of the final product. Adding certain inclusions to the clay – such as the ubiquitous grasses, straw, plant fibre, chaff or dung – results in a more plastic and malleable fresh paste, reduces the time necessary for drying and thus also firing, reduces shrinkage and prevents cracking during firing, and increases thermal-stress resistance and hardness after firing. During the firing, the organic material most frequently burns out and disappears, leaving behind visible pores or holes in the pottery fabric, outlining in negative the shape of a part of the remnant (Rye 1976: 115). Reduction firing, where oxygen is not present, turns organic temper into charcoal, making it easy to identify the proportion of organic inclusions in the paste. Furthermore, under such conditions, some pottery becomes carbonized and can be found as such. A large quantity of crushed organic material in the clay mixture is reflected in darker tones, bordering on black, visible in pottery cross-sections, while grey tones, on the other hand, indicate smaller quantities of organic temper. One of the shortcomings of organic-tempered vessels is poorer heating effectiveness, which has prompted the assumption that such vessels were not used for cooking over a fire, but rather for stone boiling. On the other hand, their advantage is that they are lighter than vessels not tempered with organic material or tempered with other inclusions, making them more suitable for transport. Additionally, tempering clay with organic material makes it more resistant to mechanical blows and breakage (Kudelić 2016: 209–210; 2017: 138; Miloglav 2016: 32–33). A hidden potential of organic tempers lies in their two main aspects: agricultural (farming) and technological (pottery production) at the local level (Dzhanfezova 2020: 61).

It is important to determine precisely the nature of organic temper in the clay in various clay media: for example, whether it consists of cultivated plants or wild plants, and whether the organic inclusions were added deliberately or they were originally contained in the clay procured for pottery-making. Deliberate organic inclusions can provide information on the complex interaction between technological decisions and existential patterns within a local environment. On the other hand, unintentional inclusions – that is, those that were contained in the original clay – can indica-

i obrazaca egzistencije unutar lokalnog okruženja. S druge strane, nenamjerno dodavane primjese odnosno one koje su bile originalni dio gline indiciraju strategije nabave kao i lokacije na kojima je glina nabavljana, a keramika izrađivana (Dzhanfezova 2020: 63). Arheobotanička tumačenja ovise o vrstama biljaka prisutnih u keramici pa je iz tog razloga bitno razlikovati: (a) nusproizvode obrade žitrica od organskih ostataka koji se prirodno nalaze u glinenim naslagama, (b) divlje biljke koje se namjerno mogu koristiti kao primjesa u glinenoj smjesi, (c) korove oranica koji se pronalaze zajedno s otpadom žitarica te (d) probavljene biljke koje su produkt dodavanja balege u smjesu (Dzhanfezova 2020: 67).

Uz mineralne i organske primjese, jedan od dodataka glinenoj smjesi bila je usitnjena reciklirana keramika ili grog. Njegovo stavljanje u smjesu primjer je svjesne apciklaže, a on se kao antropogena primjesa pronalazi već kod zajednica gornjeg paleolitika (Chi 2002: 33). Grog dobro upija vlagu čime ubrzava proces sušenja, a posudi daje čvrstoću i otpornost na termalne stresove. No, ta se otpornost može postići jedino dodavanjem groga u omjeru manjem od 5 %, dok veći omjer smanjuje mehaničku izdržljivost prilikom izlaganja vatri (Miloglav 2016: 39). Prisustvo groga u smjesi stoga može biti dobar indikator posuđa ponajprije namijenjenog kuhanju jer bolje podnosi visoke temperature. Ipak, etnografski primjeri donose različite podatke o tradicijama korištenja groga u glinenoj smjesi. Primjeri idu od stavljanja groga u smjesu korištenu u izradi donjeg dijela posude koji je u izravnom kontaktu s vatrom do izbjegavanja stavljanja groga kao primjese u keramiku namijenjenu korištenju za kuhanje (Miloglav 2016: 33–34).

Makrobotanička analiza na glinenim medijima

Spoznaja o tome kako glineni materijal može sadržavati informacije o biljnom sastavu seže u konac 19. stoljeća kada je F. Christiansen, danski učitelj i arheolog-amater, primjetio specifične i njemu prepoznatljive udubine na brončanodobnoj keramici i interpretirao ih kao otiske žitarica. Na taj način definiran je do tada nepoznat izvor iz kojega se mogu crpiti podatci o kultivaciji biljnih vrsta i o njihovom korištenju u izradi glinenih predmeta (Helbæk 1940: 176; Hjelmqvist 1982: 229; Grabowski 2014: 8). Pu-

te procurement strategies and sites from which the clay was procured and where the pottery was made (Dzhanfezova 2020: 63). Archaeobotanical interpretation depends on types of plants present in the pottery, and for this reason it is important to distinguish among: a) by-products of cereal processing and organic remains present naturally in clay deposits, b) wild plants that can be deliberately used to temper the clay matrix, c) arable weeds that can be found together with cereal waste, and d) digested plants resulting from tempering pottery paste with dung (Dzhanfezova 2020: 67).

In addition to mineral and organic temper, one of the inclusions added to the clay mixture was crushed recycled pottery, or grog. Its addition to the paste is an example of deliberate upcycling, and this anthropogenic inclusion can be found as early as in the Upper Palaeolithic communities (Chi 2002: 33). Grog absorbs moisture and thus accelerates the process of drying, and it increases the vessel's hardness and resistance to thermal stress. However, this resistance can only be achieved if the quantity of grog added is under 5%, since a higher proportion would reduce the vessel's mechanical resistance when exposed to fire (Miloglav 2016: 39). Thus, the presence of grog in the paste can be a good indicator that the vessel was primarily intended for cooking, because it can endure high temperatures. Still, there are ethnographic examples of diverse traditions of using grog as clay temper. In some cases, grog is added to the paste used to produce the lower part of the vessel, which will be in contact with fire, while, at the other end of the spectrum, tempering cooking pottery with grog is avoided (Miloglav 2016: 33–34).

Macrobotanical analysis on clay media

Awareness of the fact that clay material can contain information on plant composition dates to the late 19th century, when F. Christiansen, a Danish teacher and amateur archaeologist, noticed some specific and recognizable (to him) depressions on Bronze Age pottery, and interpreted them as cereal imprints. Thus, he identified a previously unknown source from which data can be extracted about the cultivation of plants and their use in pottery-making (Helbæk 1940: 176; Hjelmqvist 1982: 229; Grabowski 2014: 8). Publications discussing plant imprints are associated with the early 20th century and authors J. H. Mortimer (1905) and J. Cree (1908), but the first to

blikacije o biljnim otiscima vezuju se za početak 20. stoljeća i autore J. H. Mortimera (1905). i J. Creea (1908) no pristup je prvi aktivno počeo koristiti danski botaničar i arheolog G. F. L. Sarauw krajem 19. stoljeća. On se smatra pionirom proučavanja biljnih otisaka (Sarauw 1899; Helbæk 1940: 176; Hjelmqvist 1982; Lempiäinen, Levkovskaya 1994: 191). No, on nije publicirao sva svoja istraživanja pa to čini G. Hatt koji objedinjuje nalaze otisaka i direktne nalaze žitarica u svrhu stvaraja općeg pregleda prapovijesnog uzgoja žitarica na prostoru Danske (Grabowski 2014: 8). Opus poznavanja poljoprivrede putem proučavanja otisaka K. Jessen (1951) proširuje dodavanjem podataka o karboniziranim makrofosilima koji postaju sve zastupljeniji tip nalaza tijekom prve polovice 20. stoljeća. Udruživanjem podataka dobiva informacije o poljoprivrednim praksama prapovijesnih zajednica te kasnije izdaje prvi arheobotanički pregled regije južne Skandinavije (Grabowski 2014: 8). Švedski arheobotaničar H. Hjelmqvist (1955) je analizu otisaka kombinirao s analizom vodom natopljenih i karboniziranih biljnih ostataka s brojnih lokaliteta datiranih od neolitika do željeznog doba na području južne Švedske (Lempiäinen, Levkovskaya 1994: 191; Magid, Krzywinski 1995: 121).

Nakon sredine 20. stoljeća identifikacijom biljnih svojti iz otisaka na glinenim predmetima počeo se baviti veći broj arheobotaničara poput primjerice H. P. Helbæka (1953), inače utemeljitelja arheobotaničke discipline, te M. Hopf, koja je, između ostalog, analizirala otiske na neolitičkom kućnom lijepu s lokaliteta Danilo kod Šibenika (Hopf 1964). Tom je prilikom identificirala četiri fragmenta klasa (eng. *spikelet fork* – baza pljeve, pljevica i dr.) te fragmentirano zrno dvozrne pšenice (*Triticum dicoccum*), tri fragmenta klasa jednozrne pšenice (*Triticum monococcum*) i fragment klasa nepljevičastog ječma (*Hordeum vulgare* var. *nudum*) (Hopf 1964; Reed, Colledge 2016: 10–11). U početku su se pri arheobotaničkim analizama sakupljali samo oni *in situ* golim okom vidljivi karbonizirani uzorci na terenu koji su nadopunjavali spoznaje dobivene proučavanjem biljnih otisaka. Do napretka u metodologiji dolazi *flotacijskom revolucijom* kroz sedamdesete godine prošlog stoljeća koja omogućava brzu obradu velike količine sedimenta pa analiza biljnih otisaka postupno biva napuštena i zamijenjena novom, ekonomičnijom i bržom metodom (Lodwick 2019).

use this approach actively was the Danish botanist and archaeologist G. F. L. Sarauw in the late 19th century. He is considered to be the pioneer of analysis of plant imprints (Sarauw 1899; Helbæk 1940: 176; Hjelmqvist 1982; Lempiäinen, Levkovskaya 1994: 191). However, he did not publish all his research; this was done by G. Hatt, who unified finds of imprints and direct finds of cereals, with a view to obtaining a general overview of cereal cultivation in prehistory in the territory of Denmark (Grabowski 2014: 8). The knowledge of agriculture gained through imprint study was expanded by K. Jessen (1951) through the addition of data on carbonized microfossils, which became an increasingly frequent find in the first half of the 20th century. By putting such data together, he obtained information on the farming practices of prehistoric communities, and subsequently published the first archaeobotanical overview of the southern Scandinavian region (Grabowski 2014: 8). The Swedish archaeobotanist, H. Hjelmqvist (1955), combined imprint analysis with the analysis of waterlogged and carbonized plant remains from numerous sites in southern Sweden whose dates range from the Neolithic to the Iron Age (Lempiäinen, Levkovskaya 1994: 191; Magid, Krzywinski 1995: 121).

In the second half of the 20th century more archaeobotanists started to identify plant taxa from imprints on pottery, such as, for example, H. P. Helbæk (1953), who founded the discipline of archaeobotany, and M. Hopf, who, among other things, analysed imprints on Neolithic house daub from the site of Danilo, near Šibenik (Hopf 1964). On that occasion, she identified four ear fragments (e.g. spikelet forks and glume) and a fragmented grain of emmer (*Triticum dicoccum*), three fragments of a spikelet fork of einkorn (*Triticum monococcum*) and a fragment of a spikelet fork of naked barley (*Hordeum vulgare* var. *nudum*) (Hopf 1964; Reed, Colledge 2016: 10–11). In the early days, only carbonized samples that were visible *in situ* to the naked eye were collected for archaeobotanical analysis and used to complement information obtained by the study of plant imprints. The methodological advancement was marked by the *flotation revolution* in the 1970s, which allowed fast processing of large quantities of sediment. Consequently, the plant-imprints analysis was gradually abandoned and replaced by the new, faster and more cost-effective method (Lodwick 2019).

In the late 20th century, authors were still publishing papers focusing on the analysis of plant

Krajem 20. stoljeća autori i dalje izdaju radove na temu analize biljnih otisaka na keramici poput S. Amblard i J. Pernès (1989) koji analiziraju otiske prosa na keramici s lokaliteta iz Mauritanije u Africi, zatim T. Lempiäinen i G. M. Levkovskaye (1994) koje istražuju otiske pšena na keramici s nalazišta na prostoru Rusije. Nadalje, posebnu metodu proučavanja biljnih otisaka uvode A. Magid i K. Krzywinski (1995), a radi se o izradi odljeva biljnih otisaka u pozitivu koji su u negativu prepoznati na glinenim medijima. Međutim, treba napomenuti da su i puno ranije pojedini autori, poput već spomenute M. Hopf (1965: 183–184, Taf. 50: 3, 5), radili odljeve otisaka pretpostavljenog biljnog podrijetla. U novije vrijeme pojavio se alternativni pristup u proučavanju otisaka i biljnih ostataka na glinenim medijima, a to je impregnacija ili prevlačenje sloja polimera koji daje sliku fluorescentnog prikaza zapunjenih površina. Na taj način olakšano je brojanje pojedinih udubina organskog materijala, proučavanje strukturne organizacije otisaka te identifikacija ostataka biljnih primjesa (Sestier et al. 2003; 2007).

Nakon ustaljivanja metode analize otisaka na keramici, počinju se proučavati biljni otisci na drugim glinenim medijima kao što je kućni lijep. Neki od autora koji su se bavili analizom otiska na kućnom lijepu su S. Ayyad i suradnici (1991), G. Willcox i M. Tengberg (1995), G. Willcox i S. Fornite (1999) i drugi. Oni se u svojim istraživanjima posvećuju svim ostacima biljnih otisaka poput pljeve, baze pljeve, stapki, osja, sjemenki i listova. U radovima koji obrađuju kućni lijep znanstvenici su, uz otiske biljaka, uočili i ostatke mineraliziranih biljnih dijelova. Oni se formiraju putem topivih silikata koje biljka uzima iz podzemnih voda te tvori naslage u vanjskim i unutrašnjim staničnim strukturama čime replicira njen izgled (Ryan 2011: 294–295; Bonnaire 2016). Također je moguće pronaći osušene i karbonizirane biljne ostatke unutar glinenog medija (Newton 2004; Hovsepyan, Willcox 2008; Henn, Pál 2015). T. Henn i suradnici (2015) bavili su se osušenim ostacima biljaka iz opeke koja pripada kući iz 19. stoljeća. U tom kontekstu još možemo spomenuti i francusku arheobotaničarku E. Bonnaire (2005; 2006) koja je magistrirala na temi proučavanja otisaka i fitolita žitarica koje se koriste kao primjesa u sirovoj građevinskoj opeci. Otisci biljaka nisu nužno uvijek u svojstvu primjesa dodavani u glinenu smjesu, što dokazuje nalaz pečatnjaka (pintadera) iz kasnog brončanog doba u Mađarskoj. Na njima su s namjerom

imprints on pottery, such as S. Amblard and J. Pernès (1989), who analysed imprints of broomcorn millet on pottery from a site in Mauritania, in Africa, or T. Lempiäinen and G. M. Levkovskaya (1994), who investigated imprints of grains on pottery from sites in Russia. Furthermore, A. Magid and K. Krzywinski (1995) introduced a special method of analysis of plant imprints, which includes making a cast in positive of plant imprints that were identified on clay media in negative. However, it should be noted that, even earlier, some authors, such as the aforementioned Hopf (1965: 183–184, Pl. 50: 3, 5), produced casts of imprints of assumed plant origin. More recently, an alternative approach to the study of imprints and plant remains in clay media has emerged, which consists of impregnation or coating with a polymer layer that provides a fluorescent image of the filled surfaces. This facilitates the counting of voids left by organic material, analysis of the structural organization of the imprints, and identification of the remains of plant inclusions (Sestier et al. 2003; 2007).

Once the analysis of imprints on pottery became a standard method, the study of plant imprints began on other clay media, such as house daub. Some of the authors who analysed imprints on house daub are S. Ayyad and associates (1991), G. Willcox and M. Tengberg (1995), G. Willcox and S. Fornite (1999) and others. In their research they included all the elements of plant imprints, such as glumes, glume bases, stems, awns, grains and leaves. In their work focusing on house daub, in addition to plant imprints, the scientists noticed remains of mineralized plant parts. They are formed from soluble silicates that the plant takes up from ground waters, deposited in the outer and inner cell structures and thus replicating its appearance (Ryan 2011: 294–295; Bonnaire 2016). It is also possible to find dry and carbonized plant remains in a clay medium (Newton 2004; Hovsepyan, Willcox 2008; Henn, Pál 2015). Dry plant remains found in a brick from a 19th century house were researched by T. Henn and associates (2015). In this context, one can also mention the French archaeobotanist, E. Bonnaire (2005; 2006), who devoted her master's thesis to the topic of the study of imprints and phytoliths of cereals used as temper in unbaked construction bricks. Plant imprints are not necessarily always a result of inclusions added to the clay mixture, as demonstrated by the Late Bronze Age signets (pintadera) discovered in Hungary. They contain deliberately reproduced grain imprints, created

reproducirani otisci pšena u svrhu dobivanja aktivne površine s karakterističnim uzorkom. Princip stvaranja otisaka dobiven je pritiskanjem svježeg glinenog materijala u rasuta pšena koja bi se potom zalijepila na aktivnu površinu pečatnjaka, a prilikom pečenja bi izgorila. Na taj način dobiven je otisak u negativu koji jasno prikazuje o kakvim pšenima se radi (Mervel 2019).

Što se tiče područja Hrvatske, tek je u novije vrijeme provedeno nekoliko sličnih analiza. R. Šoštarić (2001) identificirala je otisak lista paprati (*Pteridium aquilinum*) na dvama oblutcima koji su pronađeni izvan željeznodobne grobne komore iz 6. st. pr. Kr. na lokalitetu Jalžabet – Bistričak. Nedavno provedena analiza otiska lista na ostatku kasnoantičke peći za taljenje željezne rude na lokalitetu Virje – Sušine omogućila je pretpostavku godišnjeg doba u kojem se odvijala proizvodnja rude (Valent et al. 2021). Pored navedenog, provedena je i analiza djelomično fosiliziranog lista u troski datiranoj u prijelaz iz kasnoantičkog u ranosrednjovjekovni period na lokalitetu Hlebine – Velike Hlebine (Šoštarić, Vilović 2021).

Bez obzira na pouzdanost metode analize biljnih otisaka, ona je u skorije vrijeme slabo korištena. Zbog ekonomičnijih i bržih klasičnih metoda stavljena je u drugi plan i koristi se najčešće samo kao dopunska analiza te onda kada sediment zbog svojih karakteristika iz određenog razloga ne sadrži biljni zapis (Newton 2004: 62). Uistinu, analiza biljnih otisaka ne može nadomjestiti listu biljnih taksona dobivenih iz sedimenta koja je redovito bogatija (Willcox, Tengberg 1995; Willcox, Fornite 1999; Bonnaire, Tengberg 2007: 80; Bonnaire 2014: 285). Danas se većina analiza biljnih otisaka na glinenom mediju provodi putem SEM mikroskopije koja olakšava determinaciju. Njome je moguće dobiti kvalitetne fotografije u visokoj rezoluciji s dojmom dubine, fokusom te lakoćom manipulacije i fotografiranja. Kalibracija je moguća unutar sustava čime je pruženo automatsko određivanje dimenzija ostatka ili debljine njegove vanjske stijenke što nije moguće postići stereo mikroskopom (Magid, Krzywinski 1995: 128; Frahm 2014).

Nadin – Gradina

Lokalitet Nadin – Gradina smješten je na vrhu i padinama najviše glavice nadinske bore (265 m n.v.), u središtu plodonosnog prostora Ravnih kotara u sjevernoj Dalmaciji (sl. 1). Recentnim sustavnim istraživanjima utvrđeno je

to obtain an active surface with a characteristic pattern. The impression was made by pressing fresh clay material onto scattered grains, which would become attached to the active surface of the signets and burn out during the firing. The resulting imprint in negative clearly showed the types of grain (Mervel 2019).

In Croatia, only recently have several similar analyses been conducted. Bracken (*Pteridium aquilinum*) imprints were identified by R. Šoštarić (2001) on two pebbles discovered outside an Iron Age burial chamber dating from the 6th century BC at the site of Jalžabet – Bistričak. The recent analysis of a leaf imprint on the remains of a Late Classical iron-ore smelting furnace at the site of Virje – Sušine made it possible to hypothesize on the season in which the ore was produced (Valent et al. 2021). In addition, analysis was made of a partially fossilized leaf found in slag dated to the turn from the Late Classical period to the Early Mediaeval at the site of Hlebine – Velike Hlebine (Šoštarić, Vilović 2021).

Despite the reliability of the method of plant-imprint analysis, it has not been widely used in recent years. It has been marginalized because of the faster and more cost-effective methods, and it is most often employed only as a complementary analysis, or in those cases in which the sediment for some reason does not contain a plant record (Newton 2004: 62). Indeed, the analysis of plant imprints cannot replace the list of plant taxa obtained from the sediment, with the latter being richer in most cases (Willcox, Tengberg 1995; Willcox, Fornite 1999; Bonnaire, Tengberg 2007: 80; Bonnaire 2014: 285). Nowadays, the majority of analyses of plant imprints in a clay medium is conducted using SEM microscopy, which facilitates the identification. It can produce high-quality and high-resolution photographs which create an impression of depth and focus, and are easily manipulated. The calibration can be performed within the system, which provides for an automatic determination of the size of the remnant, or the thickness of its outer wall, which cannot be achieved on a stereo microscope (Magid, Krzywinski 1995: 128; Frahm 2014).

Nadin – Gradina

The site of Nadin – Gradina is located on the crest and slopes of the highest hilltop of the Nadin ridge (265 m asl), in the centre of the fertile region of Ravni Kotari, in northern Dalmatia (Fig. 1). Recent systematic excavations have establis-

kako razvoj naselja započinje krajem kasnog brončanog doba (Čelhar, Zaro 2023b). Tijekom željeznog doba prerasta u red najvećih i najistaknutijih liburnskih naselja, što je u vremenu rimske uprave kapitalizirano stjecanjem statusa municipija (ant. *Nedinum*) (Wilkes 1969: 212–213; Čače 1993: 31). Dugotrajni naseobinski kontinuitet prekinut je na izmaku kasne antike kada je položaj napušten. Posljednje arheološki dokumentirane aktivnosti na lokalitetu potaknute su strateškom važnošću pozicije u vremenu kasnog srednjeg i ranog novog vijeka, a u kontekstu turbulentnih mletačko-osmanskih sukoba (Zaro et al. 2020).

Arheološka istraživanja na lokalitetu započinju relativno kasno, tek u periodu nakon II. svjetskog rata, kada Šime Batović 1968. godine dovršava istraživanje dvaju tzv. helenističkih grobova (Batović, Batović 2013). Značajniji iskorak učinjen je 80-ih godina 20. stoljeća u sklopu međunarodnog projekta *Neotermalna*

hed that the evolution of this settlement began at the end of the Late Bronze Age (Čelhar, Zaro 2023b). During the Iron Age, it grew to become one of the largest and most prominent Liburni settlements, a fact capitalized on during Roman rule, when the settlement obtained the status of a municipium (*Nedinum* being its classical name) (Wilkes 1969: 212–213; Čače 1993: 31). The many years of inhabitation were discontinued at the end of Late Classical Antiquity, when the settlement was abandoned. The most recent activity at the site that has been archaeologically documented was prompted by the strategic importance of its location during the Late Middle Ages and Early Modern Era, in the context of the turbulent Ottoman-Venetian conflicts (Zaro et al. 2020).

Archaeological investigation of the site began relatively late, in the period following World War II, when Šime Batović completed the excavation of two so-called Hellenistic graves in 1968 (Batović, Batović 2013). The most important step forward

Sl. 1 — Karta sjeverne Dalmacije s položajem Nadina, Zadra i Benkovca (Kukoč, Čelhar 2019: 12, Fig. 2)
Fig. 1 — Map of northern Dalmatia with the locations of Nadin, Zadar and Benkovac (Kukoč, Čelhar 2019: 12, Fig. 2)

Dalmacija (_Neothermal Dalmatia Project_) tijekom kojeg je proveden ekstenzivan terenski pregled unaprijed određenih cjelina na prostoru Ravnih kotara popraćen probnim iskopavanjima odabranih lokaliteta s primarnim ciljem uočavanja promjena krajolika i okoliša, uzoraka naseljavanja i društvene strukture tijekom posljednjih 8000 godina (Chapman et al. 1996). Tom prilikom je sustavno rekognoscirano šire nadinsko područje (Chapman et al. 1996: 116–125) te je godine 1986. obavljeno probno istraživanje na nadinskoj Gradini (Batović, Chapman 1987a; 1987b; Chapman et al. 1996: 231–251).

Tijekom 2002. i 2003. godine, prilikom izgradnje dionice autoceste A1 u neposrednoj blizini Gradine, izvršena su zaštitna istraživanja na trasi buduće prometnice kojima je obuhvaćen i dio nadinske nekropole pod humcima, a 2004. godine je provedeno istraživanje još jednog humka (humak 13) koji je ostao izvan obuhvata trase (Batović, Čondić 2005; Kukoč, Batović 2005; Kukoč 2006; 2009). Od 2005. godine započinje sustavno istraživanje nekropole na ravnom na sjeverozapadnoj padini Gradine u Nadinu na kojoj su ustanovljene dvije osnovne kulturno-vremenske faze – liburnska i rimska (Kukoč 2006; 2009; Kukoč, Batović 2006; Kukoč, Čelhar 2010; 2019).

Konačno, od 2015. godine u sklopu međunarodnog projekta Sveučilišta u Zadru i Sveučilišta u Maineu (SAD) započinju i sustavna istraživanja unutar naseobinskog areala. Pet probnih sondi istraženo je na različitim položajima unutar perimetra naselja (sl. 2) da bi se omogućilo razumijevanje dubine depozita, kronološka sekvenca i integritet arheološkog zapisa (Čelhar, Zaro 2016; 2023a; Zaro, Čelhar 2018). Kao najperspektivnija pozicija za širenje iskopne površine profilirala se sonda B na sjevernom dijelu Gradine koja je postupno proširena sve do pravca pružanja tzv. megalitskog bedema i istražena u narednom periodu između 2016. i 2020. godine.[1] Upravo s prostora sonde B potječu i keramički nalazi s biljnim tragovima koji se obrađuju ovom prilikom.

Tijekom istraživanja na Gradini u Nadinu provedenih 80-ih godina prošlog stoljeća prove-

1 Istraživanja su većim dijelom provedena u sklopu i zahvaljujući potpori projekta Hrvatske zaklade za znanost *Ravni Kotari: urbanizacija i promjene krajolika u sjevernoj Dalmaciji* (IP-2016-06-5832) voditeljice Martine Čelhar. Također, financiranje su podržali i National Geographic Society, Ministarstvo kulture Republike Hrvatske, Zavičajni muzej Benkovac, Rust family foundation te, posebno, Odjel za arheologiju Sveučilišta u Zadru i Odjel za antropologiju Sveučilišta u Maineu (SAD) pri čemu je lokalitet ujedno poslužio kao poligon za provođenje studentske terenske prakse.

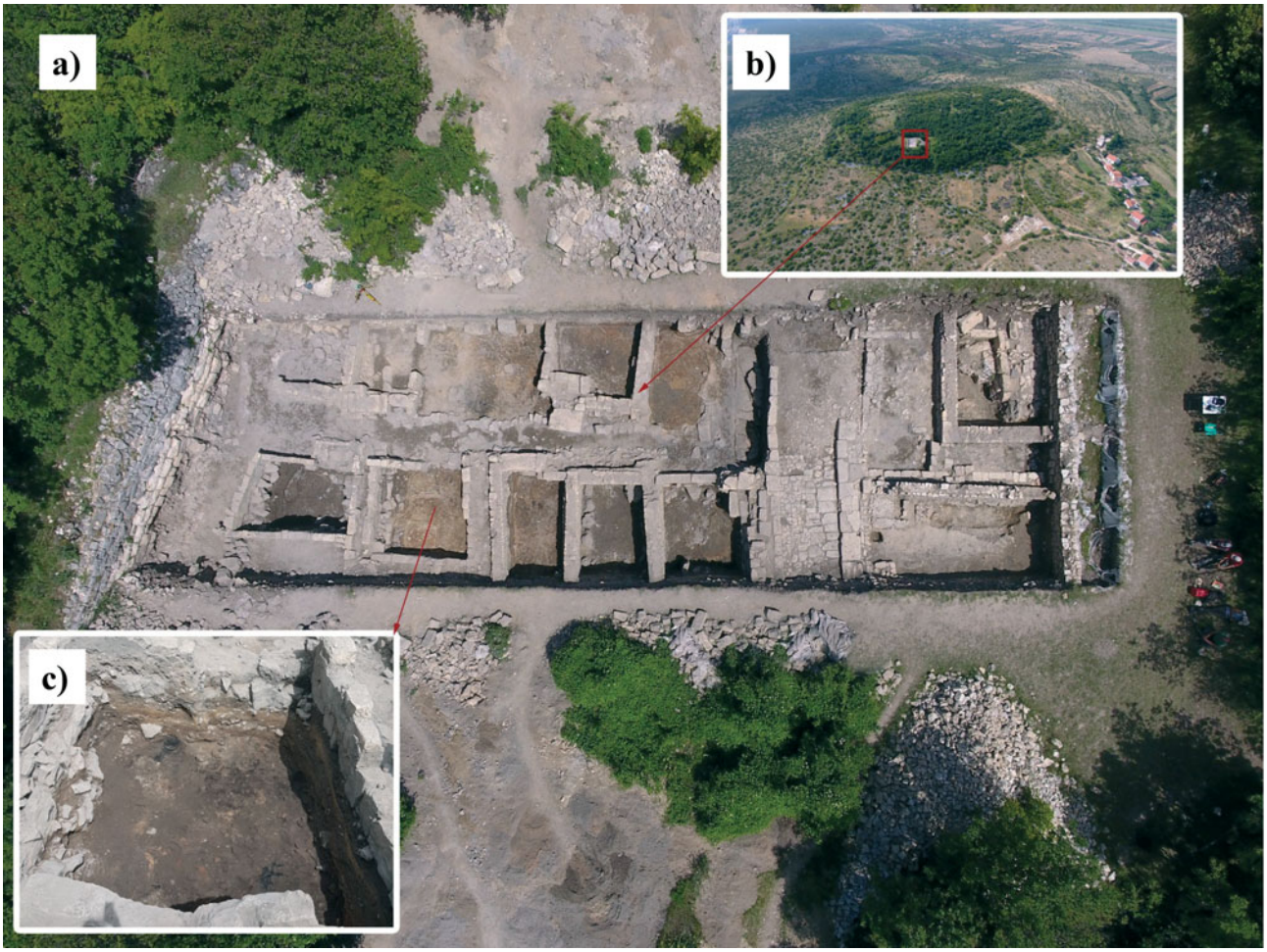
was made in the 1980s, in the framework of the international *Neothermal Dalmatia Project*. An extensive field survey was conducted of the previously designated areas of Ravni Kotari, accompanied by trial excavation of selected sites, primarily aimed at identifying changes in the landscape and environment, settlement patterns and social structure during the last 8000 years (Chapman et al. 1996). A wider area of Nadin was included in this systematic field survey (Chapman et al. 1996: 116–125), and in 1986 a trial excavation was conducted at the Gradina hillfort in Nadin (Batović, Chapman 1987a; 1987b; Chapman et al. 1996: 231–251).

In 2002 and 2003, during construction of the A1 motorway section in the immediate vicinity of Gradina, rescue excavation was conducted on the course of the future road, which encompassed part of the Nadin mounds necropolis. In 2004, another mound (mound 13), which had been outside the scope of the motorway's course, was also investigated (Batović, Čondić 2005; Kukoč, Batović 2005; Kukoč 2006; 2009). The systematic excavation of the flat necropolis on the north-western slope of the Nadin Gradina began in 2005, and resulted in the identification of two main cultural and chronological phases: the Liburni phase and the Roman one (Kukoč 2006; 2009; Kukoč, Batović 2006; Kukoč, Čelhar 2010; 2019).

Finally, in 2015 the systematic excavation of the settlement area also began within an international project conducted by the University of Zadar and the University of Maine (USA). Five test pits were investigated in various locations within the settlement perimeter (Fig. 2) to obtain a better understanding of the deposit's depth, the chronological sequence and the integrity of the archaeological record (Čelhar, Zaro 2016; 2023a; Zaro, Čelhar 2018). Test pit B, in the northern part of Gradina, emerged as the most promising location for expanding the excavation area, and it was gradually expanded all the way to the line of the so-called megalithic rampart and investigated between 2016 and 2020.[1] The pottery finds that contain the plant traces analysed in this paper were recovered from the area of test pit B.

During the excavations of Gradina, in Nadin, undertaken in the 1980s, a carpological analysis of

1 The excavation was conducted mostly within the *Ravni Kotari: Urbanization and Landscape Change in Northern Dalmatia* project (IP-2016-06-5832) of the Croatian Science Foundation, led by Martina Čelhar, and thanks to its support. In addition, the excavation was financially supported by the National Geographic Society, Ministry of Culture of the Republic of Croatia, Benkovac Heritage Museum, Rust Family Foundation, and especially by the Department of Archaeology of the University of Zadar and the Department of Anthropology of the University of Maine (USA), where the site was also used as a training ground for students' field practice.



Sl. 2 — Fotografije: a) sonde B (snimio: L. Bogdanić); b) Gradine u Nadinu s označenim položajem sonde B (snimila: M. Grgurić); c) stratigrafske jedinice (SJ 419) u kv. B 8/10 unutar koje su pronađeni keramički fragmenti s otiscima biljaka (snimila: M. Čelhar)

Fig. 2 — Photographs of: a) test pit B (photo by: L. Bogdanić); b) Gradina hillfort at Nadin, with the location of test pit B marked (photo by: M. Grgurić); c) stratigraphic unit (SU 419) in quadrant B 8/10, in which pottery sherds containing plant imprints have been found (photo by: M. Čelhar)

dena je karpološka analiza sedimenta iz željeznog doba, a od žitarica su tada identificirani ječam (*Hordeum vulgare*), pravi pir (*Triticum spelta*) i proso (*Panicum miliaceum*) (Nye 1996: 242). Recentne arheobotaničke analize provedene su na području Gradine u Nadinu u okviru projekta Hrvatske zaklade za znanost *Ravni kotari: urbanizacija i promjene krajolika u sjevernoj Dalmaciji*. Arheobotaničku analizu biljnih makrofosila na Gradini u Nadinu kroz prapovijesnu i antičku sekvencu naseljavanja provodi J. Countryman sa Sveučilišta u Chicagu u sklopu svog doktorskog rada dok je arheobotaničku analizu željeznodobnih sedimenata iz jedne izdvojene prostorne cjeline (kv. B 8/10) unutar sonde B odradila D. Knežić sa Sveučilišta u Zadru u okviru diplomskog rada (Knežić 2022).

Iron Age sediments was conducted, which resulted in the identification of the following cereals: barley (*Hordeum vulgare*), spelt (*Triticum spelta*) and broomcorn millet (*Panicum miliaceum*) (Nye 1996: 242). The recent archaeobotanical analyses were conducted in the area of Gradina, in Nadin, within the *Ravni Kotari: Urbanization and Landscape Change in Northern Dalmatia* project of the Croatian Science Foundation. An archaeobotanical analysis of plant macrofossils from Gradina, in Nadin, over the prehistoric and classical settlement sequence is being conducted by J. Countryman of the University of Chicago as part of his doctoral thesis, while an archaeobotanical analysis of the Iron Age sediments of an isolated spatial unit (sq. B 8/10) within test pit B was performed by D. Knežić of the University of Zadar within the preparation of her master thesis (Knežić 2022).

Arheobotanički nalazi u sedimentima i u glinenim medijima na liburnskom području

U liburnskim naseobinskim kontekstima, pa tako i u ovdje promatranom nadinskom, zastupljenošću se primarno ističu keramički predmeti, i to ponajprije stolno i kuhinjsko posuđe te transportni i skladišni recipijenti pretpostavljeno dominantno lokalne[2] i, u znatno manjem obujmu, oni zasigurno strane provenijencije koji se jasno izdvajaju svojim tehnološkim i dekorativnim karakteristikama.[3] Unatoč činjenici da su navedeni nalazi brojni i sveprisutni, još uvijek izostaje sustavna tipo-kronološka, funkcionalna te tehnološka analiza i klasifikacija „domaćeg" prapovijesnog keramičkog posuđa na liburnskom prostoru. Brojni radovi koji više ili manje opsežno problematiziraju željeznodobnu keramičku produkciju uglavnom navode njezine osnovne karakteristike: ručnu izradu od gline u koju su nadodavane raznovrsne, ponajprije mineralne primjese uglavnom prepoznate na osnovi makroskopske analize i procjene, te pečenje na otvorenom ili u jami iskopanoj u zemlji koje zbog različite mogućnosti kontrole temperature kao posljedicu često ima neujednačene tonove na posuđu. Način i kvaliteta izrade i pečenja te obrada površine su, po svemu sudeći, u uzročno-posljedičnom odnosu s namjenom posuđa i shodno tome željenim karakteristikama (Batović 1968: 60; 1987: 372; Čelhar, Borzić 2016: 70–72; Čondić, Vuković 2017: 51–52).

Š. Batović (1980: 72) dodatno ističe da je kod pojedinih specifičnih kategorija (lijep, pokretne peći, velike skladišne posude tipa *pithos*/*dolia*) uočeno miješanje gline s pljevom. Navedeni podatak bitan je i u kontekstu ovdje prezentirane građe iz Gradine u Nadinu. Naime, pregledani keramički korpus iz jednog izdvojenog naseobinskog konteksta (SJ 419) jasno ukazuje da su biljni ostatci dokumentirani gotovo isključivo na fragmentima jedne veće skladišne posude izražene debljine stijenki. S druge strane, struktura posuđa iz sloja koja se može okvirno tipološki odrediti u kategoriju lonaca i zdjela, odnosno kao kuhinjsko i stolno posuđe, ne pokazuje ostatke biljnih primjesa ili se one javljaju iznimno i pojedinačno. Dakle, njihovu pojavu

2 Petrografske i geokemijske analize lončarije s nadinske Gradine trenutno provode Maja Miše i Courtney Allardice na University College u Londonu.

3 Riječ je o keramičkim vrstama ponajprije iz italskih i grčkih radionica (usp. Čelhar et al. 2023).

Archaeobotanical finds in sediments and clay media from the Liburni area

In the Liburni settlement contexts, including the one under discussion in Nadin, the most prominent finds in terms of their frequency are pottery, primarily tableware and cooking pots, as well as vessels for transport and storage, presumed to have been produced mostly locally[2] and, to a much smaller extent, those that have certainly been imported, whose technological and decorative features clearly set them apart.[3] Despite the fact that such finds are numerous and omnipresent, a systematic typochronological, functional and technological analysis and classification of the 'local' prehistoric pottery from the Liburni area is still missing. Numerous papers that discuss Iron Age pottery production more or less extensively mostly state its main characteristics: hand-made from clay tempered with diverse (but primarily mineral) inclusions, identified mostly on the basis of macroscopic analyses and estimations, and fired in the open or a pit dug in the ground, which, because of varying temperature-control possibilities, often results in uneven tones of the ceramic wares. The method and quality of pottery shaping and firing and of its surface treatment were, by all accounts, in a cause-and-effect relationship with the function of the vessels and, accordingly, with its desired characteristics (Batović 1968: 60; 1987: 372; Čelhar, Borzić 2016: 70–72; Čondić, Vuković 2017: 51–52).

It is also emphasized by Š. Batović (1980: 72) that it has been noticed that the clay used for some specific pottery categories (house daub, portable ovens, large storage vessels of the *pithos*/*dolia* type) was mixed with chaff. This piece of information is important also in the context of Gradina, in Nadin, discussed here. The examined pottery finds from a distinct settlement context (SU 419) clearly indicate that plant remains have been recorded almost exclusively on fragments of a large storage vessel with pronounced wall thickness. On the other hand, the structure of vessels discovered in the same layer, which can be typologically identified roughly as pots and bowls, that is, cookware and tableware, shows no signs of plant-temper remains, or they appear only exceptionally and individually. Thus, their appe-

2 Petrographic and geochemical analyses of pottery from Gradina, in Nadin, are being conducted by Maja Miše and Courtney Allardice at University College London.

3 These are primarily pottery types from Italian and Greek workshops (cf. Čelhar et al. 2023).

treba prije promatrati kao slučajnost, a ne kao rezultat namjerne strategije prilikom pripravljanja smjese.

S obzirom na činjenicu kako arheobotaničke analize na liburnskom prostoru gotovo uopće nisu provođene, biljni materijal iz kojeg su crpljeni podatci o vegetaciji, gospodarstvu i zemljoradnji Liburna bio je vrlo oskudan i gotovo u potpunosti ograničen na *in situ* nalaze lako zamjetljivih većih količina karboniziranih zrna. Takvi nalazi najčešće su dokumentirani unutar keramičkog posuđa skladišne namjene, poput onih iz jednog većeg pitosa/dolije nađene na podnici kuće na Beretinovoj gradini u Radovinu (Batović 1968: 61, T. XII: 2; 1987: 377). Š. Batović (1968: 62) donosi podatak da su uz pšena žitarica (*Cerealia*) u liburnskom naselju na Beretinovoj gradini pronađeni i karbonizirani ostaci žira (*Quercus* sp.). U željeznodobnom naselju u Ninu, na poziciji sv. Križ, biljni ostaci pronađeni su unutar otpadnih jama koje su se nalazile unutar i izvan stambenih jedinica. One su većinom sadržavale otpadni materijal u vidu keramičkih, ali i drugih predmeta koji se pronalaze istraživanjem kulturnih slojeva u naselju. Uz ostale nalaze Batović (1970: 37) spominje sporadičnu prisutnost pšena najvjerojatnije žitarica (*Cerealia)* i prosa (*Panicum miliaceum*). Osim putem direktnih nalaza biljnog materijala, Š. Batović (1970: 37–38; 1974: 165; 1987: 377) glavne zaključke o poljoprivredi i gospodarstvu dobiva funkcionalnom analizom predmeta materijalne kulture poput velikog broja pronađenih žrvnjeva i željeznih rala u istraživanim naseljima ili, pak, crpeći oskudne vijesti iz antičkih izvora. Autor spominje kako su velike keramičke posude čest repertoar liburnskih kuća te da su najvjerojatnije služile za spremanje hrane, o čemu ponekad direktno svjedoči i njihov sadržaj, ili tekućina.

Ovdje promatrani keramički ulomci, na osnovi stratigrafskog položaja i popratne materijalne građe, ponajprije daunijske mat slikane keramike, pripadaju naseobinskom kontekstu starijeg željeznog doba čija je kronologija i apsolutno-kronološki potvrđena radiokarbonskim datiranjem u vremenski okvir između 827. i 762. g. pr. Kr.[4] Ova analiza bitna je jer je do sada provedena i publicirana samo jedna makrobotanička analiza vezana uz navedeni prostorni i vremenski okvir (Nye

4 Uzorak Beta-554230 je dao datum 2600 ± 30 BP, odnosno 827–762 cal BC (2776–2711 cal BP) (95.4 %), 807–785 cal BC (2756–2734 cal BP) (68.2%).

arance should be considered as accidental, and not a result of any deliberate strategy employed during the preparation of the pottery paste.

In view of the fact that few archaeobotanical analyses have ever been conducted in the Liburni area, plant material used as a source of information on the vegetation, economy and farming practices of the Liburni has been very scarce and almost completely limited to *in situ* finds of easily discernible larger quantities of carbonized grains. Such finds were mostly recorded inside ceramic vessels used for storage, such as those from a large pythos/dolia discovered on the floor of a house at Beretinova Gradina, in Radovin (Batović 1968: 61, Pl. XII: 2; 1987: 377). As reported by Š. Batović (1968: 62), in addition to cereal (*Cerealia*) grains, carbonized remains of acorn (*Quercus* sp.) were also found in the Liburni settlement at Beretinova Gradina. In the Iron Age settlement in Nin, at the site of Sveti Križ, plant remains were discovered in waste pits found both inside and outside housing units. They contained waste material in the form of pottery and other objects that can be discovered during the investigation of cultural layers in the settlement. Among other finds, Batović (1970: 37) mentions occasional presence of grains, most probably of cereals (*Cerealia)* and broomcorn millet (*Panicum miliaceum*). Batović (1970: 37–38; 1974: 165; 1987: 377) draws main conclusions on farming and the economy not only from direct finds of plant material, but also from a functional analysis of items of material culture, such as the high number of grindstones and iron ploughs discovered in the settlements excavated, and from meagre information found in classical sources. The author mentions that large pottery vessels have often been found in Liburni houses, and that they were most probably used for storing food – as occasionally evidenced directly by their contents – and liquids.

On the basis of their stratigraphic position and accompanying material finds, primarily the Daunian matt-painted pottery, the pottery sherds analysed here belong to an Early Iron Age settlement context, whose chronology has been confirmed in terms of absolute chronology by radiocarbon dating to the period between 827 and 762 BC.[4] This analysis is important, because only one macrobotanical analysis linked to this spatial and chronological framework has been published to date (Nye 1996), which makes all new resear-

4 Beta-554230 sample provided the date 2600 ± 30 BP, that is, 827–762 cal BC (2776–2711 cal BP) (95.4 %), 807–785 cal BC (2756–2734 cal BP) (68.2%).

1996) te je stoga svako novo istraživanje na tom polju izuzetno značajno i bitno.[5] Nadalje, analizirani su makroskopski biljni tragovi s keramičkih ulomaka koji predstavljaju sekundarni medij u kojem se biljni ostaci mogu očuvati, pa donose nešto drugačije podatke od onih koje dobivamo klasičnom analizom sedimenta na nalazištu[6] – putem njih je moguće potvrditi lokalni uzgoj i vršidbu žitarica koju klasičnom arheobotaničkom analizom sedimenta teže možemo dokazati. Tako dobiveni podaci mogu se kombinirati i pridružiti drugim arheobotaničkim analizama koje zajedno omogućavaju širu preglednost biljnih vrsta i bolje razumijevanje iskorištavanja vegetacije. Putem ove analize spoznajemo tehnološka dostignuća zajednice u procesu vršidbe žitarica i izrade keramičkih predmeta s organskim primjesama te dobivamo podatke o ekonomiji i reducirane podatke o ondašnjoj okolnoj vegetaciji.

METODOLOGIJA I MATERIJALI

Keramički ulomci s dodatkom organskih primjesa analizirani u ovom radu pripadaju skladišnoj keramici i potječu iz stratigrafske jedinice 419 istražene 2019. godine na prostoru sonde B na sjevernom dijelu nadinske Gradine. Ondje je pronađeno više fragmentiranih ulomaka jedne skladišne keramičke posude većih dimenzija, čvrste fakture i stijenki čija debljina varira od 2,5 do 4 cm s većom količinom organskih i vrlo malo mineralnih primjesa koje su dodavane glini i tako modelirane. Arheobotanička analiza biljnih ostataka na keramičkim ulomcima započela je pregledavanjem opranih i čistih ulomaka koji su po potrebi bili dodatno očišćeni tankim zašiljenim predmetom kako bi se odstranio sediment iz rupica ili otisaka koje su formirale biljne primjese. Zatim je uslijedilo izdvajanje i označavanje posebnom oznakom onih ulomaka na kojima su primijećeni dovoljno kvalitetni otisci čija identifikacija je moguća do adekvatne taksonomske kategorije. Nakon označavanja, definirana

5 Ostali željeznodobni lokaliteti na kojima su provedene makrobotaničke analize sedimenta nalaze se u kontinentalnoj Hrvatskoj, to su Kaptol kod Požege (Šoštarić et al. 2007; 2016; 2017; 2020; Potrebica 2013; 2019), Pogorelec u Sisku (Reed, Drnić 2016; Drnić et al. 2020) te Kamensko kod Karlovca i Skradinik kod Josipdola (Šoštarić 2003).

6 Dosad je provedena makrobotanička analiza sedimenta iz jedne izdvojene prostorne cjeline sa željeznodobnim slojevima i makrobotanička analiza keramičkih ulomaka iz stratigrafske jedinice 419 unutar sonde B u sklopu izrade diplomskog rada (Knežić 2022). Također, u tijeku je provođenje analiza makrobotaničkog materijala Gradine u Nadinu koje će biti znanstveno valorizirane u okviru jednog doktorskog rada (J. Countryman, University of Chicago).

ch in this field very significant.[5] Furthermore, the analysed macrobotanical plant traces come from pottery sherds, which are a secondary medium in which plant remains can be preserved, resulting in data that are somewhat different from those obtained by a classical analysis of sediment at the site.[6] Plant imprints on pottery sherds can be used to confirm local cultivation and threshing of cereals, which is hard to prove using the classical archaeobotanical analysis of sediment. The data thus obtained can be combined and added to other archaeobotanical analyses, and together they provide a wider picture of plant species and better understanding of the exploitation of vegetation. Such analysis provides information on the community's economy and its technological achievements used in the process of cereal threshing and pottery production with organic inclusions – and, to a lesser extent, on the surrounding vegetation of the time.

METHODOLOGY AND MATERIALS

The pottery sherds with organic temper analysed in this paper belong to the category of storage pottery and originate from stratigraphic unit 419, investigated in 2019 in test pit B in the northern part of the Gradina hillfort in Nadin. Several fragmented sherds of a large storage vessel were discovered there. The sherds have firm fabric, with wall thickness varying between 2.5 and 4 cm, a substantial amount of organic temper and a very small quantity of mineral inclusions added to the clay and then modelled. The archaeobotanical analysis of plant remains on pottery sherds began with inspection of washed, clean sherds, additionally cleaned where necessary with a thin pointed tool, used to remove sediment from small holes or imprints left by plant temper. The following step consisted of the separation and labelling of those sherds selected because they displayed imprints of sufficient quality, which could be identified to an appropriate taxonomic category. After the labelling, the imprint quality was determined, and then they were observed using the interplay of

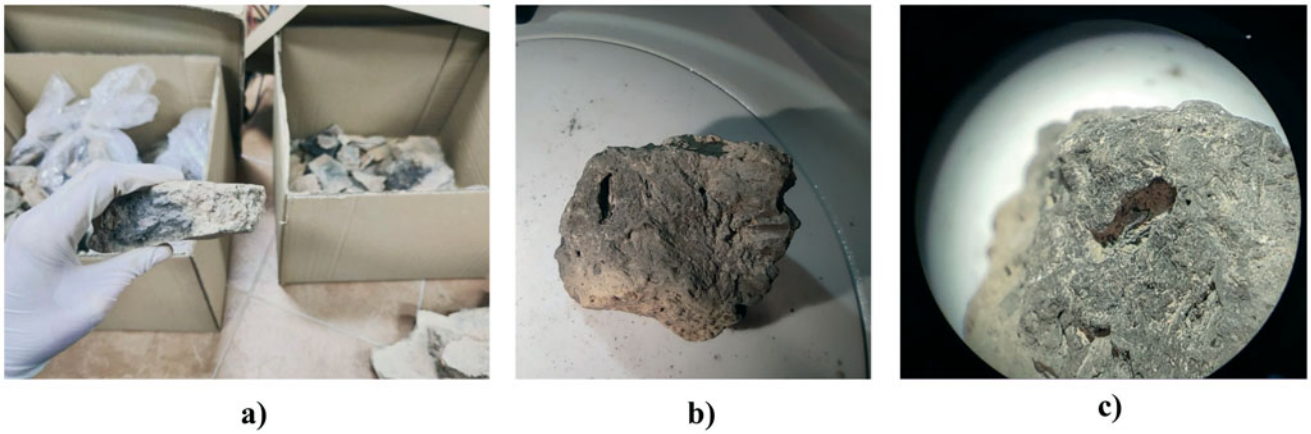
5 Other Iron Age sites from which sediment was taken for macrobotanical analysis are located in continental Croatia, and those are Kaptol near Požega (Šoštarić et al. 2007; 2016; 2017; 2020; Potrebica 2013; 2019), Pogorelec in Sisak (Reed, Drnić 2016; Drnić et al. 2020), and Kamensko near Karlovac and Skradinik near Josipdol (Šoštarić 2003).

6 To date, macrobotanical analysis has been conducted of sediment from a distinct spatial unit with Iron Age layers as well as the macrobotanical analysis of pottery sherds from stratigraphic unit 419 in test pit B within the preparation of a graduation thesis (Knežić 2022). Furthermore, analyses of macrobotanical material from Gradina in Nadin are being conducted, and they will be scientifically evaluated within a doctoral thesis (J. Countryman, University of Chicago).

je kvaliteta otiska, a potom je uslijedilo njihovo promatranje kroz igru svjetla i sjene (sl. 3: a–b) te opisivanje i unošenje podataka u posebne formulare. U slučaju kada se otisak nalazio na keramičkom ulomku čvrste fakture koji ne sadrži fragilne ostatke biljnog podrijetla, radio se silikonski odljev čime se dobio otisak biljke u pozitivu (usp. Magid, Krzywinski 1995) (sl. 4). U slučaju kada je keramički ulomak bio fragilan, lomljiv ili su se u njemu i dalje nalazili mineralizirani ostaci biljaka (poput recimo pljeve), nije se radio silikonski odljev, već se otisak analizirao kao takav (usp. Hamshaw Thomas 1912: 111) (sl. 3: c). Postupak identifikacije biljnih otisaka i ostataka te izrada silikonskih odljeva obavljeni su pomoću mikroskopa s povećanjem od 10–20x i uz pomoć ručnog povećala s povećanjem od 5x.

Identifikacija uzoraka vršena je pomoću standardne relevantne literature (Renfrew 1973; Kohler-Schneider 2001; Cappers et al. 2006; Akeret, Jacomet 2010; Cappers, Bekker 2013), karpološke kolekcije Botaničkog zavoda Prirodoslovno-matematičkog fakulteta u Zagrebu, osobne komparativne kolekcija u vlasništvu prvopotpisnice ovog rada te referentne kolekcije dostupne online, poput *Flora Croatica Database i Digital Plant Atlas*-a. Prakticirana je i izrada otisaka pojedinih pretpostavljenih biljnih otisaka u glini kako bi se oni mogli usporediti s nalazima otisaka na keramici. Identifikacija biljnih ostataka vođena je po načelu dva pouzdana kriterija, a to su morfologija i dimenzije biljnih ostataka. U slučaju da je površinska struktura light and shade (Fig. 3: a–b) and then described, and the data were entered into special templates. Where an imprint was located on a pottery sherd of firm fabric, which does not contain fragile plant remains, a silicone cast was made, resulting in a plant imprint in positive (cf. Magid, Krzywinski 1995) (Fig. 4). Where the pottery sherd was fragile or breakable, or still contained mineralized plant remains (such as a glume, for example), a silicone case was not made, and the imprint was analysed as such (cf. Hamshaw Thomas 1912: 111) (Fig. 3: c). The processes of identifying plant imprints and remains and of creating silicone casts were carried out using a microscope with magnification 10–20x and a handheld magnifier with magnification 5x.

The samples were identified using the standard relevant literature (Renfrew 1973; Kohler-Schneider 2001; Cappers et al. 2006; Akeret, Jacomet 2010; Cappers, Bekker 2013), the carpological collection of the Division of Botany of the Zagreb Faculty of Natural Science, personal comparative collections owned by the author of this paper, and reference collections available online, such as *Flora Croatica Database* and *Digital Plant Atlas*. Clay casts of imprints of some assumed plant remains were also made, with a view to comparing them to the imprints discovered on the pottery. The plant remains were identified following the principle of two reliable criteria, these being the morphology and dimensions of the plant remains. Where the surface structure was preserved, it was also taken into consideration during the identification. Following the identification, the data obtained we-



Sl. 3 — Prikaz pregledavanja: a) keramičkih ulomaka iz SJ 419 i odabira onih s jasno vidljivim tragovima biljnih primjesa u smjesi; b) otisaka golim okom pomoću igre svjetla i sjene; c) otiska pod mikroskopom (snimila: D. Knežić)
Fig. 3 — Inspection of: a) pottery sherds from stratigraphic unit SU 419 and the selection of those with clearly visible traces of plant temper in the mixture; b) imprints with the naked eye, using the interplay of light and shade; c) imprints under a microscope (photo by: D. Knežić)

Sl. 4 — Izrada pozitiva otiska biljke s keramičkog ulomka pomoću tekućeg silikona (snimila: D. Knežić)
Fig. 4 — Making a plant imprint in positive from a pottery sherd using liquid silicone (photo by: D. Knežić)

očuvana i ona je uzeta u obzir prilikom identifikacije. Nakon identifikacije, dobiveni podaci su analizirani i interpretirani. Fotografiranje nalaza vršeno je pomoću stereo mikroskopa malog povećanja i USB elektronskog *Dino-Lite Pro* mikroskopa, a mjerenje dimenzija izvedeno je pomoću milimetarskog papira. Doseg identifikacije ovisi o nekoliko kriterija, ponajprije stupnju morfološke očuvanosti i cjelovitosti, pravilnosti orijentacije nalaza, očuvanosti dijelova ključnih za determinaciju i površinske strukture. Treba imati na umu da je pojedine taksone općenito teže razlikovati od drugih, stoga je identifikacija varijabilna ovisno o stanju u kojem se otisak nalazi, a kreće se od razine najniže taksonomske kategorije – podvrste sve do porodice (Bonnaire, Tengberg 2007: 84).

Također, pri proučavanju biljnih otisaka u glinenom mediju uzeta su u obzir ranija opažanja i iskustva autora prema kojima suhe biljne primjese apsorbiraju dio vode iz svog glinenog okruženja, a prolazak vode iz gline taloži sloj finih čestica oko biljnih ostataka zbog čega takav otisak često proizvodi detaljnu morfologiju površine vlažne sjemenke ili kojeg drugog biljnog ostatka pa su otisci nešto veći od ekvivalentnih karboniziranih primjeraka (Renfrew 1973; Magid, Krzywinski 1995: 122). Prema Körber-Grohne (1991) duljina se povećava za otprilike

re analysed and interpreted. The finds were photographed using a stereo microscope with small magnification and the *Dino-Lite Pro* USB electronic microscope, while their dimensions were measured with graph paper. The success of identification depends on several factors, primarily on the degree of preserved morphology and integrity, regularity of the remnant's orientation, degree of preservation of the elements that are vital for identification, and the surface structure. One should bear in mind that some taxa are generally more difficult to identify than others, making the identification variable, depending on the condition of the imprint. The range starts from the subspecies, the lowest taxonomic category, and extends all the way to the family (Bonnaire, Tengberg 2007: 84).

Furthermore, during the analysis of plant remains in the clay medium, the author's earlier observations and experience were taken into consideration. Those demonstrate that dry plant temper absorbs some of the water from its clay environment; and, when passing from the clay, the water deposits a layer of fine particles around the plant remains, often resulting in the imprint's replicating the detailed morphology of the surface of a moist grain or other plant remnant, and such imprints are somewhat bigger than the equivalent carbonized samples (Renfrew 1973; Magid, Krzywinski 1995: 122). According to Körber-Grohne (1991), the len-

10 %, a širina za 5–12 % u usporedbi s originalnim sjemenkama. Već se na makroskopskoj razini prilikom pregleda velikih keramičkih ulomaka grube fakture jasno naziru dijelovi tamnije boje kao posljedice pečenja bez prisutnosti kisika, ali i povećane prisutnosti organskog materijala u glinenoj smjesi kao i brojne perforacije prepoznatljivih oblika koji ukazuju na prisustvo veće količine biljnih primjesa u glinenoj smjesi (Dumpe, Stivrins 2015).

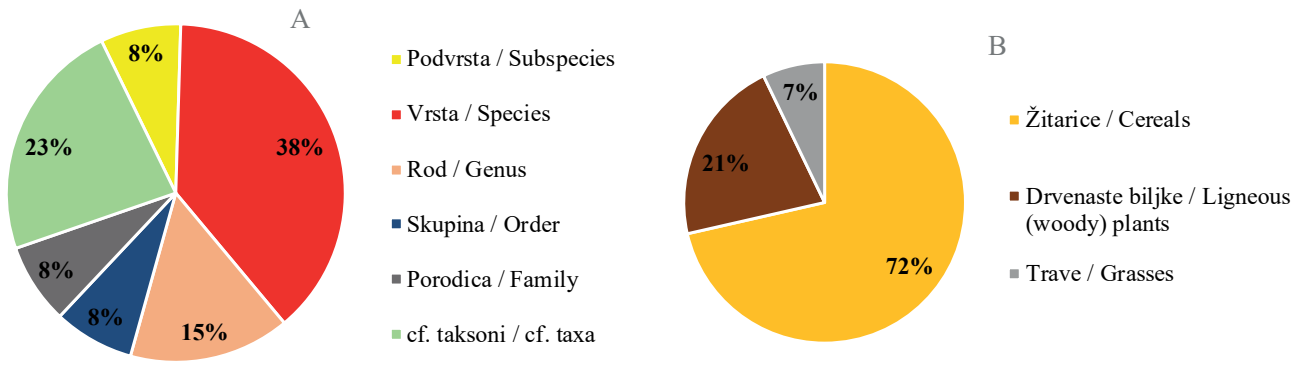
REZULTATI

Unutar pregledanog keramičkog korpusa iz jednog nadinskog naseobinskog konteksta (SJ 419), biljni ostaci uočeni su gotovo isključivo na ulomcima koji pripadaju jednoj skladišnoj posudi većih dimenzija. Posuda je pronađena u dobro definiranom i zatvorenom naseobinskom kontekstu koji je apsolutno datiran radiokarbonskom metodom u vremenski okvir koji obuhvaća posljednja tri desetljeća 9. i prva četiri desetljeća 8. st. pr. Kr. Datiranje je provedeno na karboniziranim pšenima očuvanim unutar jedne keramičke posude pronađene *in situ* na podnici objekta. Među fragmentima su odabrani i podrobno analizirani samo oni s bolje očuvanim biljnim otiscima iz kojih se moglo isčitati konkretne podatke o zastupljenim biljnim vrstama koje su dodavane u glinenu smjesu. Riječ je o ukupno 70-ak većih i manjih fragmenata iste posude koji su sadržavali otiske biljnog podrijetla, ali se kod većine ti otisci nisu očuvali u zadovoljavajućoj kvaliteti. Prema tome, od sveukupnog broja fragmenata keramičke posude za analizu je uzeto 9 keramičkih ulomaka s kvalitetnim otiscima. Na njima je dokumentirano 38 biljnih nalaza u formi otisaka te karboniziranih i mineraliziranih biljnih ostataka (tab. 1). Definirano je 13 taksona: jedan do razine porodice (*Poaceae*), jedan do razine skupine (*Cerealia*), dva do razine roda (*Triticum* sp., *Panicum/Setaria* sp.), pet do razine vrste (*Hordeum vulgare*, *Triticum durum* s.l., *Panicum miliaceum*, *Setaria italica*, *Olea europaea*), jedan do razine podvrste (*Hordeum vulgare* subsp. *distichum*) i tri *cf.* taksona (*Triticum* cf. *monococcum*, cf. *Triticum monococcum/dicoccum/spelta/ Hordeum vulgare*, cf. *Cornus mas*) (sl. 5: a). Najveći broj pronađenih taksona pripada skupini žitarica (72 %), zatim slijede drvenaste biljke (21 %) te trave (7 %) (sl. 5: b). Prema pojavnosti na analiziranim ulomcima najčešće biljne primjese čine žitari-

gth is increased by approximately 10%, and the width by 5–12%, in comparison to the original grains. At the macroscopic level, the inspection of coarse large pottery sherds already clearly shows darker patches, which are the results of firing without oxygen, and also of an increased presence of organic material in the clay paste, as well as numerous perforations in familiar shapes, indicating the large quantities of plant inclusions present in the clay paste (Dumpe, Stivrins 2015).

RESULTS

Within the inspected pottery collection from a settlement context in Nadin (SU 419), plant remains have been observed almost exclusively on sherds of one large storage vessel. The vessel was discovered in a well-defined and closed settlement context dated in absolute terms using radiocarbon dating to the period encompassing the last three decades of the 9th century BC and the first four decades of the 8th century BC. The sample used for dating consisted of carbonized grains preserved within a ceramic vessel discovered *in situ* on the floor of the house. The sherds selected for detailed analysis were those with better-preserved plant imprints which could yield concrete results on the plant species that had been added to the pottery paste. There were around 70 sherds of various sizes belonging to the same vessel, which contained imprints of plant origin, but in the majority of cases the level of preservation of the imprints was insufficient. Thus, of the total number of pottery sherds, 9 were selected for analysis, since they contained high-quality imprints. On them, 38 plant finds in the form of imprints and carbonized and mineralized plant remains have been recorded (Tab. 1). Thirteen taxa have been identified: one at the level of the family (*Poaceae*), one at the level of the order (*Cerealia*), two at the level of the genus (*Triticum* sp., *Panicum/Setaria* sp.), five at the level of the species (*Hordeum vulgare*, *Triticum durum* s.l., *Panicum miliaceum*, *Setaria italica*, *Olea europaea*), one at the level of the subspecies (*Hordeum vulgare* subsp. *distichum*) and three *cf*. taxa (*Triticum* cf. *monococcum*, cf. *Triticum monococcum/dicoccum/spelta / Hordeum vulgare*, cf. *Cornus mas*) (Fig. 5: a). The highest number of identified taxa belong to the order of cereals (72%), followed by ligneous (woody) plants (21%) and grasses (7%) (Fig. 5: b). Based on their occurrence in the analysed samples, the most frequent plant inclusions consisted of cereals (84%), with grasses



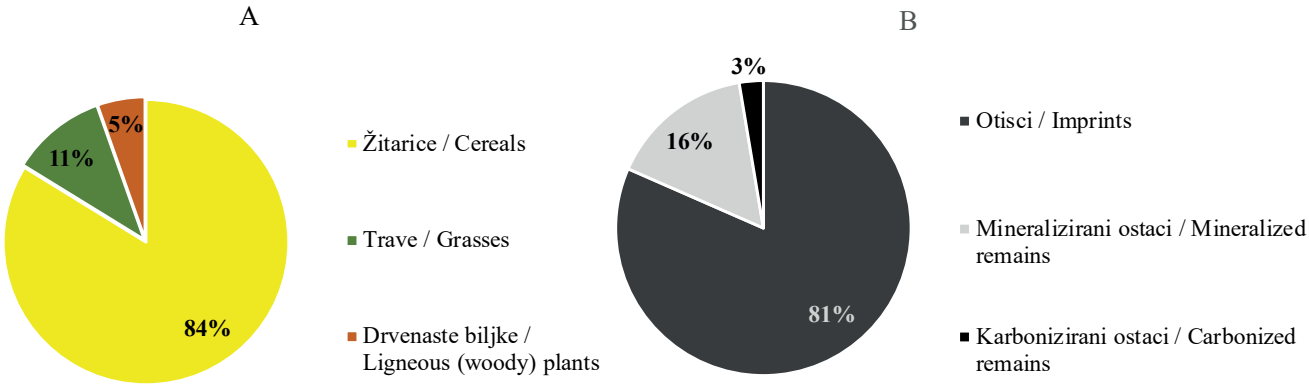
Sl. 5 — Grafikon zastupljenosti: a) determiniranih svojti prema taksonomskim razinama u analiziranim uzorcima; b) pojedinih ekoloških kategorija u uzorcima (izradila: D. Knežić)
Fig. 5 — Graph showing incidence of: a) identified taxa in the analysed samples by taxonomic level; b) individual ecological categories in the samples (made by: D. Knežić)

ce (84 %), a u manjem broju pojavljuju se trave (11%) i drvenaste biljke (5 %)[7] (sl. 6: a). Najviše je biljnih tragova ostalo sačuvano u obliku otisaka (81 %), potom u mineraliziranom (16 %) te karboniziranom obliku (3 %) (sl. 6: b).

U nastavku slijedi detaljan opis svih keramičkih nalaza s organskim primjesama i arheobotaničkih nalaza po uzorcima, a pojavnosti te brojnost pojedinih biljnih svojti u i na analiziranim keramičkim ulomcima prikazana je u tablici 1.

(11%) and ligneous (woody) plants (5%)[7] appearing to a lesser extent (Fig. 6: a). The majority of plant traces have been preserved in the shape of imprints (81%), followed by mineralized (16%) and carbonized remains (3%) (Fig. 6: b).

A detailed description of all pottery finds containing organic inclusions and archaeobotanical finds per sample is given in the continuation, while the occurrence and abundance of individual plant taxa in and on the analysed pottery sherds is shown in Table 1.



Sl. 6 — Grafikon zastupljenosti: a) biljnih ostataka prema ekološkim kategorijama na analiziranim keramičkim ulomcima; b) vrste ili tipa nalaza na analiziranim keramičkim ulomcima (izradila: D. Knežić)
Fig. 6 — Graph showing incidence of: a) plant remains on the analysed pottery sherds, by ecological category; b) type of find on the analysed pottery sherds (made by: D. Knežić)

7 Otisak drveta koji se vidi na vanjskoj stijenki keramičkog ulomka nije uzet u obzir prilikom interpretacije s obzirom da se ne odnosi na primjese koje su dodavane glinenoj smjesi već je mogao nastati prilikom oblikovanja skladišne posude ili prilikom sušenja ili pak netom prije pečenja.

7 A wood imprint on the outer wall of a potsherd was not taken into consideration during the interpretation, given that it is not a result of temper added to the clay mixture, but rather an imprint that could have been created during the shaping of the storage vessel or its drying, or immediately prior to its firing.

Taksoni / Taxa	Vrsta ostatka / Type of remain	Stanje ostatka / State of remains	UZORAK / SAMPLE								
			1	2	3	4	5	6	7	8	9
Žitarice / Cereals											
Cerealia (žitarice / cereals)	pljeva / glume	M				+					
	pšeno / grain	O	+								
	stabljika / stem	O					+			+	
		M				+					
	vlat / leaf	O				+			+		
	klas / ear	O	+							+	
	klasić / spikelet	O						+		+	
	osje / awn	O								+	
Hordeum vulgare L. (ječam / barley)	pljeva / glume	M					+				
	pšeno / grain	O					+				
Hordeum vulgare subsp. *distichum* (L.) Asch. (dvoredni ječam / two-rowed barley)	rahis / rachis	O			+						
cf. *T. monococcum, T. dicoccum, T. spelta* or *H. vulgare* (jednozrna pšenica, dvozrna pšenica, pir ili ječam / einkorn, emmer, spelt wheat or barley)	struktura dva klasića / structure of two spikelets	O									+
Triticum durum s.l. Desf. (tvrda pšenica / durum wheat)	rahis / rachis	O				+					
Triticum cf. monococcum L. (jednozrna pšenica / einkorn wheat)	baza pljeve / glume base	O	+								
Triticum sp. (pšenica / wheat)	vlat / leaf	O	+								
	pljeva / glume	O		+							
Panicum and Setaria sp. (proso i klipasti muhar / broomcorn millet and foxtail millet)	pšeno / pljeva // grain / glume	O				+		+		+	
	cf. vlat / *cf.* leaf	O								+	
Panicum miliaceum L. (proso / broomcorn millet)	pšeno / grain	O							+		
	pljeva / glume	M							+		
Setaria italica L. (klipasti muhar / foxtail millet)	pšeno / grain	O						+		+	
	pljeva / glume	M						+		+	
Drvenaste biljke / Ligneous (woody) plants											
Olea europaea L. (maslina / olive)	koštica / pit	O									+
cf. *Cornus mas* L. (drijen / cornelian cherry)	plodovna stapka / peduncle	K	+								
		O		+							
Drvo *indet.* (wood unidentified)	stabljika / stem	O									+
Trave / Grasses											
Poaceae (trave / grasses)	pšeno / grain	O				+					
	stabljika / stem	O	+	+	+						
UKUPNO / TOTAL	= 38		6	3	2	6	3	4	3	8	3

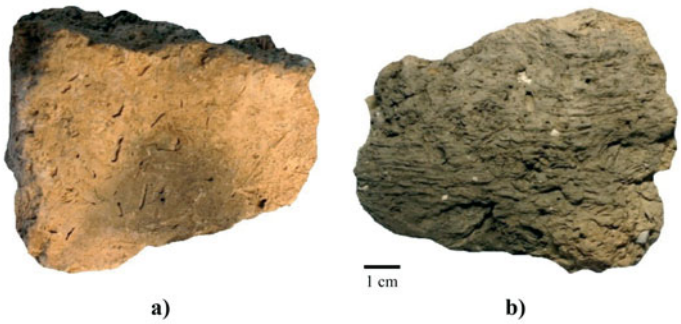
Tab. 1 — Pregled biljnih otisaka i ostataka evidentiranih na keramičkim ulomcima iz stratigrafske jedinice 419 s lokaliteta Nadin – Gradina (K – karbonizirano, M – mineralizirano, O – otisak) (izradila: D. Knežić, 2022)
Tab. 1 — Overview of plant imprints and remains recorded on pottery sherds recovered from stratigraphic unit 419 at the Nadin – Gradina site (C – carbonized, M – mineralized, I – imprint) (made by: D. Knežić, 2022)

UZORAK 1

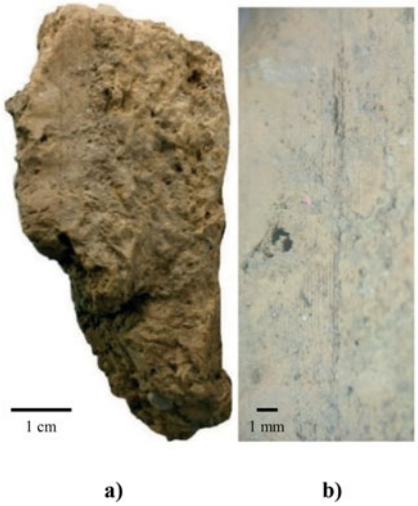
Keramički ulomak dimenzija 7,4 cm x 6,2 cm x 3,5 cm (sl. 7) ima vanjsku stijenku koja je lagano zaobljena s vidljivim zaglađivanjem, dok unutrašnja stijenka nije očuvana. S obje strane uočene su šupljine u kojima su izvorno bile primjese organskog i anorganskog podrijetla. Svijetlo smeđa boja (10YR 6/3) je ujednačena na gotovo cijeloj prednjoj strani ulomka izuzev manjeg lokaliziranog sivog traga uz rub, dok je boja odlomljenog središnjeg dijela tamno siva (10YR 4/1). Pročišćena glina ujednačene teksture sadrži organske primjese i malu količinu mineralnih inkluzija. Na ulomku je determiniran otisak vlati pšenice (*Triticum* sp.) duljine 35 mm i širine 6 – 8 mm kod kojeg se vidi izražena središnja brazda od koje se naizmjenično do ruba lista širi nekoliko paralelnih nižih brazdi nakon kojih slijedi jedna istaknutija. Također, vidljivo je kako se vlat pravilno sužava od šireg središnjeg dijela prema vrhu (sl. 8). Definirani su otisci fragmenata stabljika trava (*Poaceae*) (sl. 9) te otisci pšena i klasa žitarica (*Cerealia*) (sl. 10), a uočen je i otisak baze pljeve pšenice čija širina iznosi oko 1 mm (sl. 11), što, u ovom stanju očuvanosti, može upućivati i na jednozrnu i na dvozrnu

SAMPLE 1

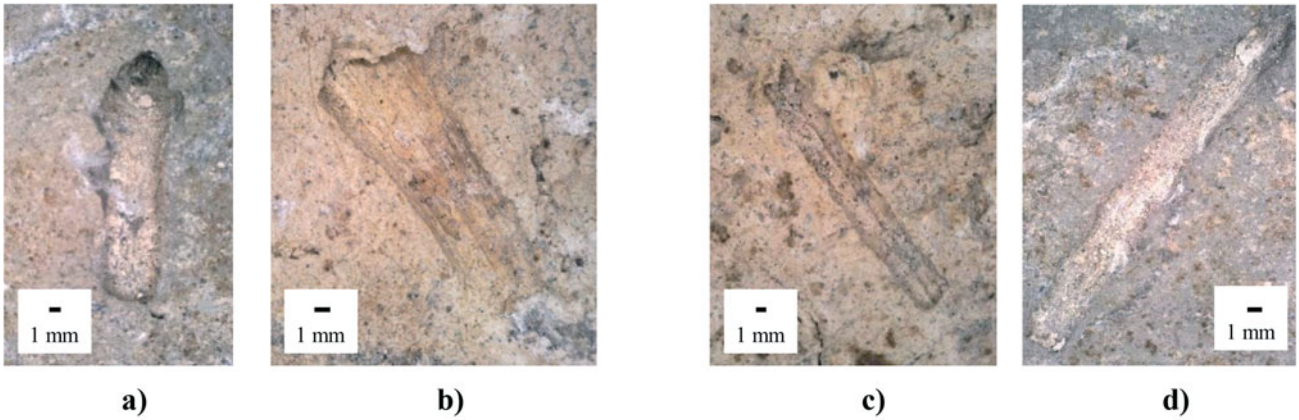
The potsherd measures 7.4 cm x 6.2 cm x 3.5 cm (Fig. 7) and has an outer wall that is slightly rounded with visible polishing, while the inner wall has not been preserved. Cavities which originally contained inclusions of organic and inorganic origin are noticeable on both sides. The light brown colour (10YR 6/3) is uniform over nearly the entire front of the sherd, with the exception of a small localized grey trace along the edge, while the broken-off central segment is dark grey (10YR 4/1). The texture of the purified clay is uniform, and it contains organic temper and a small quantity of mineral inclusions. The imprint of a wheat leaf (*Triticum* sp.) has been identified on the sherd, 35 mm long and 6–8 mm wide, with a pronounced central groove and several parallel lower grooves extending from it alternately to the edge of the leaf, followed by one that is more pronounced. Furthermore, the leaf visibly tapers from its wider central part to its tip (Fig. 8). Imprints of grass (*Poaceae*) stem fragments (Fig. 9) have been identified, as well as imprints of cereal (*Cerealia*) grains and ears (Fig. 10), and also an imprint of a wheat glume base that is around 1 mm wide (Fig. 11). Given the state of preservation, this can indicate both einkorn wheat and emmer (*Triticum monococcum/dicoccum*). Still, taking into con-



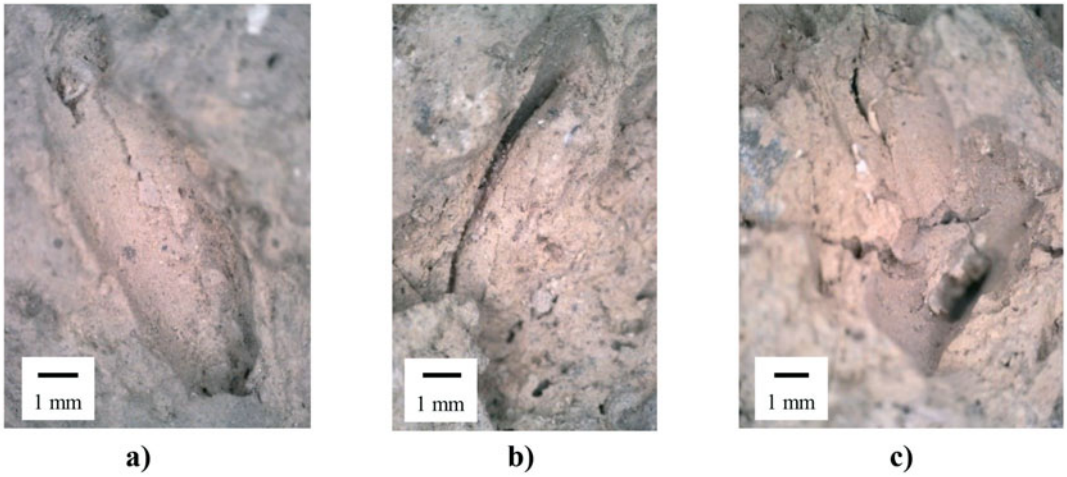
Sl. 7 — Nadin – Gradina, uzorak 1: a) vanjska stijenka i b) unutrašnja strana keramičkog ulomka s tragovima biljnog podrijetla (snimila: D. Knežić)
Fig. 7 — Nadin – Gradina, sample 1: a) outer wall and b) inner side of a pottery sherd containing traces of plant origin (photo by: D. Knežić)



Sl. 8 — Nadin – Gradina, uzorak 1: a) bočna strana keramičkog ulomka na kojem se nalazi otisak lista žitarice (*Cerealia*); b) uvećani otisak pod lupom (snimila: D. Knežić)
Sl. 8 — Nadin – Gradina, sample 1: a) lateral face of a pottery sherd containing an imprint of a cereal (*Cerealia*) leaf; b) enlarged imprint under a magnifier (photo by: D. Knežić)



Sl. 9 — Nadin – Gradina, uzorak 1: otisci stabljike trava (*Poaceae*) (snimila: D. Knežić)
Fig. 9 — Nadin – Gradina, sample 1: imprints of a grass (*Poaceae*) stem (photo by: D. Knežić)

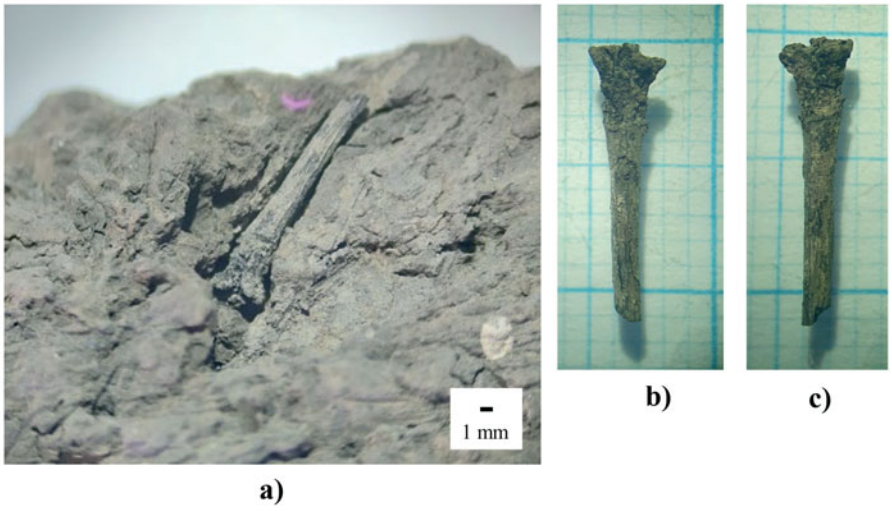


Sl. 10 — Nadin – Gradina, uzorak 1: a)–b) otisak pšena žitarica (*Cerealia*); c) otisak dijela klasa žitarica (*Cerealia*) – okomito (snimila: D. Knežić)
Fig. 10 — Nadin – Gradina, sample 1: a)–b) imprint of a cereal (*Cerealia*) grain; c) imprint of part of a cereal (*Cerealia*) ear – set vertically (photo by: D. Knežić)

pšenicu (*Triticum monococcum/dicoccum*). Ipak, s obzirom na naizgled vrlo suženi donji dio glume, najvjerojatnije se radi o jednozrnoj pšenici (*Triticum* cf. *monococcum*). Zanimljiv i jedinstven nalaz u unutrašnjosti keramičkog ulomka (sl. 12: a) predstavlja karbonizirani biljni ostatak plodovne stapke dimenzija 11 x 3 – 1,1 mm koja je bila vidljiva upravo zbog neočuvanosti stijenke (sl. 12: b–c). Način prezervacije u takvom obliku najvjerojatnije je povezan s položajem na ulomku koji je omogućio savršene uvjete za karbonizaciju – odsutnost kisika i polagano pečenje bez direktnog dodira s vatrom. Kako su klasičnom arheobotaničkom analizom (Knežić 2022) pronađeni ostaci vinove loze

sideration the seemingly very narrow lower part of the glume, it was most probably einkorn wheat (*Triticum* cf. *monococcum*). An interesting and unique discovery inside the potsherd (Fig. 12: a) is the carbonized plant remnant of a peduncle of 11 x 3–1.1 mm, visible precisely because the wall is poorly preserved (Fig. 12: b–c). The preservation in this form is probably related to its position on the sherd, which provided perfect conditions for its carbonization (lack of oxygen and slow firing with no direct contact with fire). In view of the fact that the classical archaeobotanical analysis (Knežić 2022) identified the remains of grape vine (*Vitis vinifera*), wild cherry (*Prunus avium*), blackthorn (*Prunus spinosa*) and cornelian cherry (*Cornus mas*), these species were primarily taken into

Sl. 11 — Nadin – Gradina, uzorak 1: a) otisak baze pljeve jednozrne pšenice (*Triticum monococcum*); b) usporedni crtež baze pljeve jednozrne pšenice (*Triticum monococcum*) (prema: Knežić 2022: 115, sl. 57)
Fig. 11 — Nadin – Gradina, sample 1: a) imprint of an einkorn (*Triticum monococcum*) glume base; b) comparative drawing of an einkorn (*Triticum monococcum*) glume base (after: Knežić 2022: 115, Fig. 57)



Sl. 12 — Nadin – Gradina, uzorak 1: a) dio keramičkog ulomka s krabooniziranim nalazom unutar otiska; b) jedna strana karbonizirane plodovne stapke drijena (cf. *Cornus mas*); c) druga strana karbonizirane plodovne stapke drijena (cf. *Cornus mas*) (snimila: D. Knežić)
Fig. 12 — Nadin – Gradina, sample 1: a) part of a pottery sherd containing a carbonized remnant within the imprint; b) one side of a carbonized cornelian cherry (cf. *Cornus mas*) peduncle; c) the other side of the carbonized cornelian cherry (cf. *Cornus mas*) peduncle (photo by: D. Knežić)

(*Vitis vinifera*), trešnje (*Prunus avium*), trnine (*Prunus spinosa*) i drijena (*Cornus mas*), te smo vrste prvenstveno uzeli u obzir pri identifikaciji. Teoretski, mogla bi biti i divlja šljiva (*Prunus cerasifera*) koja se smatra autohtonom na području Balkana (Zohary et al. 2012: 141), pa smo usporedili i njene stapke, ali ne odgovaraju, prije svega duljinom. Stapka vinove loze izgleda bitno dru-

consideration during the identification. In theory, the peduncle could also belong to the cherry plum (*Prunus cerasifera*), deemed autochthonous in the Balkans (Zohary et al. 2012: 141), so we also compared it to cherry-plum peduncles. They were not a match, primarily due to their length. The grapevine peduncle is very different in appearance. The blackthorn peduncle is noticeably shorter than the other species, and the breakage

gačije. Stapka trnine je često zamjetno kraća od ostalih vrsta, a lom nađene stapke stvara dojam da je bila veće duljine. Stapka divlje trešnje (*Prunus avium*) djeluje nešto tanje i sitnije, barem prema dostupnom materijalu za usporedbu. Nabliže nađenom ostatku je drijen, pa se najvjerojatnije radi o plodovnoj stapci drijena (cf. *Cornus mas*).

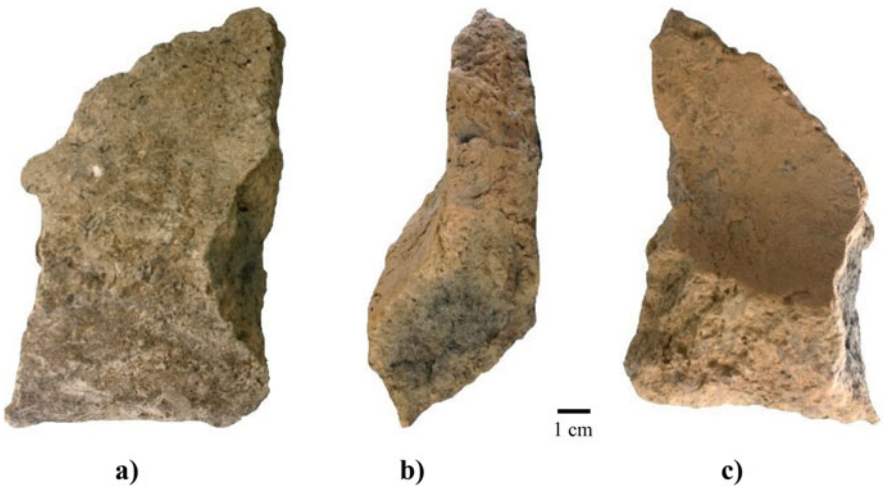
UZORAK 2

Ulomak dna posude ima dimenzije 13 cm x 6,5 cm x 2,5 – 4 cm (sl. 13) i nemarno zaravnjene stijenke na kojima su jasno vidljive perforacije, odnosno otisci organskog podrijetla. Površina je ujednačene svjetlosmeđe boje (7.5YR 6/3), dok je u presjeku uočljiva siva boja (7.5YR 5/1). Pročišćena glina ujednačene teksture sadrži organske primjese i malu količinu mineralnih inkluzija. Izdvojen je jasan otisak cilindričnog oblika 19 mm x 3 – 1,5 mm za koji je prvotno pretpostavljeno kako se radi o stabljici žitarica zbog robusnosti (sl. 14: a). No, izradom silikonskog odljeva vidljivo je kako morfologija više odgovara plodovnoj stapki nego stabljici žitarica s nodijem. Šire globularno ili oblo zadebljanje na kraju silikonskog odljeva oblikom podsjeća na karakteristično zadebljanje gornjeg dijela stapke širine 3 mm koja je bila pričvršćena za granu kod pojedinih vrsta roda *Prunus* (sl. 14: b). Isto tako, vidljiva je veća širina plodovne stapke uz gornji kraj (2,5 mm) u odnosu na središnji dio stapke koji je tanji (2 mm), a primjetno je i blago savijanje po dužini (sl. 14: b).

of the discovered peduncle leaves the impression that it was a longer one. The wild cherry (*Prunus avium*) peduncle appears to be somewhat thinner and smaller, at least on the basis of the available comparative material. The closest match to the discovered remnant is cornelian cherry, so it is most probably a cornelian-cherry peduncle (cf. *Cornus mas*).

SAMPLE 2

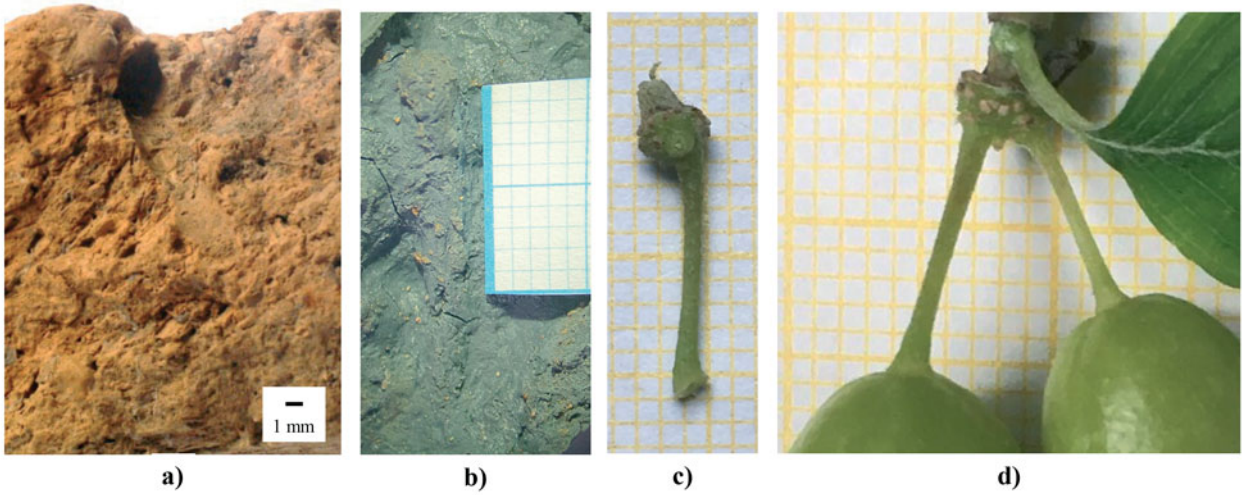
This shard of a vessel bottom is 13 cm x 6.5 cm x 2.5–4 cm (Fig. 13), with carelessly levelled wall displaying clearly visible perforations, that is, imprints of organic origin. The surface is uniformly light brown (7.5YR 6/3), while a grey colour (7.5YR 5/1) can be noticed at the cross-section. The uniformly-textured purified clay contains organic temper and a small quantity of mineral inclusions. A clear cylindrically-shaped imprint of 19 mm x 3–1.5 mm has been singled out, originally assumed to have been left by a cereal stem, on the basis of its robustness (Fig. 14: a). However, the silicone cast produced has revealed that its morphology is more consistent with a peduncle than a cereal stem with a nodium. The shape of the wide globular or round thickening at the end of the silicone cast resembles the characteristic thickening in the upper section of the peduncle, 3 mm wide, which was attached to the branch of certain species of the *Prunus* genus (Fig. 14: b). Furthermore, the peduncle is visibly wider at its upper end (2.5 mm) if compared to the central part of the peduncle, which is thinner (2 mm), and it can also be



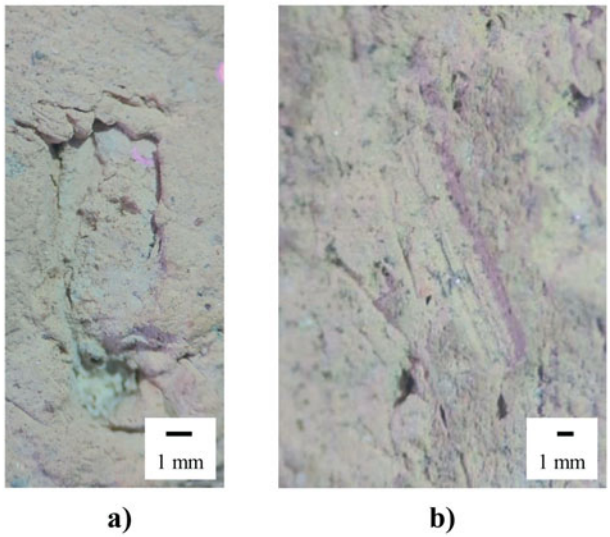
Sl. 13 — Nadin – Gradina, uzorak 2: a) vanjska stijenka; b) unutrašnja stijenka; c) bočni lom keramičkog ulomka s otiscima biljnog podrijetla (snimila: D. Knežić)
Fig. 13 — Nadin – Gradina, sample 2: a) outer wall; b) inner wall; c) lateral fracture of a pottery sherd containing imprints of plant origin (photo by: D. Knežić)

Navedeni elementi upućuju na dvije vrste – divlju šljivu (*Prunus cerasifera*) ili drijen (*Cornus mas*), no detaljna usporedba plodovnih stapki ipak više ide u prilog drijenu (cf. *Cornus mas*) (sl. 14: c–d). Nadalje, definiran je otisak unutrašnjeg dijela pljeve ili obuvenca (lat. *lemma*) pšenice (*Triticum* sp.) dimenzija 7 x 3 mm (sl. 15: a). Na temelju morfologije bočnih rubova otiska koji se doimaju paralaleni što bi odgovaralo pljevi ili obuvencu, dok je kod košuljice (lat. *palea*), bilo pljevičaste ili nepljevičaste pšenice (*Triticum* sp.), karakteristično sužavanje od središta prema vrhu. Zamijećeni su i otisci stabljika trava (*Poaceae*) koje su prepoznatljive po površinskoj strukturi s uzdužnim paralelnim linijama (sl. 15: b).

noticed that it is slightly curved lengthwise (Fig. 14: b). These elements suggest two species: wild cherry plum (*Prunus cerasifera*) and cornelian cherry (*Cornus mas*). A detailed comparison of these peduncles goes in favour of cornelian cherry (cf. *Cornus mas*) (Fig. 14: c–d). In addition, an imprint of the inner part of a wheat (*Triticum* sp.) lemma has been identified, of 7 x 3 mm (Fig. 15: a). On the basis of the morphology of the lateral edges of the imprint, which seem to be parallel, the imprint corresponds to a lemma, whereas the palea of both hulled and naked wheat (*Triticum* sp.) tapers characteristically from the central part to the tip. Imprints of grass (*Poaceae*) stems have also been identified, recognizable by their surface structure with parallel longitudinal lines (Fig. 15: b).



Sl. 14 — Nadin – Gradina, uzorak 2: a) dio keramičkog ulomka s otiskom cilindričnog oblika koji se manjim dijelom nastavlja u unutrašnjost; b) silikonski odljev otiska gornjeg dijela plodovne stapke (snimila: D. Knežić); c) recentni primjer peteljke nezrelog drijena (*Cornus mas*) s globularnim zadebljanjem na gornjem dijelu koji je bio pričvršćen na granu i donjim krajem iz kojeg raste plod; d) recentni primjer nezrelog drijena (*Cornus mas*) (snimila: R. Šoštarić)
Fig. 14 — Nadin – Gradina, sample 2: a) part of a pottery sherd with a cylindrical imprint, a small part of which continues on the inner side; b) silicone cast of the imprint of the upper part of a peduncle (photo by: D. Knežić); c) recent example of a petiole of an unripe cornelian cherry (*Cornus mas*) with a globular thickening in its upper part where it was attached to a branch, and the lower end from which the fruit grows; d) recent example of an unripe cornelian cherry (*Cornus mas*) (photo by: R. Šoštarić)



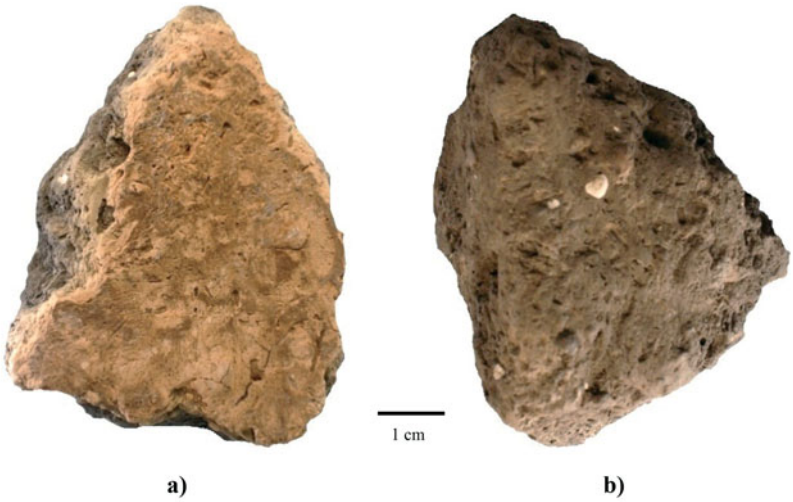
Sl. 15 — Nadin – Gradina, uzorak 2: a) otisak obuvenca (lat. *lemmae*) pšenice (*Triticum* sp.); b) otisak stabljike trave (*Poaceae*) (snimila: D. Knežić)
Fig. 15 — Nadin – Gradina, sample 2: a) imprint of a wheat (*Triticum* sp.) lemma; b) imprint of a grass (*Poaceae*) stem (photo by: D. Knežić)

UZORAK 3

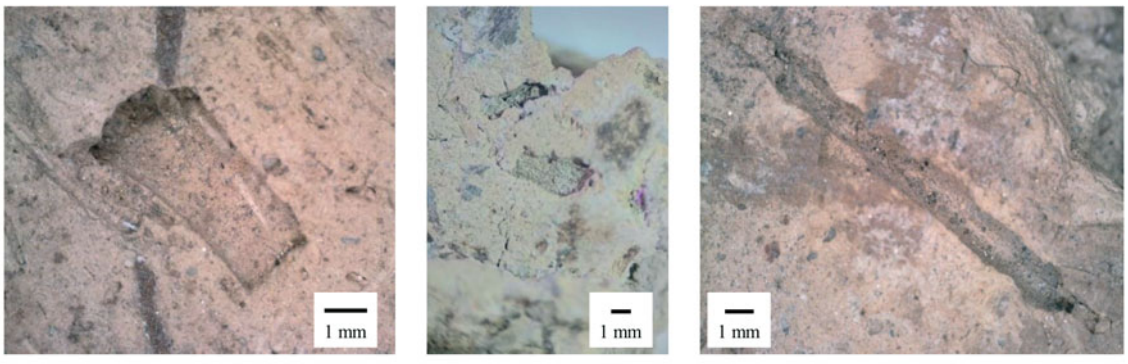
Keramički ulomak dimenzija 6,5 x 4,5 x 2,8 cm ima očuvanu samo vanjsku stijenku svijetlo smeđe boje (7.5YR 6/4) koja je zaravnjena (sl. 16), dok je središnji dio tamno sive boje (7.5YR 4/1). Izrađen je od pročišćene gline ujednačene teksture koja sadrži organske primjese i malu količinu mineralnih inkluzija. Na vanjskoj stijenci uočen je otisak rahisa ječma (*Hordeum vulgare*) dimenzija 3,5 x 1,8 mm kao i otisci usitnjenih stabljika trava (*Poaceae*) (sl. 17). S obzirom na oblik rahisa ječma, koji je više pravokutan, izduženiji s manje izraženim proširenjem u gornjem dijelu, za razliku od rahisa šesterorednog ječma koji ima izrazito prošireni gornji dio rahisa i nešto je kraći (usp. npr. Motuzaite Matuzeviciute et al. 2021), otisak smo identificirali kao dvoredni ječam (*Hordeum vulgare* subsp. *distichum*).

SAMPLE 3

Only the outer wall of this pottery sherd of 6.5 x 4.5 x 2.8 cm has been preserved. It is light brown (7.5YR 6/4) and has been levelled (Fig. 16), while its cross-section is dark grey (7.5YR 4/1). It was made of uniformly-textured purified clay which contains organic temper and a small quantity of mineral inclusions. On the outer wall, the imprint of a barley (*Hordeum vulgare*) rachis of 3.5 x 1.8 mm has been identified, as well as imprints of chopped grass (*Poaceae*) stems (Fig. 17). In view of the shape of the barley rachis, which is rather rectangular and extended, with a widening in its upper part, and thus differs from the rachis of a 6-rowed barley, whose upper part is much wider, and which is somewhat shorter (cf. for example Motuzaite Matuzeviciute et al. 2021), the imprint has been identified as 2-rowed barley (*Hordeum vulgare* subsp. *distichum*).



Sl. 16 — Nadin – Gradina, uzorak 3: a) vanjska stijenka i b) unutrašnja strana keramičkog ulomka s tragovima biljnih otisaka (snimila: D. Knežić)
Fig. 16 — Nadin – Gradina, sample 3: a) outer wall and b) inner side of a pottery sherd containing traces of plant imprints (photo by: D. Knežić)



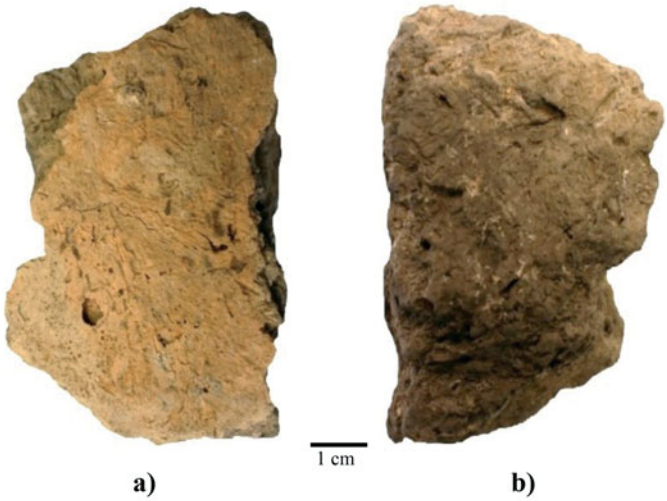
Sl. 17 — Nadin – Gradina, uzorak 3: a) vanjska stijenka ulomka s otiskom rahisa dvorednog ječma (*Hordeum vulgare* var. *distichum*); b) – c) otisci usitnjenih stabljika trava (*Poaceae*) (snimila: D. Knežić)
Fig. 17 — Nadin – Gradina, sample 3: a) outer wall of a sherd with imprint of a rachis of two-rowed barley (*Hordeum vulgare* var. *distichum*); b) – c) imprints of chopped-up grass (*Poaceae*) stems (photo by: D. Knežić)

UZORAK 4

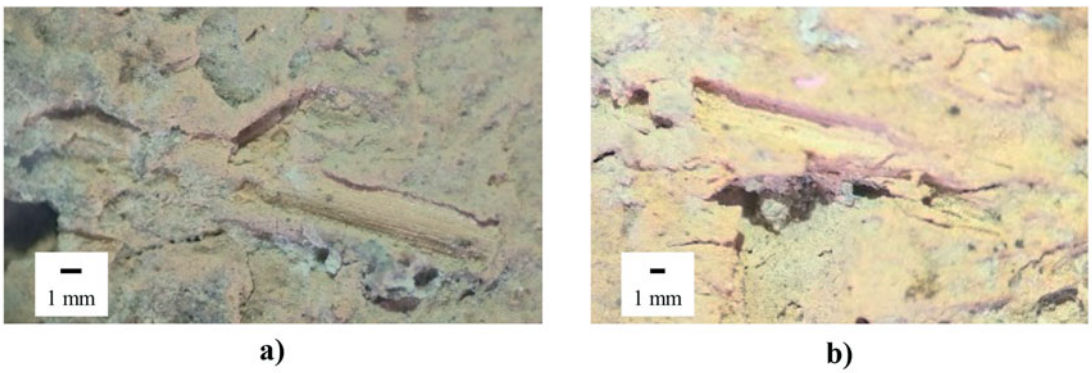
Keramički ulomak dimenzija 7 x 4,5 x 2,5 cm ima očuvanu samo vanjsku zaravnjenu stijenku nemarno zaglađene površine (sl. 18). S druge strane nalazi se središnji dio ulomka gdje je lom nastao. Boja ulomka je neujednačena, na vanjskoj stijenki vidi se svijetlo smeđa boja (7.5YR 6/4), a na ostalim je dijelovima tamno sive boje (7.5YR 4/1). Pročišćena glina ujednačene teksture sadrži organske primjese i malu količinu mineralnih inkluzija. Na ulomku su evidentni tragovi mineralizirane stabljike, vlati i otisak pljeve žitarica (*Cerealia*) (sl. 19–20). Uočen je otisak rahisa nepljevičaste pšenice labavog klasa (*Triticum durum* s.l.) dimenzija 4 x 2 mm te iznad njega otisak stabljike trava (*Poaceae*) (sl. 21). Pronađeni su i otisci sitnozrnih žitarica (*Panicum/Setaria* sp.) i otisci pljeve istih (sl. 22).

SAMPLE 4

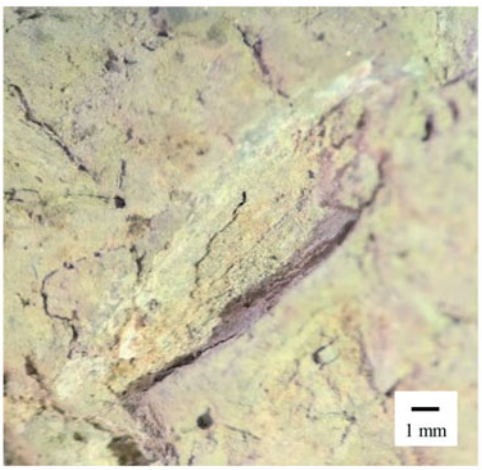
Only the levelled outer wall of this potsherd of 7 x 4.5 x 2.5 cm has been preserved, with carelessly polished surface (Fig. 18). On the other side there is the central part of the sherd with the breakage. The colour of the sherd is uneven: the outer wall is light brown (7.5YR 6/4), while the other sections are dark grey (7.5YR 4/1). The uniformly-textured purified clay contains organic temper and a small quantity of mineral inclusions. Traces of mineralized cereal (*Cerealia*) stem, leaf and imprint of glume have been recorded on the sherd (Figs. 19–20). An imprint of a rachis of naked wheat with lax ears (*Triticum durum* s.l.) has been observed, with dimensions of 4 x 2 mm, and an imprint of a grass (*Poaceae)* stem above it (Fig. 21). Imprints of small-grained cereals (*Panicum/Setaria* sp.) and of their glumes have also been found (Fig. 22).



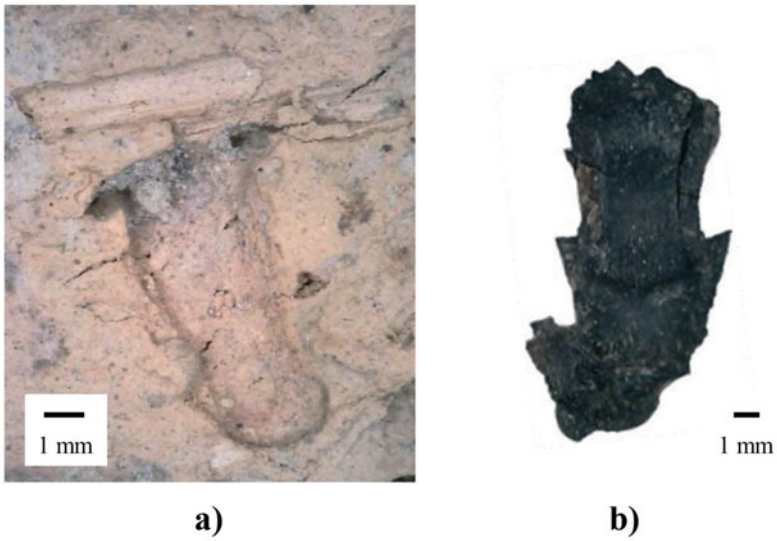
Sl. 18 — Nadin – Gradina, uzorak 4: a) vanjska stijenka i b) unutrašnja strana keramičkog ulomka (snimila: D. Knežić)
Fig. 18 — Nadin – Gradina, sample 4: a) outer wall and b) inner side of a pottery sherd (photo by: D. Knežić)



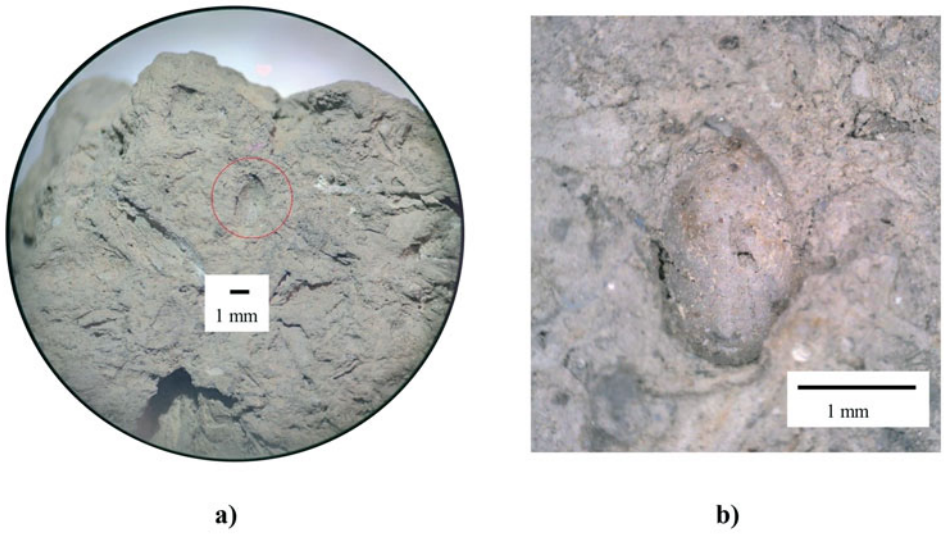
Sl. 19 — Nadin – Gradina, uzorak 4: mineralizirani ostatak a) stabljike i b) vlati žitarica (*Cerealia*) (snimila: D. Knežić)
Fig. 19 — Nadin – Gradina, sample 4: mineralized remains of a) a stem and b) leaves of a cereal (*Cerealia*) (photo by: D. Knežić)



Sl. 20 — Nadin – Gradina, uzorak 4: otisak žitarice (*Cerealia*) s dijelovima mineralizirane pljevice (snimila: D. Knežić)
Fig. 20 — Nadin – Gradina, sample 4: imprint of a cereal (*Cerealia*) with parts of a mineralized glume (photo by: D. Knežić)



Sl. 21 — Nadin – Gradina, uzorak 4: a) otisak rahisa tvrde pšenice (*Triticum durum* s.l.) iznad koje je vidljiv otisak stabljike trava (*Poaceae*); b) usporedni karbonizirani primjerak rahisa tvrde pšenice (*Triticum durum* s.l.) iz proučavanih uzoraka sedimenta s Gradine (snimila: D. Knežić)
Fig. 21 — Nadin – Gradina, sample 4: a) imprint of a rachis of durum wheat (*Triticum durum* s.l.) with an imprint of a grass (*Poaceae*) stem visible above it; b) comparative carbonized example of a rachis of durum wheat (*Triticum durum* s.l.) from the analysed samples of sediment taken from Gradina (photo by: D. Knežić)



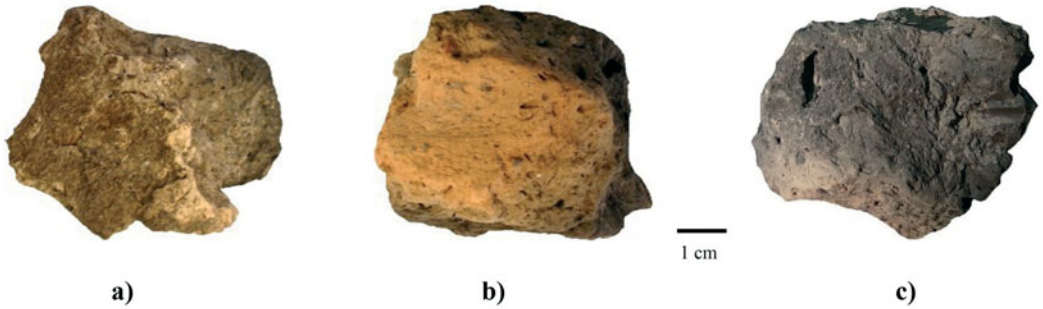
Sl. 22 — Nadin – Gradina, uzorak 4: a) otisak pšena sitnozrne žitarice (*Panicum/Setaria* sp.) pod malim i b) pod velikim povećanjem (snimila: D. Knežić)
Fig. 22 — Nadin – Gradina, sample 4: imprint of a grain of a small-grained cereal (*Panicum/Setaria* sp.) under a) low and b) high magnification (photo by: D. Knežić)

UZORAK 5

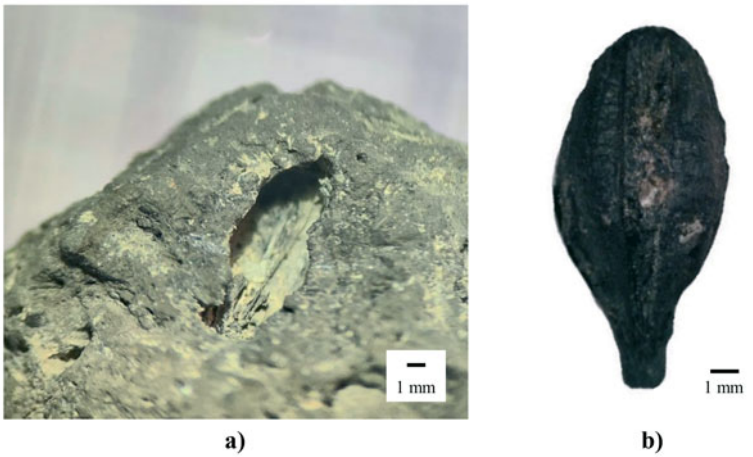
Manji keramički ulomak nepravilnog četvrtastog oblika ima dimenzije 4 x 3,5 x 3 cm (sl. 23). Vanjska stijenka je glatka i blago cilindrična u bočnom pogledu, a unutrašnja zaravnjena i hrapava. Boja keramike nije ujednačena već je na vanjskoj površinskoj stijenki svijetlo smeđe boje (2.5Y 8/2) (sl. 23: a), unutrašnja stijenka je nešto drugačije nijanse svijetlo smeđe boje (7.5YR 6/4) (sl. 23: b), dok je u presjeku evidentna tamno siva boja (7.5YR 4/1) (sl. 23: c). Pročišćena glina ujednačene teksture sadrži organske primjese i malu količinu mineralnih inkluzija. Na ulomku je determiniran otisak ječma (*Hordeum vulgare*) dimenzija 8 x 3,5 mm s mineraliziranom pljevom koja je i dalje vidljiva u udubini otiska (sl. 24) te otisak stabljike žitarica (*Cerealia*) (sl. 25).

SAMPLE 5

The dimensions of this small irregularly-shaped four-sided pottery sherd are 4 x 3.5 x 3 cm (Fig. 23). Its outer wall is smooth and slightly cylindrical when viewed from the side, while its inner wall is levelled and coarse. The colour is uneven: the outer surface wall is light brown (2.5Y 8/2) (Fig. 23: a), while the tone of the inner wall is somewhat different light brown (7.5YR 6/4) (Fig. 23: b), with dark grey recorded in the cross-section (7.5YR 4/1) (Fig. 23: c). The uniformly-textured purified clay contains organic temper and a small quantity of mineral inclusions. An imprint of barley (*Hordeum vulgare*) of 8 x 3.5 mm has been identified on the sherd, with a mineralized glume still visible in the imprint void (Fig. 24), as well as the imprint of a cereal (*Cerealia*) stem (Fig. 25).



Sl. 23 — Nadin – Gradina, uzorak 5: a) vanjska, b) unutrašnja i c) bočna stijenka keramičkog ulomka s vidljivim tragovima biljnih otisaka (snimila: D. Knežić)
Fig. 23 — Nadin – Gradina, sample 5: a) outer, b) inner and c) side wall of a pottery sherd with visible traces of plant remains (photo by: D. Knežić)



Sl. 24 — Nadin – Gradina, uzorak 5: a) otisak pšena ječma (*Hordeum vulgare*) s dijelovima karbonizirane pljeve koja se i dalje nalazi sljubljena s podlogom na ulomku; b) primjer karboniziranog pljevičastog ječma (*Hordeum vulgare*) iz proučavanih uzoraka sedimenta koji bi teoretski odgovarao otisku (snimila: D. Knežić)
Fig. 24 — Nadin – Gradina, sample 5: a) imprint of a barley (*Hordeum vulgare*) grain with parts of a carbonized glume which is still attached to the surface on the sherd; b) example of carbonized hulled barley (*Hordeum vulgare*) from the analysed samples of sediment that theoretically corresponds to the imprint (photo by: D. Knežić)

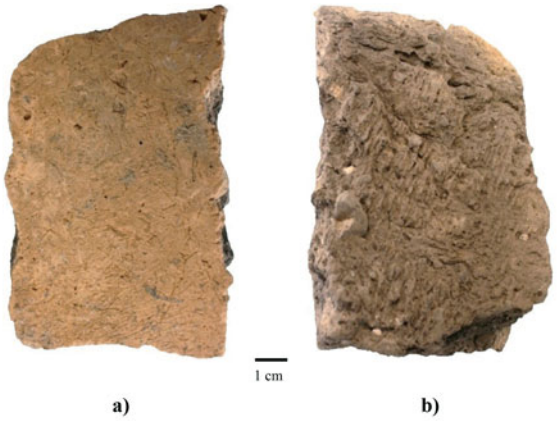
Sl. 25 — Nadin – Gradina, uzorak 5: otisak fragmenta stabljike žitarica (*Cerealia*) (snimila: D. Knežić)
Fig. 25 — Nadin – Gradina, sample 5: imprint of a fragment of a cereal (*Cerealia*) stem (photo by: D. Knežić)

UZORAK 6

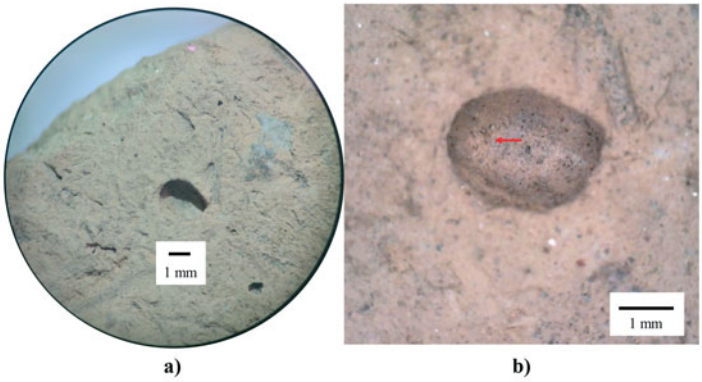
Keramički ulomak ima dimenzije 8,5 x 5,5 x 2,5 cm i kod njega je očuvana samo vanjska stijenka svijetlo smeđe boje (7.5YR 6/4) koja je zaglađena (sl. 26), dok je u presjeku evidentna tamno siva boja (7.5YR 4/1). Pročišćena glina ujednačene teksture sadrži organske primjese i malu količinu mineralnih inkluzija. Na ulomku je evidentiran jedan otisak sitnozrne žitarice (*Panicum/Setaria* sp.) s diskretno vidljivim otiskom embrija (sl. 27) i otisak pšena žitarica (*Cerealia*) kod koje se pljeva očuvala u mineraliziranom obliku (sl. 28).

SAMPLE 6

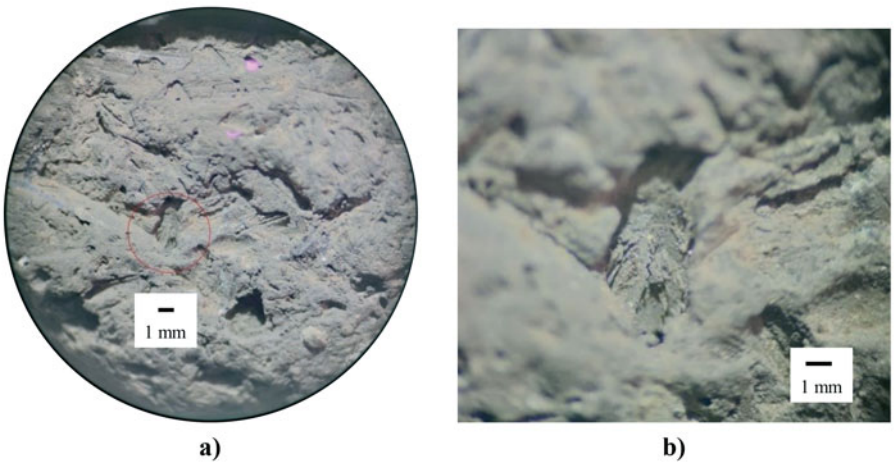
Only the outer wall of this pottery sherd of 8.5 x 5.5 x 2.5 cm has been preserved. It is light brown (7.5YR 6/4) and polished (Fig. 26), while its cross-section is dark grey (7.5YR 4/1). The uniformly-textured purified clay contains organic temper and a small quantity of mineral inclusions. The imprint of a small-grained cereal (*Panicum/Setaria* sp.) has been recorded on the sherd, with the discretely visible imprint of an embryo (Fig. 27) and the imprint of a cereal (*Cerealia*) grain with glume preserved in mineralized form (Fig. 28).



Sl. 26 — Nadin – Gradina, uzorak 6: a) vanjska stijenka i b) unutrašnja strana keramičkog ulomka s tragovima biljnih otisaka (snimila: D. Knežić)
Fig. 26 — Nadin – Gradina, sample 6: a) outer wall and b) inner side of a pottery sherd with traces of plant remains (photo by: D. Knežić)



Sl. 27 — Nadin – Gradina, uzorak 6: a) otisak sitnozrne (*Panicum/Setaria* sp.) žitarice i b) isti otisak pod uvećanjem s naznačenim otiskom embrionalnog dijela odnosno hiluma u bočnom dijelu unutrašnjosti otiska (snimila: D. Knežić)
Fig. 27 — Nadin – Gradina, sample 6: a) imprint of a small-grained cereal (*Panicum/Setaria* sp.) and b) the same imprint under magnification with indicated imprint of the embryonal part or hilum in the lateral part of the inner side of the imprint (photo by: D. Knežić)



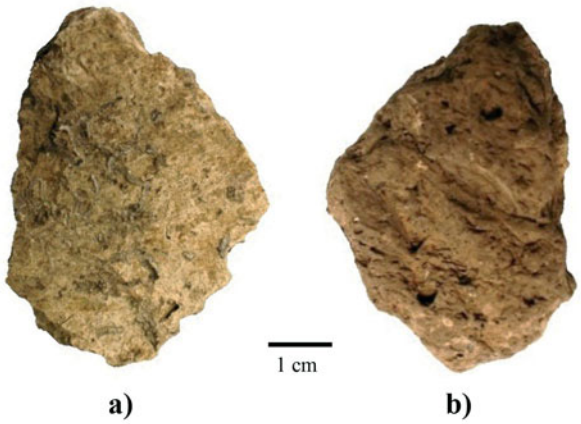
Sl. 28 — Nadin – Gradina, uzorak 6: a) otisak s dijelom mineralizirane pljevice žitarica (*Cerealia*) koja se nazire iz dubine otiska i b) otisak pod uvećanjem (snimila: D. Knežić)
Fig. 28 — Nadin – Gradina, sample 6: a) imprint with part of a mineralized cereal (*Cerealia*) glume discernible from the depth of the imprint and b) imprint under magnification (photo by: D. Knežić)

UZORAK 7

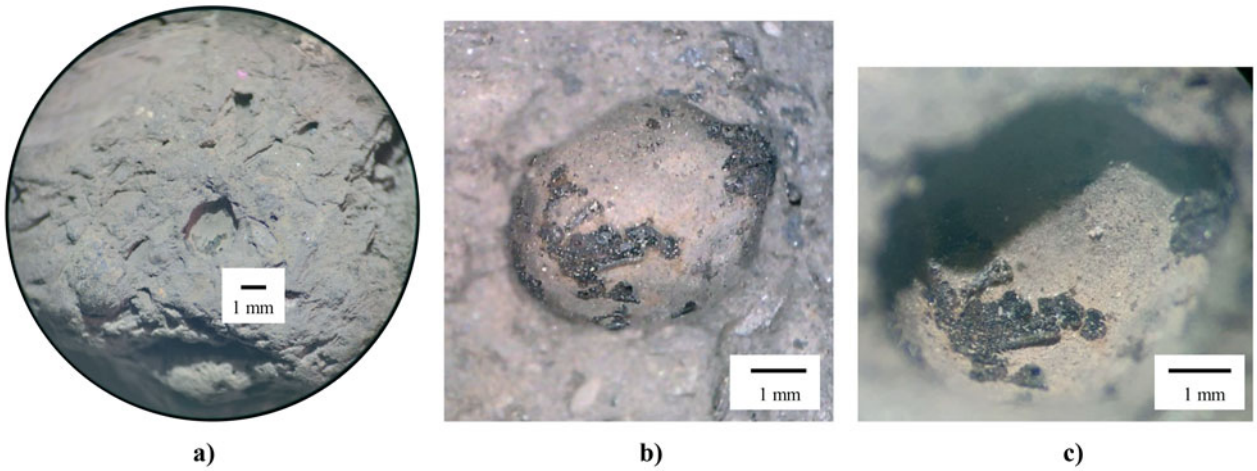
Keramički ulomak dimenzija 4 x 3 x 1,3 cm ima očuvanu samo vanjsku stijenku koja je nemarno zaglađena (sl. 29). Ulomak je lagano konveksna oblika. Boja stijenke je svijetlo smeđe siva (7.5YR 6/2), dok je u presjeku evidentirana tamno siva boja (7.5YR 4/1). Pročišćena glina ujednačene teksture sadrži organske primjese i malu količinu mineralnih inkluzija. Na ulomku je detektiran jedan otisak sitnozrne žitarice prosa (*Panicum miliaceum*) dimenzija 3 x 2,5 mm s dijelovima pljeve koji su se očuvali u mineraliziranom obliku na površini otiska (sl. 30; usp. s: Bonnaire 2016: 108, Fig. 1). Na najvećem ostatku mineralizirane pljeve moguće je raspoznati sitne, paralelne linije koje idu po dužini, što odgovara morfologiji dorzalne strane pšena prosa. Na ulomku je uočen i prilično velik necjeloviti otisak lista s nejasnim uzdužnim paralelnim linijama duljine oko 15 mm i širine 6 mm koji najvjerojatnije pripada skupini žitarica (*Cerealia*) (sl. 31), no porodica trava (*Poaceae*), u koju spadaju i spomenute žitarice, je jako velika i razlike u morfologiji i strukturi vlati među određenim vrstama su minorne stoga je iznimno teško sa sigurnošću odrediti konkretnu vrstu.

SAMPLE 7

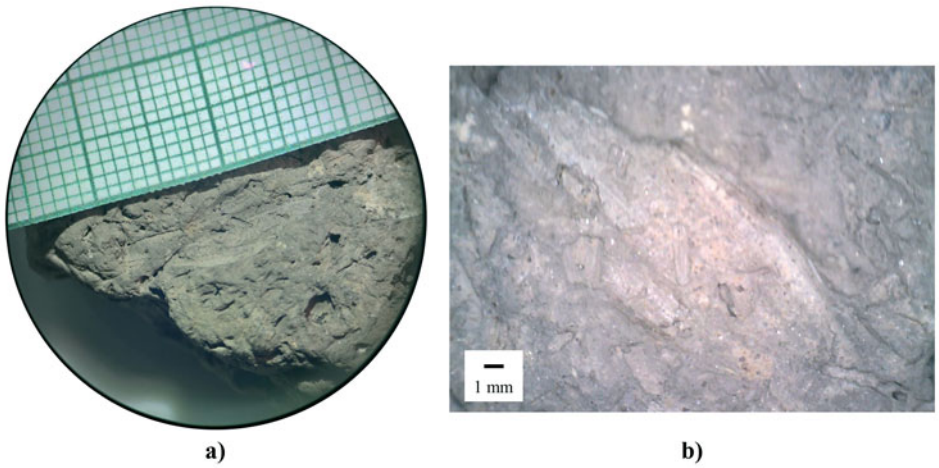
A pottery sherd of 4 x 3 x 1.3 cm, with only the outer wall preserved, carelessly polished (Fig. 29). The sherd is slightly convex. The wall of the sherd is light brown-grey (7.5YR 6/2), while the cross-section is dark grey (7.5YR 4/1). The uniformly-textured purified clay contains organic temper and a small quantity of mineral inclusions. The imprint of a small-grained cereal, broomcorn millet (*Panicum miliaceum*) has been identified on the sherd. It is 3 x 2.5 mm in size, and includes elements of a glume preserved in mineralized form on the surface of the imprint (Fig. 30; cf. Bonnaire 2016: 108, Fig. 1). Small parallel longitudinal lines can be discerned on the largest remnant of the mineralized glume, which corresponds to the morphology of the dorsal side of a broomcorn-millet grain. A rather large incomplete leaf imprint with unclear longitudinal parallel lines, approximately 15 mm long and 6 mm wide, has also been noticed on the sherd. It most probably belongs to the order of cereals (*Cerealia*) (Fig. 331), but the grass family (*Poaceae*), which includes those cereals, is very wide, and the differences in the leaf morphology and structure among specific species are minor, making it very difficult to identify the concrete species with certainty.



Sl. 29 — Nadin – Gradina, uzorak 7: a) prednja i b) stražnja strana keramičkog ulomka s otiscima biljnog podrijetla (snimila: D. Knežić)
Fig. 29 — Nadin – Gradina, sample 7: a) front and b) back of a pottery sherd with imprints of plant origin (photo by: D. Knežić)



Sl. 30 — Nadin – Gradina, uzorak 7: a) definirani otisak prosa (*Panicum miliaceum*) s pljevom i b) mineralizirana pljevica prosa koja je i dalje slijepljena s površinom unutar otiska te c) vidljiva celularna struktura mineralizirane pljeve prosa s tankim, paralelnim uzdužnim linijama (snimila: D. Knežić)
Fig. 30 — Nadin – Gradina, sample 7: a) defined imprint of broomcorn millet (*Panicum miliaceum*) with glume and b) mineralized broomcorn-millet glume, still attached to the surface within the imprint, and c) visible cellular structure of the mineralized broomcorn-millet glume with thin, parallel longitudinal lines (photo by: D. Knežić)



Sl. 31 — Nadin – Gradina, uzorak 7: otisak lista žitarice (*Cerealia*) na keramičkom ulomku (snimila: D. Knežić)
Fig. 31 — Nadin – Gradina, sample 7: imprint of a cereal (*Cerealia*) leaf on a pottery sherd (photo by: D. Knežić)

UZORAK 8

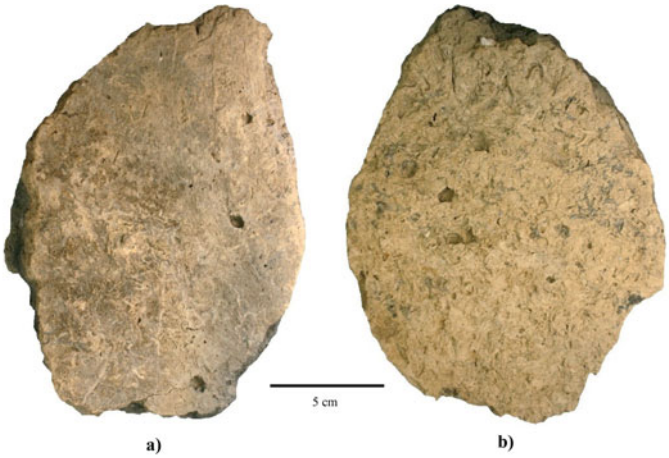
Keramički ulomak ima dimenzije 16 x 12,3 x 2,5 cm i potpuno je ravan (sl. 32). Prednja je stijenka obrađena zaglađivanjem, a unutrašnja je stijenka nezaglađena s neravnom površinom s velikim brojem otisaka. Boja keramičke smjese nije ujednačena već je na vanjskoj svijetlo smeđe-sive boje (10YR 6/2), unutrašnja stijenka je nešto svijetlije smeđe boje (10YR 7/3), a na lomu se nazire središnji dio koji je tamno sive boje (10YR 4/1). Pročišćena glina ujednačene

SAMPLE 8

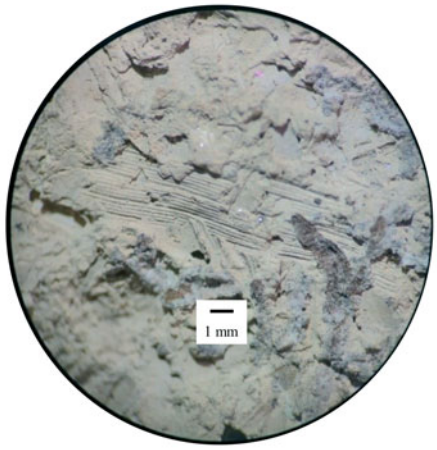
This pottery sherd of 16 x 12.3 x 2.5 cm is completely flat (Fig. 32). The front wall is polished, while the inner wall is unpolished, with uneven surface and a number of imprints. The clay-paste colour is uneven: it is light brown-grey (10YR 6/2) on the outside and somewhat lighter brown on the inside (10YR 7/3), while the breakage displays a central part that is dark grey (10YR 4/1). The uniformly-textured purified clay contains organic temper and a small quantity of mineral inclusions. The exposed central part of the

teksture sadrži organske primjese i malu količinu mineralnih inkluzija. Izložen središnji dio ulomka prekriven je brojnim otiscima organskog podrijetla. Ondje su identificirani ostaci vlati najvjerojatnije sitnozrnih žitarica (cf. *Panicum/Setaria* sp.) (sl. 33) duljine 1 cm i širine 3 – 2 mm s istaknutom središnjom brazdom, a iza pet niskih paralelnih brazda ide jedna naglašenija pa ponovno pet niskih brazdi i jedna izraženija koja čini marginu lista. Na istom ulomku nađeni su i drugi otisci vlati i stabljika kultiviranih trava (*Cerealia*) (sl. 34). Uočeni su i brojni otisci sitnozrnih žitarica s pljevom i bez nje (*Panicum/Setaria* sp.) (sl. 35: a, d, c, f), a među njima je definiran otisak klipastog muhara (*Setaria italica*) s mineraliziranim ostacima pljeve (sl. 35: b, e). Nađeni su i otisci klasića žitarica (*Cerealia*) u pljevi (sl. 36) od kojih jedan ima tragove osja (sl. 36: b), pronađen je i otisak dijela klasa žitarica (*Cerealia*) (sl. 37).

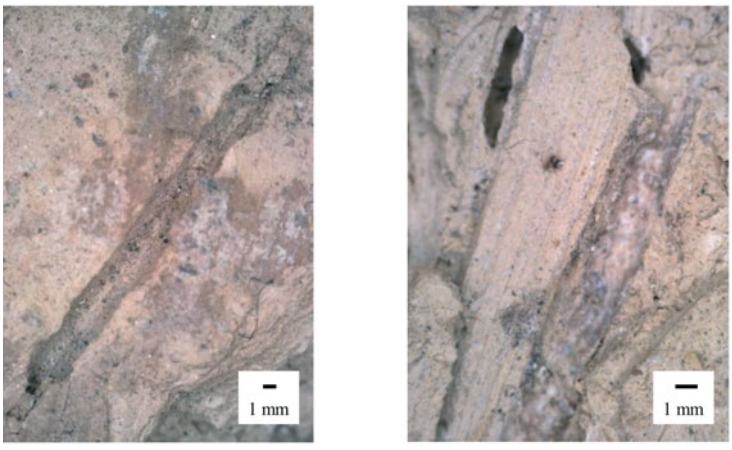
sherd is covered with numerous imprints of organic origin. Remains of leaves, most probably of small-grained cereals (cf. *Panicum/Setaria* sp.) (Fig. 33), have been identified there. They are 1 cm long and 3–2 mm wide, with a pronounced central groove, and after five rows of parallel grooves there is one that is more pronounced, followed by another five rows of parallel grooves and another pronounced one which makes up the edge of the leaf. Other imprints of leaves and stems of cultivated grasses (*Cerealia*) have been found on the same sherd (Fig. 34). Numerous imprints of small-grained cereals, with and without glume (*Panicum/Setaria* sp.), have also been observed (Fig. 35: a, c, d, f), including an identified imprint of foxtail millet (*Setaria italica*) with mineralized remains of a glume (Fig. 35: b, e). Remains of cereal (*Cerealia*) spikelets in glumes have also been found (Fig. 36), one of them with traces of the awn (Fig. 36: b), and there was also an imprint of a segment of a cereal (*Cerealia*) ear (Fig. 37).



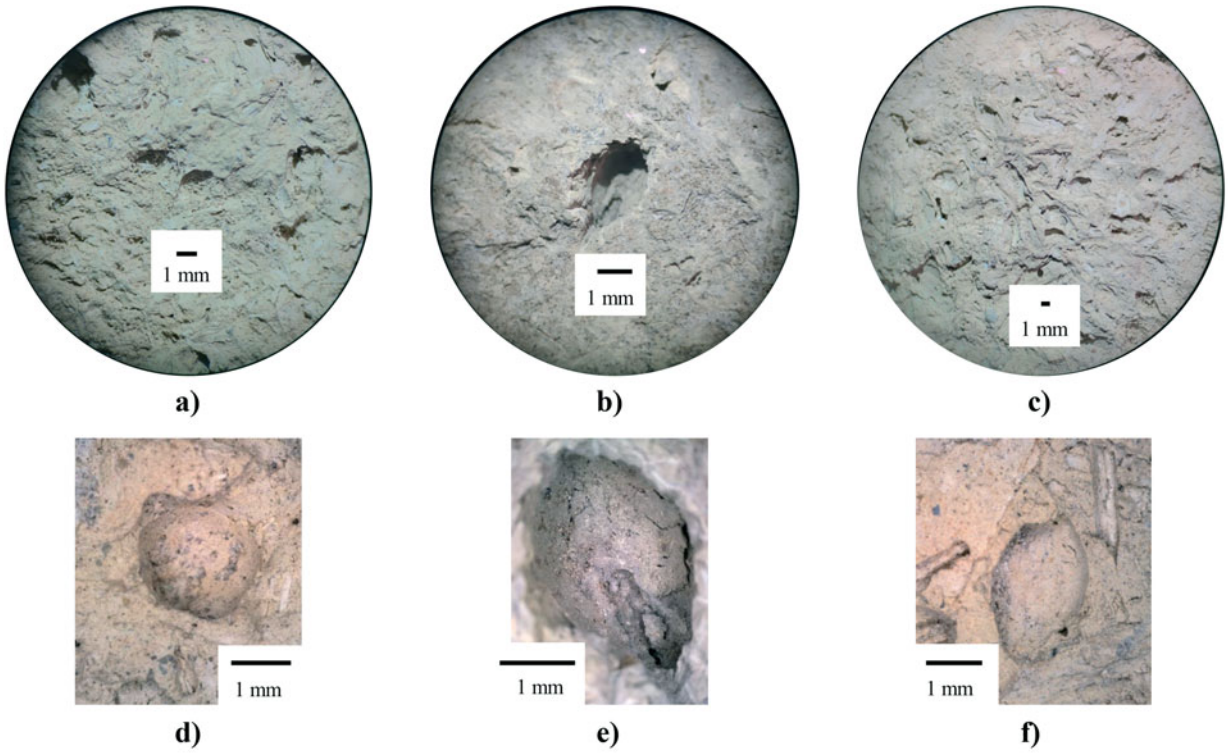
Sl. 32 — Nadin – Gradina, uzorak 8: a) vanjska i b) unutrašnja stijenka keramičkog ulomka s tragovima otisaka biljnog podrijetla (snimila: D. Knežić)
Fig. 32 — Nadin – Gradina, sample 8: a) outer and b) inner wall of a pottery sherd with traces of imprints of plant origin (photo by: D. Knežić)



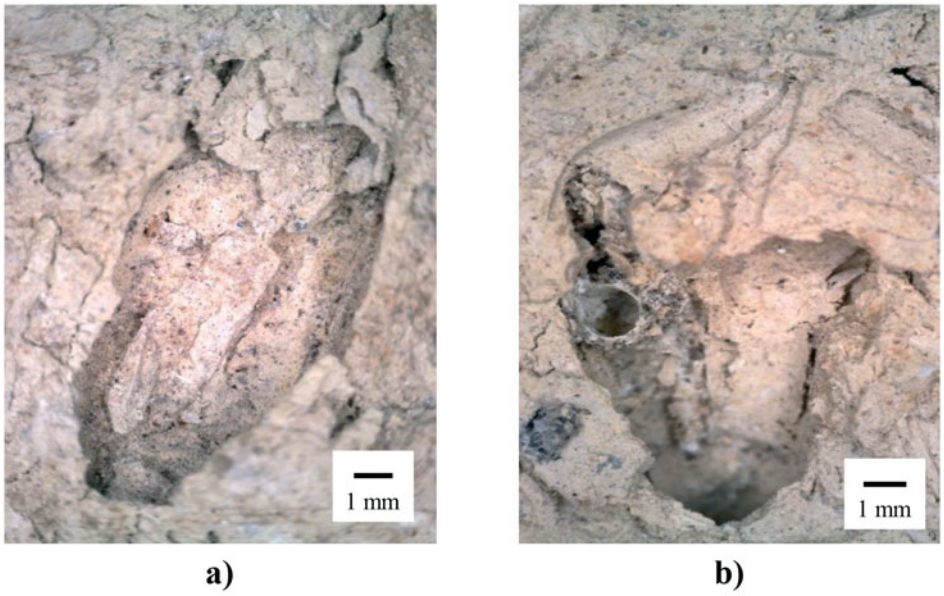
Sl. 33 — Nadin – Gradina, uzorak 8: otisak lista žitarice (Cerealia) (snimila: D. Knežić)
Fig. 33 — Nadin – Gradina, sample 8: imprint of a cereal (Cerealia) leaf (photo by: D. Knežić)



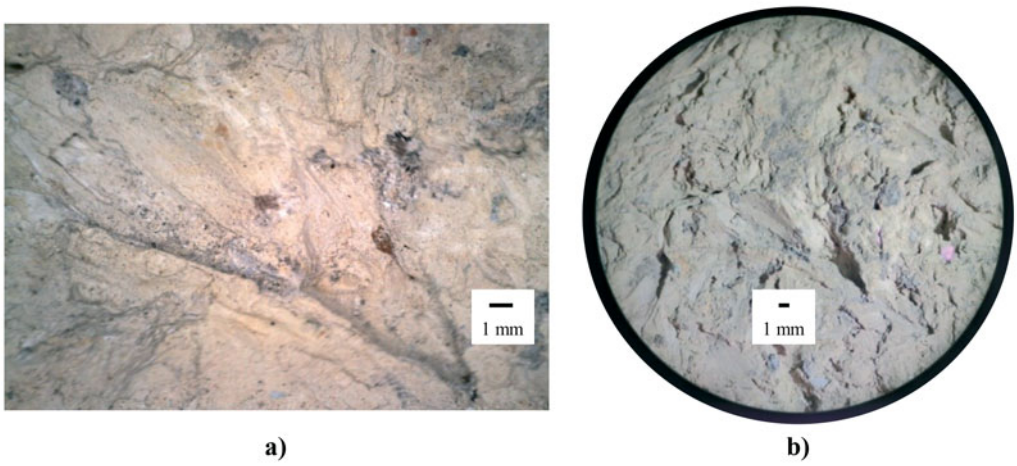
Sl. 34 — Nadin – Gradina, uzorak 8: otisak a) lista i b) stabljike žitarice (Cerealia) (snimila: D. Knežić)
Fig. 34 — Nadin – Gradina, sample 8: imprint of a cereal (Cerealia) a) leaf and b) stem (photo by: D. Knežić)



Sl. 35 — Nadin – Gradina, uzorak 8: a), c), d), f) otisci sitnozrnih žitarica (*Panicum/Setaria* sp.); b), e) otisak pretpostavljenog klipastog muhara (cf. *Setaria italica*) s mineraliziranom pljevom (snimila: D. Knežić)
Fig. 35 — Nadin – Gradina, sample 8: a), c), d), f) imprints of small-grained cereals (*Panicum/Setaria* sp.); b), e) imprint of (assumed to be) foxtail millet (cf. *Setaria italica*) with mineralized glume (photo by: D. Knežić)



Sl. 36 — Nadin – Gradina, uzorak 8: a) otisak klasića i b) klasić s osjem žitarice (*Cerealia*) (snimila: D. Knežić)
Fig. 36 — Nadin – Gradina, sample 8: a) imprint of a spikelet and b) spikelet with cereal (*Cerealia*) awn (photo by: D. Knežić)



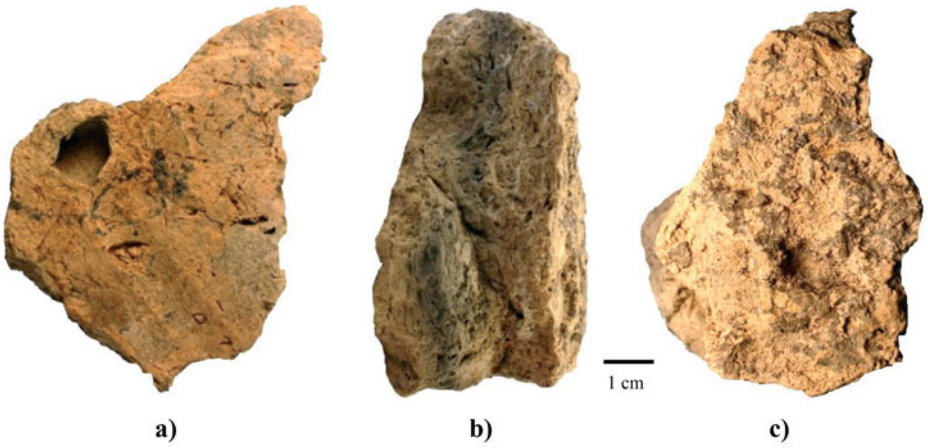
Sl. 37 — Nadin – Gradina, uzorak 8: dio klasa žitarice (*Cerealia*) (snimila: D. Knežić)
Fig. 37 — Nadin – Gradina, sample 8: part of a cereal (*Cerealia*) ear (photo by: D. Knežić)

UZORAK 9

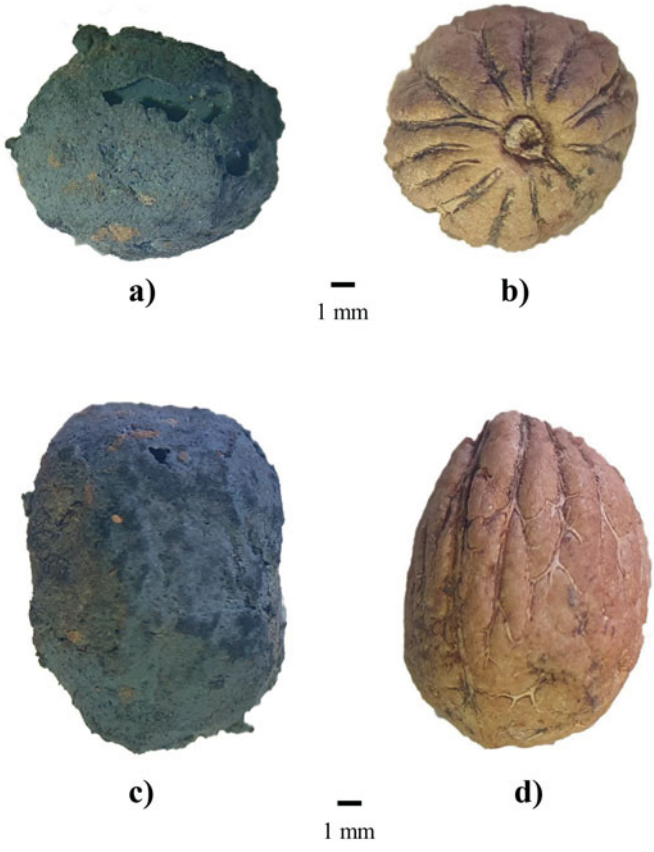
Keramički ulomak ima dimenzije 6,5 x 5 x 3 cm (sl. 38: a–c) i u potpunosti je ravan. Pročišćena glina ujednačene teksture sadrži organske primjese i malu količinu mineralnih inkluzija. Vanjska stijenka ima tragove namjernog zaglađivanje površine, dok je unutrašnja stijenka rustikalnog izgleda s neravnom površinom. Boja keramičke smjese nije ujednačena na svim dijelovima već su vanjska i unutrašnja stijenka svijetlo smeđe boje (7.5YR 6/4), a u presjeku se vidi da je unutrašnjost smjese sive boje (7.5YR 5/1). Na vanjskoj stijenci keramičkog ulomka uočen je dijagonalni otisak drvenaste stabljike (sl. 38: a), a on dijelom prelazi preko otiska dimenzija 1,2 x 0,7 cm koji je zbog svoje veličine i pozicije na kvalitetno pečenom keramičkom ulomku dozvoljavao izradu silikonskog odljeva. Pregledavanjem silikonskog odljeva u pozitivu utvrđeno je da se radi o koštici masline (*Olea europaea*) na temelju kakrakterističnog okruglasto-izduženog oblika sa zaravnjenim vršnim dijelom na mjestu hiluma, djelomično vidljivim karakterističnim razgranjenim brazdama po površini te blago zašiljenim donjim dijelom koštice (sl. 39). Na ulomku je još definiran otisak pljeve sitnozrne žitarice (*Panicum/Setaria* sp.) visine 2,5 mm i širine 1,5 mm (sl. 40: a) te otisak širine 2 – 5 mm i duljine 1 cm koji bi mogao odgovarati strukturi od dva klasića pljevičaste pšenice ili ječma (cf. *Triticum monococcum/dicoccum/spelta / Hordeum vulgare*) (sl. 40: b).

SAMPLE 9

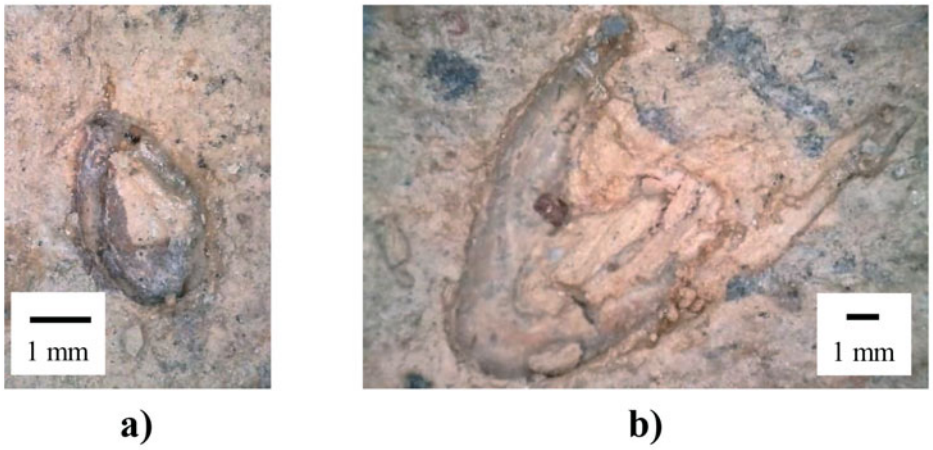
This pottery sherd of 6.5 x 5 x 3 cm is completely flat (Fig. 38: a–c). The uniformly-textured purified clay contains organic temper and a small quantity of mineral inclusions. The outer wall displays traces of deliberate polishing of the surface, while the inner wall is rustic, with uneven surface. The colour of the pottery paste is uneven: while the outer and inner walls are light brown (7.5YR 6/4), the cross-section reveals that the inside of the paste is grey (7.5YR 5/1). A diagonal imprint of a woody stem (Fig. 38: a) has been observed on the outer wall of the sherd; it partly overlaps with an imprint of 1.2 x 0.7 cm, whose size and position on the high-quality fired pottery sherd allowed us to make a silicone cast. The inspection of the silicone cast in positive resulted in the identification of an olive (*Olea europaea*) pit, identified on the basis of the characteristic round and elongated shape, with flattened tip at the location of the hilum, partially-visible characteristically-branching surface grooves, and a slightly pointed lower end of the pit (Fig. 39). In addition, the imprint of a small-grained cereal (*Panicum/Setaria* sp.) glume has been identified on the sherd, 2.5 mm long and 1.5 mm wide (Fig. 40: a), and an imprint 2–5 mm wide and 1 cm long, which could correspond to the structure of two spikelets of hulled wheat or barley (cf. *Triticum monococcum/dicoccum/spelta / Hordeum vulgare*) (Fig. 40: b).



Sl. 38 — Nadin – Gradina, uzorak 9: keramički ulomak s vidljivim otiscima biljnog podrijetla na a) vanjskoj stijenci gdje je vidljiv dijagonalni otisak drvenaste stabljike, b) unutrašnjoj stijenci i c) bočnom lomu (snimila: D. Knežić)
Fig. 38 — Nadin – Gradina, sample 9: pottery sherd with visible imprints of plant origin on a) the outer wall, where a diagonal imprint of a woody stem is visible, b) inner wall, and c) lateral fracture (photo by: D. Knežić)



Sl. 39 — Nadin – Gradina, uzorak 9: a) silikonski odljev otiska gornjeg dijela koštice masline (*Olea europaea*) te b) usporedni recentni primjer gornjeg dijela koštunice masline; c) silikonski odljev koštice masline s vidljivim zaravnjenim gornjim dijelom i lagano zašiljenim donjim dijelom te d) usporedni primjer recentne koštunice masline s blago zašiljenim donjim dijelom (snimila: D. Knežić)
Fig. 39 — Nadin – Gradina, sample 9: a) silicone cast of the imprint of the upper part of an olive (*Olea europaea*) pit and b) comparative recent example of the upper part of an olive pit; c) silicone cast of an olive pit with visibly flattened upper part and slightly tapered lower part and d) comparative example of a recent olive pit with slightly tapered lower part (photo by: D. Knežić)



Sl. 40 — Nadin – Gradina, uzorak 9: a) otisak koji bi mogao pripadati dijelu duplog klasića pljevičaste pšenice ili ječma (cf. *Triticum monococcum/dicoccum/spelta* ili *Hordeum vulgare*); b) otisak pljevice sitnosjemene žitarice (*Panicum/Setaria* sp.) (snimila: D. Knežić)
Fig. 40 — Nadin – Gradina, sample 9: a) imprint that could belong to part of a double spikelet of hulled wheat or barley (cf. *Triticum monococcum/dicoccum/spelta* or *Hordeum vulgare*); b) imprint of the glumelle of a small-grained cereal (*Panicum/Setaria* sp.) (photo by: D. Knežić)

RASPRAVA

Detaljnijim pregledom ulomaka keramike debljih stijenki koje pripadaju većoj posudi skladišne namjene ustanovljeno je postojanje kvalitetnih biljnih tragova u vidu otisaka i ostataka biljaka te je ona podvrgnuta makrobotaničkoj analizi. Analizom je utvrđeno postojanje tri oblika biljnih tragova unutar glinenog medija, a to su: a) biljni otisci koji predstavljaju indirektne nalaze odnosno nevidljive biljne ostatke u vidu otiska dijela biljke u negativu, b) karbonizirani biljni ostaci koji se najčešće pronalaze u sedimentima različitih kulturnih slojeva, no mogu se očuvati i u glinenom mediju tako što su stvoreni uvjeti polaganog pečenja na optimalnoj temperaturi i ograničenog pristupa zraku te c) mineralizirani biljni ostaci koji se najčešće pojavljuju zajedno s otiscima pri proučavanju glinenih medija, ali se mogu pronaći i u sedimentima, a nastaju tako što se tijekom raspadanja u staničnu stijenku biljnih ostataka ugrađuju različiti minerali koji pri tome mogu promijeniti finu površinsku strukturu te time otežati identifikaciju nalaza. Nalazi karboniziranih i mineraliziranih ostataka na keramičkim predmetima rijetko su odvojeni od otisaka na glinenom mediju i gotovo uvijek se promatraju zajedno iako predstav-

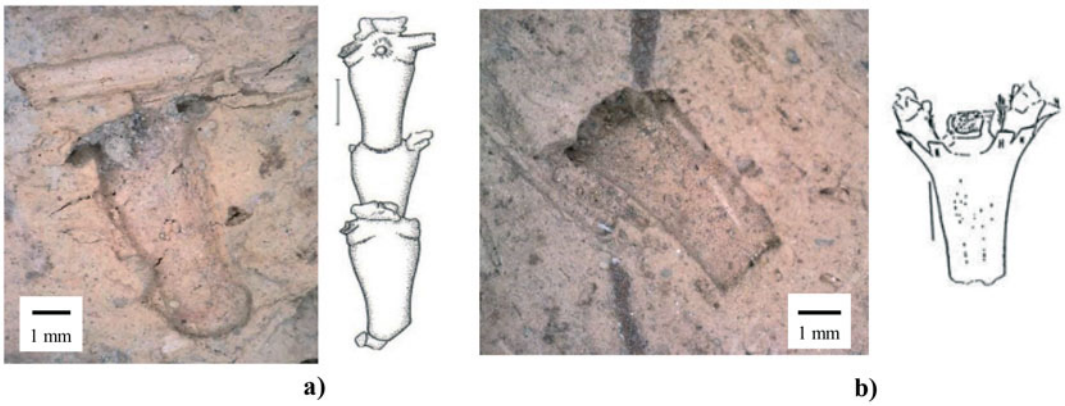
DISCUSSION

Detailed inspection of potsherds of a large storage vessel with thick walls revealed the existence of high-quality plant traces consisting of imprints and plant remains, so the vessel was subjected to a macrobotanical analysis. The analysis has established that the clay medium contained three types of plant traces: a) plant remains which are indirect traces, that is, invisible plant remains consisting of imprints of plant elements in negative, b) carbonized plant remains, which are typically found in sediments of diverse cultural layers, but can also be preserved in a clay medium if the conditions were met for slow firing at an optimal temperature and with limited air intake, and c) mineralized plant remains, which often appear together with imprints when clay media are studied, but can also be found in sediments; they result from a decomposition process during which various minerals are incorporated in the cell wall of plant remains, modifying its fine surface structure and thus making it harder to identify the trace. Carbonized and mineralized traces on pottery are rarely separate from imprints in the clay medium and are almost always studied together, although they represent different types of evidence (Ryan 2011: 292–293; Zohary et al. 2012: 11–12).

ljaju drugu vrstu nalaza (Ryan 2011: 292–293; Zohary et al. 2012: 11–12).

Na devet analiziranih keramičkih ulomaka ustanovljeno je postojanje nekoliko kategorija biljnih nalaza koje u načelu možemo podijeliti na kultivirane žitarice, drvenaste biljke i porodicu trava. Prema tablici 1 krupnozrne žitarice pronađene su na svim keramičkim ulomcima. Identificirani su otisci pšena ječma (*Hordeum vulgare*) s pljevom i otisak rahisa koji pripada dvorednom ječmu (*Hordeum vulgare* subsp. *distichum*) (sl. 41: b). Na keramici su otkriveni otisci obuvenca (lat. *lemma*) i rahisa nepljevičaste pšenice (*Triticum durum* s.l.) (sl. 41: a). Identificiran je otisak baze pljeve dvozrne pšenice (*Triticum dicoccum*) te otisak koji bi mogao odgovarati strukturi dva klasića pljevičaste pšenice ili ječma (cf. *Triticum monococcum/dicoccum/spelta / Hordeum vulgare*). Pronađeni su i otisci stabljike (s nodijem), vlati, klasa, klasića, pšena i osja koji najvjerojatnije pripadaju žitaricama (*Cerealia*). Što se tiče navedenih žitarica, nalazi se poklapaju s rezultatima klasične arheobotaničke analize (Knežić 2022). Svi analizirani uzorci keramičkih ulomaka pripadaju jedinstvenom željeznodobnom sloju (SJ 419) koji je dokumentiran unutar objekta s glinenom podnicom (SJ 430) na kojoj se nalazila keramička posuda sa žitaricama (SJ 428). Upravo spomenuti slojevi (SJ 419, 428 i 430) sadržavali su kontekste u kojima su, između ostaloga, pronađene veće količine pšena raznih vrsta ži-

On nine potsherds that have been analysed, several categories of plant traces have been identified. Generally, they can be divided into cultivated cereals, woody (or ligneous) plants and the grass family. As shown in Table 1, large-grained cereals have been found on all potsherds. Imprints of barley (*Hordeum vulgare*) grain with glume have been identified, as well as an imprint of a rachis belonging to two-rowed barley (*Hordeum vulgare* subsp. *distichum*) (Fig. 41: b). Imprints of lemma and rachis belonging to naked wheat (*Triticum durum* s.l.) have been discovered on the pottery (Fig. 41: a). An imprint of a glume base of emmer (*Triticum dicoccum*) has also been identified, as well as an imprint that could correspond to the structure of two spikelets of hulled wheat or barley (cf. *Triticum monococcum/dicoccum/spelta / Hordeum vulgare*). Imprints of a stem (with a node), leaf, ear, spikelet, grain and awn, most probably belonging to cereals (*Cerealia*), have also been found. As regards these cereals, the discovered traces correspond to the result of the classical archaeobotanical analysis (Knežić 2022). All the analysed samples of potsherds belong to a single Iron Age layer (SU 419), recorded within a structure with clay flooring (SU 430), on which a ceramic vessel with cereals had been placed (SU 428). These layers (SU 419, 428 and 430) contained contexts in which substantial quantities of grains of diverse cereals, both large-grained and small-grained, have been found, as well as glumes and remains such as glume bases, lemmas



Sl. 41 — Usporedba crteža: a) dijela rahisa tvrde pšenice s nalazom otiska tvrde pšenice (*Triticum durum* s.l.); b) rahisa ječma s otiskom i rahisa dvorednog ječma (*Hordeum vulgare*) (prema: Knežić 2022: 216, sl. 165)
Fig. 41 — Comparative drawings: a) of part of a rachis of durum wheat with the discovered imprint of durum wheat (*Triticum durum* s.l.); b) of a barley rachis with an imprint of a rachis of two-rowed barley (*Hordeum vulgare*) (after: Knežić 2022: 216, Fig. 165)

tarica kako krupnozrnih tako i sitnozrnih, zatim pljeve te ostatke poput baze pljeve, obuvenca i rahisa (Knežić 2022).

S obzirom na značajan udio različitog žitaričnog „otpada", poput pljeva, rahisa, stabljika i vlati trava, ovi nalazi se mogu tumačiti kao potvrda lokalnog uzgoja žita. Tijekom 80-ih godina prošlog stoljeća G. Hillman (1984a; 1984b; 1985) je pokazao putem etnoarheoloških studija kako proučavanjem današnje tradicionalne (ili nemehanizirane) poljoprivrede možemo dobiti podatke koji omogućavaju detaljniju analizu arheobotaničkih nalaza. Poput njega, i brojni drugi autori donose etnobotaničke podatke o žitaricama iz raznih dijelova svijeta poput G. Jonesa (1984) iz Grčke, L. Peña-Chocarroa (1999) s područja Španjolske, S. Reddya (2003) te E. Harveya i D. Fullera (2005) s područja Indije. S obzirom da se koraci vršidbe odvijaju uobičajenim redoslijedom oni su podudarni fazama vršidbe u prošlosti čiji se ostaci mogu pronaći u uzorcima (Hillman 1984a; 1984b; 1985; Hastorf 1988: 127; van der Veen 1992). Drugim riječima, tretman koji je korišten tijekom vršidbe raspoznajemo prema komponentama primjesa u glinenim medijima koji se najčešće sastoje upravo od ostataka vršidbe žitarica (Bonnaire 2011; 2016). Tako su na principu uniformističke teorije osmišljeni obrasci aktivnosti tijekom žetve, vršidbe i skladištenja žitarica pod pretpostavkom da su bili identično provođeni u prošlosti kao i danas. Požete žitarice prolaze kroz različite faze unutar lanca operacija u kojima se proizvode primarni i sekundarni produkti ili nusproizvodi koje raspoznajemo kroz varijabilne proporcije pljeve, stabljika, korova i čistog pšena kao željenog konačnog proizvoda (van der Veen 1992: 81). Ova teorija ekstenzivno se primjenjuje i danas, a tijekom vremena je modificirana (Mihelić 2002: 257, sl. 2; Stevens 2003; Heiss et al. 2021: 8, Fig. 5). Ako retrospektivno gledamo na *chaîne opératoire* vršidbe žitarica vidimo da se akumuliraju sekundarni produkti od kojih jedan dio naknadno završava u glinenoj smjesi za izradu keramičkih predmeta. Na taj način odbačeni ekofakti ponovno postaju uporabljivi produkti, odnosno primjese s novom funkcijom kao integralni dio artefakta (Bonnaire 2016: 113).

Ostaci od vršidbe žitarica se često nazivaju otpadom iako zapravo nisu odbačeni, a kada im se da utilitarna svrha oni postaju sekundarni produkti. Svaka vrsta sekundarnog produkta ima vi-

and rachises, among other things (Knežić 2022).

In view of the significant proportion of various types of cereal 'waste', such as chaff, rachis, stems and grass blades, the discovered traces can be interpreted as evidence of the local grain cultivation. In the 1980s, G. Hillman (1984a; 1984b; 1985) demonstrated, with his ethnoarchaeological studies, that research on today's traditional (i.e. non-mechanized) farming can provide us with data that allow a detailed analysis of archaeobotanical traces. Much like him, a number of other authors have published ethnobotanical data on cereals produced in various parts of the world: in Greece, G. Jones (1984), in the territory of Spain, L. Peña-Chocarro (1999), and in the territory of India, S. Reddya (2003) and E. Harvey and D. Fuller (2005), to name a few. Given that the various stages of threshing take place in a specific order, they correspond to threshing phases in the past which have left traces found in the samples (Hillman 1984a; 1984b; 1985; Hastorf 1988: 127; van der Veen 1992). In other words, the treatment applied during threshing can be identified on the basis of the components of clay-medium inclusions, which most frequently consist of remains of cereal threshing (Bonnaire 2011; 2016). Thus, patterns of activities performed during harvesting, threshing and storage of cereals have been developed on the basis of the uniformitarian principle, with the assumption that such activities were identical in the past and today. The harvested cereals underwent diverse phases in the chain of operations, resulting in primary and secondary products or byproducts that can be recognized by variable proportions of chaff, stems, weed and clean grains as the desired final product (van der Veen 1992: 81). Nowadays this theory is still widely used, though it has been modified over time (Mihelić 2002: 257, Fig. 2; Stevens 2003; Heiss et al. 2021: 8, Fig. 5). If we take a retrospective look at the *chaîne opératoire* of cereal threshing, we can see that secondary products are accumulated, and some of those subsequently end up in clay mixtures for pottery production. In this way, the discarded ecofacts are once again turned into usable products – inclusions, which have a new function as integral parts of an artefact (Bonnaire 2016: 113).

Cereal-threshing remains are often described as waste, although in reality they have not been discarded; and, when given a utilitarian purpose, they become secondary products. Each type of secondary product has more than one purpose.

še no jednu svrhu: u konstrukciji krova i za popločavanje, za gorivo, za postelju, za krmnu hranu ili kao primjesa i pojačivač svojstava u glinenom mediju iz kojeg nastaju različiti predmeti (Bonnaire 2014: 283; 2016; Dzhanfezova, 2020: 66).

Općenito je korpus arheobotaničkih znanstvenih radova posvećenih istraživanju biljaka korištenih u druge svrhe izuzev prehrane relativno oskudan. Dokazano je kako su one korištene u izradi širokog dijapazona uporabnih predmeta kao što su tkanine, košare, krovne konstrukcije, keramika, kućni lijep, peći/ognjišta, glineni utezi, briketi za sol i slično (de Moulins 2007; Ryan 2011: 294–295; Bender Jørgensen, Grömer 2012; Tolar et al. 2016: 291–292; Andonova 2021). Određene biljne vrste, poput žitarica i njihovih primarno neuporabljivih dijelova posebno su cijenjene kao primjesa u glinenoj smjesi radi poboljšanja svojstava konačnog proizvoda (Wilkinson, Murphy 1995; Bonnaire 2016: 107).

Pomoću analize biljnih tragova na glinenom mediju moguće je odrediti biljne vrste korištene u izradi proizvoda od gline. U njima se očuvaju svi oni vegetativni dijelovi biljaka koji najčešće nisu očuvani u sedimentu radi fragilnosti poput npr. pljeve, vlati, stabljike i ostalih biljnih dijelova podložnih raspadanju (sl. 42) (Dzhanfezova, 2020: 63–64). Stoga su takve analize vrlo dobar dodatak drugim arheobotaničkim analizama jer, osim što ih nadopunjavaju, omogućavaju i bolje razumijevanje šire slike utilitarnog iskorištavanja biljaka (Bonnaire 2011: 473; 2014: 285).

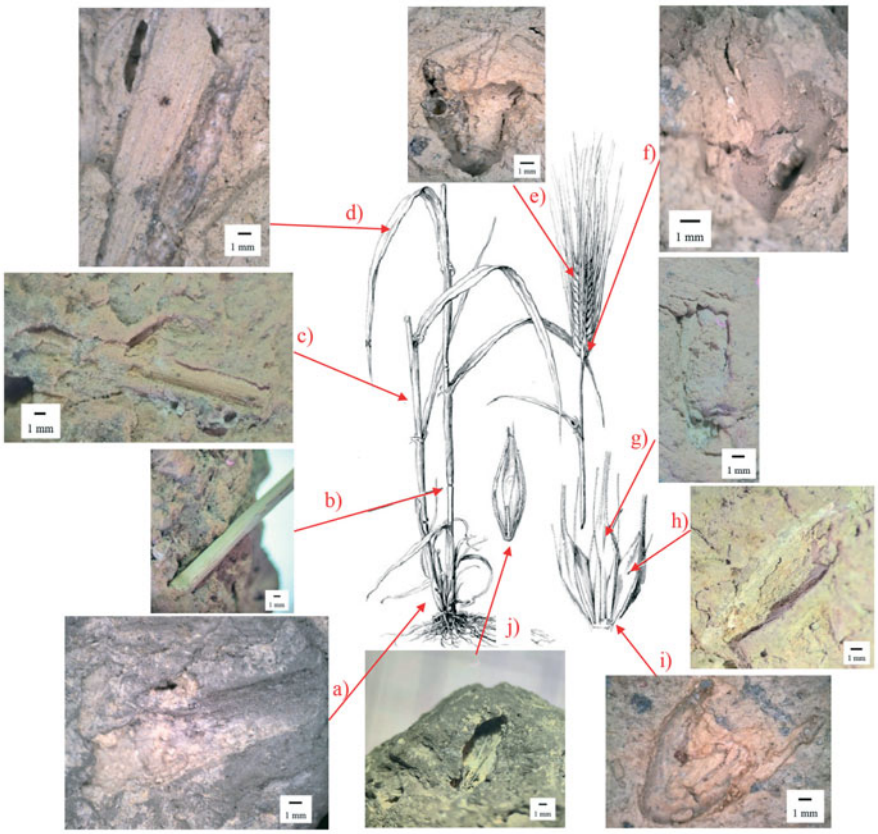
Analizama biljnih ostataka na glinenim medijima dokazano je kako većina biljnog materijala koji se koristi kao pojačivač i primjesa u glinenoj smjesi potječe od poljoprivrednih aktivnosti, najčešće od čišćenja gumna, a nastaju od otpada mlaćenja i vijanja koji je stvoren prilikom vršidbe (Willcox, Tengberg 1995; Willcox, Fornite 1999; Bonnaire, Tengberg 2007: 83). Pronađeni dijelovi žitarica unutar glinenog medija na dijelu keramičkih ulomaka iz Nadina svjedoče da su ti ostaci dobiveni mlaćenjem, vijanjem i moguće lupanjem u posudi tijekom vršidbe iako nisu primijećeni ostaci dugih stabljika koje su se mogle svrsihodno iskoristiti. To bi značilo da se otpad akumuliran prilikom mlaćenja razdvajao na velike, dugačke stabljike žitarica korištene u jednu svrhu, a sitniji dijelovi ostataka žitarica koji završe na podu poput kraćih stabljika, vlati, slučajnih klasića, korova, baza pljeva i rahi-

It can be used for roof construction and paving, as fuel, bedding or feed, or as inclusions and feature-enhancers of a clay medium used to create various objects (Bonnaire 2014: 283; 2016; Dzhanfezova, 2020: 66).

Generally, the collection of archaeobotanical scientific papers dedicated to research on plants used for purposes other than nutrition is relatively meagre. It has been proven that plants were used in the production of a wide array of objects of utility, such as textiles, baskets, roof constructions, pottery, house daub, ovens/hearths, clay weights, salt briquets etc. (de Moulins 2007; Ryan 2011: 294–295; Bender Jørgensen, Grömer 2012; Tolar et al. 2016: 291–292; Andonova 2021). Certain plants, such as cereals, and their primarily unusable parts are particularly valued as clay tempers which improve the properties of the final product (Wilkinson, Murphy 1995; Bonnaire 2016: 107).

The analysis of plant traces on a clay medium can be used to identify plant species used in the clay-product making. Such products contain preserved vegetative parts of plants that are usually not preserved in sediment, due to their fragility: for example, chaff, leaves, stems and other parts that are subject to decay (Fig. 42) (Dzhanfezova, 2020: 63–64). Thus, such analyses are a very good addition to other archaeobotanical analyses, because they not only complement them, but also allow a better understanding of a wider picture of the utilization of plants (Bonnaire 2011: 473; 2014: 285).

Analyses of plant remains on clay media have demonstrated that the majority of plant material used as clay-medium enhancer and temper derives from agricultural activities, most often the cleaning of the threshing floor, and it consists of waste created by beating and winnowing during the threshing (Willcox, Tengberg 1995; Willcox, Fornite 1999; Bonnaire, Tengberg 2007: 83). The cereal parts discovered within the clay medium in some of the potsherds from Nadin testify that those remains were produced by beating, winnowing and possibly pounding inside a vessel during threshing, although no remains of long stems that could be used for the purpose have been recorded. This means that waste accumulated during the beating was separated into large, long cereal stems used for one purpose, and smaller parts of cereal remains – such as shorter stems, leaves, accidental spikelets, weeds, glume bases and



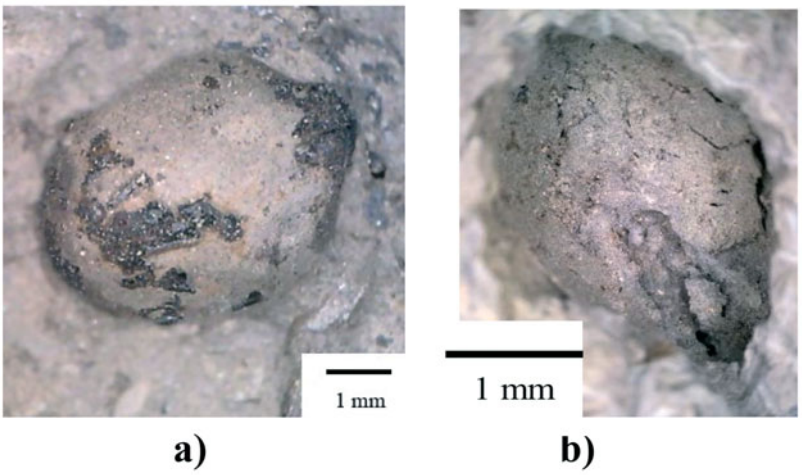
Sl. 42 — Ostaci dijelova krupnozrnih žitarica definiranih kroz otiske na keramičkim ulomcima posude s Gradine u Nadinu i prikaz njihova položaja na biljci: a)–c) različiti dijelovi stabljike, d) vlati, e) klasić s osjem, f) dio klasića, g) obuvenac, h) otisak košuljice, i) dva klasića i j) otisak pšena ječma s pljevom (prema: Knežić 2022: 215, sl. 164)
Fig. 42 — Remains of parts of large-grained cereals defined by imprints on sherds of a ceramic vessel from Gradina, in Nadin, and the schematics of their position on the plant: a)–c) various parts of the stem, d) leaves, e) spikelet with awn, f) part of the spikelet, g) lemma, h) palea imprint, i) two spikelets and j) imprint of a barley grain with glume (after: Knežić 2022: 215, Fig. 164)

sa završavali su kao primjesa u glinenoj smjesi. Isto tako, treba spomenuti i mogućnost mljevenja slame za potrebe njenog korištenja kao sirovine ili stočne hrane. Otkrivene organske primjese na Gradini u Nadinu, koje su nastale kao sekundarni produkati vršidbe, obuhvaćaju različite prepoznatljive dijelove žitarica koji su precizno prikazani na sl. 41.

Na keramičkim su ulomcima uz krupnozrne žitarice dokumentirani otisci te ostaci sitnozrnih žitarica – prosa (*Panicum miliaceum*) i klipastog muhara (*Setaria italica*) (sl. 43), koji su također dokumentirani na lokalitetu i klasičnom arheobotaničkom analizom (Knežić 2022) iako u zamjetno manjim količinama od krupnozrnih žitarica. Novija istraživanja bazirana na radiokarbonskom datiranju karboniziranih pšena koja su

rachis – which ended up on the floor and were used as clay temper. Furthermore, it should be mentioned that straw could be ground in order for it to be used as a raw material or feed. Organic temper discovered at Gradina in Nadin, created as a secondary product of threshing, includes various identifiable parts of cereals, shown in detail in Fig. 41.

In addition to large-grained cereals, imprints and remains of small-grained cereals have also been recorded on potsherds: broomcorn millet (*Panicum miliaceum*) and foxtail millet (*Setaria italica*) (Fig. 43), which have also been recorded on this site using classical archaeobotanical analysis (Knežić 2022), although in much smaller quantities than large-grained cereals. Recent research based on radiocarbon dating of carbonized gra-



Sl. 43 — Prikaz: a) otiska prosa (*Panicum miliaceum*) na keramici s vidljivim tragovima pljeve; b) otiska klipastog muhara (*Setaria italica*) na keramici s vidljivim tragovima pljeve (snimila: D. Knežić)
Fig. 43 — View: a) of a broomcorn millet (*Panicum miliaceum*) imprint on pottery with visible traces of glume; b) of an imprint of foxtail millet (*Setaria italica*) on pottery with visible traces of glume (photo by: D. Knežić)

prethodno bila atribuirana starijim prapovijesnim razdobljima donose podatke kako proso s istoka u Europu dolazi tek sredinom 2. tisućljeća pr. Kr. Tada započinje njegovo brzo širenje, a na brončanodobnim nalazištima pronalaze se veće koncentracije prosa (Filipović et al. 2020; Kirleis et al. 2022). Tako se i u Hrvatskoj na nekoliko kontinentalnih nalazišta iz neolitika i eneolitika pronalaze malene koncentracije prosa, dok su veće koncentracije u kontinentalnom području pronađene kroz brončano i željezno doba uz brojne druge kultivirane krupnozrne žitarice. Na nalazištu kasnog brončanog doba Kalnik – Igrišče u kontinentalnoj Hrvatskoj pronađene su velike količine prosa unutar izgorjele nastambe (Karavanić et al. 2015; Mareković et al. 2015; Reed et al. 2022: 96–97). Na obalnom području Hrvatske značajnija količina prosa zabilježena je tek u željeznodobnim slojevima na nalazištu Nadin – Gradina (Knežić 2022). Iako na prostoru Like nisu provedena makrobotanička istraživanja, provedene su analize stabilnih izotopa ugljika i dušika koje pokazuju kako se prehrana tijekom željeznog doba temeljila na biljkama C4 skupine čiji je glavni predstavnik proso (Zavodny et al. 2017).

Dion Kasije Kokejanin (Kasije Dion 49.36) u svom djelu *Rimska povijest* spominje barbarske navike pa za stanovnike Panonije piše kako oni ne uzgajaju maslinu i vinovu lozu zbog hladnih zima, zbog čega jedu i piju ječam i proso (Domić Kunić 2018: 54), što također potvrđuje da se proso uzgajalo i konzumiralo u različitim „hrvatskim“ dijelovima Carstva. Općenito je moguće kako su se stabljike prosa osim u prehrani koristile i u praktične svr-

ins that were previously attributed to earlier periods of prehistory has yielded the information that broomcorn millet was brought to Europe from the east only in the middle of the 2nd millennium BC. Thereafter, it spread quickly, and fairly high concentrations of broomcorn millet have been recorded at Bronze Age sites (Filipović et al. 2020; Kirleis et al. 2022). In Croatia, small quantities of broomcorn millet have also been found in several continental sites dating from the Neolithic and Copper Age, while higher concentrations have been recorded in continental Croatia at sites from the Bronze and Iron ages, together with numerous other cultivated large-grain cereals. At the Late Bronze Age site of Kalnik – Igrišče in continental Croatia, large quantities of broomcorn millet have been discovered within a burnt dwelling (Karavanić et al. 2015; Mareković et al. 2015; Reed et al. 2022: 96–97). In coastal Croatia, significant quantity of broomcorn millet has only been found in the Iron Age strata of the Nadin – Gradina site (Knežić 2022). Although macrobotanical research has not been conducted in Lika, analyses of stable carbon and nitrogen isotopes have been conducted, and they have shown that Iron Age nutrition was based on plants from group C4, with broomcorn millet as their main representative (Zavodny et al. 2017).

In his *Roman History*, Dio Cassius Cocceianus (Cassius Dio 49.36) mentions barbarian customs and writes that the inhabitants of Pannonia do not grow olives and grapes because of cold winters, and that for this reason they eat and drink barley and broomcorn millet (Domić Kunić 2018: 54), testifying to the fact that broomcorn millet was grown and consumed in various ‘Croatian’ parts of the

he pri konstrukciji krovišta gdje bi se vezale u snopove, slagale gusto i stvarale nepropusno krovište, jednako tako mogle su služiti kao postelja za stoku (Nye 1996: 240). Danas se upravo od vrsta prosa i muhara (*Panicum*/*Setaria* sp.) izrađuju organske metle za čišćenje kućanstva jer njihove stabljike nakon sušenja ostaju čvrste i savitljive. Potrebno je istaknuti kako analizom stabilnih izotopa provedenom na koštanom i dentalnom materijalu pokojnika s nadinske nekropole na ravnom, kao i na životinjskim ostacima koji su pronađeni tijekom istraživanja naselja na Gradini, nisu utvrđeni značajniji tragovi prosa, odnosno biljaka C4 skupine. Navedeni podatak ukazuje da ono nije imalo istaknutiju ulogu u prehrani pripadnika željeznodobne nadinske zajednice, a ujedno da nije bilo ni dominantna stočna hrana (Toyne et al. 2021: 251–254). S obzirom na manju zastupljenost prosa unutar naseobinskih sedimenata, njegovu namjenu treba podrazumijevati u okviru drugih funkcionalnih okvira. S obzirom na izneseno, sitnozrne žitarice imale su, u usporedbi s krupnozrnima, ulogu sekundarno značajnog kultivara što predstavlja kontrast u odnosu na prostor Like i susjedne Japode kod kojih je dokazano kako su uzgajali i konzumirali proso (Zavodny 2017).

Nadalje, na keramičkim ulomcima uočeni su tragovi divljih trava (*Poaceae*) koje čine neizostavni repertoar nalaza uz žitarice u vidu korova ili nepoželjnih vrsta. Njih je bilo vrlo teško ukloniti iz požetog i ovršenog žita pa se često iz istog razloga ponovno zasijavaju i na taj način toleriraju i konzumiraju u prehrani poput recimo ražastog ovsika (*Bromus secalinus*), koji je također dokumentiran karpološkom analizom (Knežić 2022). Za određene otiske dijelova stabljika i vlati nije bilo moguće odrediti pripadaju li divljim ili kultiviranim travama pa su iz toga razloga stavljene u skupinu trava (*Poaceae*). Za otiske stabljika trava pretpostavlja se kako se u većem dijelu radi o slami[8] (sl. 44: a), a manjem o sijenu[9] (sl. 44: b). Nisu primijećene veće i duže stabljike što znači da su ili korištene u druge svrhe ili su se

8 Slama je naziv za dozrjele, suhe stabljike kultiviranih biljaka poput raznih vrsta žitarica i mahunarki koje su prilično dugačke, imaju cjevastu strukturu, krutost, ali i savitljivost pa se mogu koristiti kao građevinski materijal, postelja za stoku ili za izradu drugih predmeta poput npr. šešira.

9 Sijeno se za razliku od slame dobiva sušenjem divljih trava. Koristi se kao stočna hrana jer se radi od svježe pokošene zelene trave koja se suši na suncu čime zadržava boju i mnoga nutritivna svojstva svježih biljaka.

Empire. Generally, it is possible that stems of broomcorn millet were used not only for food, but also for the practical purpose of roof construction, where they would be bound in sheaves placed tightly next to one another, thus creating a water-tight roof. They could also be used as bedding for cattle (Nye 1996: 240). Nowadays it is broomcorn millet and foxtail millet (*Panicum*/*Setaria* sp.) that are used to produce organic brooms for households, because their stems, when dried, remain strong and flexible. It should be underscored that the analysis of stable isotopes taken from the bone and dental material of deceased persons in the flat necropolis at Nadin, and from animal remains discovered during the excavation of the settlement at Gradina, have not identified significant traces of broomcorn millet or plants of group C4. This suggests that such plants did not play a prominent role in the nutrition of members of the Iron Age community in Nadin, and was not a dominant animal feed, either (Toyne et al. 2021: 251–254). In view of the small presence of broomcorn millet in the settlement sediments, the purpose of this plant should be viewed in the context of other functions. Given what has been said above, the small-grained cereals, when compared to the large-grained, played the role of a cultivar of secondary importance, in contrast to the situation in Lika and the neighbouring Iapodes, who have been proved to have grown and consumed broomcorn millet (Zavodny 2017).

Furthermore, traces of wild grasses (*Poaceae*) have been noticed on pottery sherds. They are an unavoidable repertoire of finds accompanying cereals, consisting of weed or undesirable species. They were hard to remove from harvested and threshed grain, and were thus often sown again, and thus tolerated and consumed. One such example is rye brome (*Bromus secalinus*), identified also during the carpological analysis (Knežić 2022). There are some imprints of stems and leaves for which it has not been possible to establish whether they belonged to wild or cultivated grasses, and those have therefore been classified as grasses (*Poaceae*). The majority of grass-stem imprints are assumed to be straw[8] (Fig. 44: a), while a minority is hay[9] (Fig. 44: b). Larger

8 Straw is a term used for mature, dry stems of cultivated plants such as various types of cereals and leguminous plants, which are rather long, with tube-like structure, firm but also flexible, and can therefore be used as construction material, animal bedding or material for the production of some other items, for example hats.

9 Hay, in contrast to straw, is a result of the drying of wild grasses. It is used as feed, since it is produced from freshly cut green grass, sun-dried, which preserves its colour and many nutritive properties of fresh plants.

a) b)

Sl. 44 — Stabljika i vlati žitarica koje u većoj količini čine slamu i fotografija pokošene divlje trave koju nazivamo sijeno (snimila: D. Knežić)
Fig. 44 — Stem and leaves of cereals forming straw when in large quantities, and a photograph of mown wild grass, known as hay (photo by: D. Knežić)

pak razlomile u procesu vršidbe žitarica prilikom mlaćenja ili u procesu izrade keramike tijekom gnjetanja (Bonnaire, Tengberg 2007: 82).

Makrobotaničkom analizom keramike ustanovljeno je postojanje još nekih biljnih nalaza koje ne vežemo uz ostatke od vršidbe žitarica, a radi se o dvjema drvenastim vrstama. Identificiran je otisak koštice masline (*Olea europaea*) i karbonizirana peteljka drijena (cf. *Cornus mas*), koji su također dokumentirani i karpološkom analizom (Knežić 2022).

Njihova prisutnost u uzorcima evidentno ne potječe od vršidbe žitarica pa je moguće kako su bile odbačene kao kuhinjski otpad na prostor na kojem se vršila priprema glinene smjese (van der Veen 1999: 213). To bi govorilo u prilog unošenju plodova drvenastih biljaka u naselje i njihovoj utilizaciji. S obzirom da je koštica masline prilično čvrsta, a time i dugotrajna, moguće je da je na neki drugi način dospjela u smjesu – kao dio ljudskog ili životinjskog koprolita ili je već bila u sedimentu koji se uzimao za izradu glinene smjese. Do nedavno su se brojni organski ostaci, biljni i životinjski, koristili kao primjesa u smjesi za lončariju. Y. B. Tsetlin (2003: 291) donosi etnografske podatke iz 19. i 20. stoljeća gdje je vidljiva pojavnost različitih vrsta biljnih i životinjskih primjesa u izradi glinene smjese kao

and longer stems have not been recorded, which means that they were used for other purposes, or that they were crushed during the beating part of the process of cereal threshing or during kneading in the process of pottery production (Bonnaire, Tengberg 2007: 82).

The macrobotanical analysis of pottery has identified some other plant traces that are not associated with the remains of cereal threshing. These are two woody species. An imprint of an olive (*Olea europaea*) pit has been identified, as well as a carbonized cornelian cherry peduncle (cf. *Cornus mas*), which have also been identified by the carpological analysis (Knežić 2022).

Their presence in the samples clearly does not originate from cereal threshing. They could have been discarded as kitchen waste in an area where clay paste was prepared (van der Veen 1999: 213). This would speak in favour of the fruit of ligneous plants having been brought to the settlement and utilized. Given that the olive pit is rather hard, and thus also durable, it could have ended up in the mixture in some other way, either as part of human or animal coprolite, or by being present already in the sediment taken to prepare the clay paste. Until recently, numerous organic remains, of both plant and animal origin, were used as pottery paste temper. For the 19th and 20th centuries, Y. B. Tsetlin (2003: 291) provides ethnographic data which show

što su izmet ptica i životinja, dlaka, vuna, pokošena trava, slama, mlijeko, krv, biljni sokovi, slomljene ljuske i kosti, no najviše se koristio izmet patkarica, stoke te goveđi i konjski izmet (usp. i Amicone et al. 2021: 1). Prednost dodavanja životinjskih koprolita u smjesu za izradu keramike je u tome što se na taj način poboljšava njena plastičnost, proces sušenja i pečenja, a predmeti su lakši jer je veliki dio organskog materijala izgorio i nestao tijekom pečenja (Amicone et al. 2021: 1). Lončari su organske ostatke poput izmeta, pljeve, slame, kose i pepela uglavnom skupljali u svom neposrednom okruženju. Stoga su takvi nalazi bitan izvor informacija o određenima aktivnostima poput poljoprivrednih praksi, iskorištavanja prirodnih bogatstava i o stočarstvu (van Doosselaere, Hayes 2007: 105; Amicone et al. 2021: 1). Spomenimo i to kako istraživanja na prostoru Mediterana potvrđuju da su nusprodukti obrade maslina na pojedinim lokalitetim korišteni kao gorivo, pa bi njihovo dodavanje u glinenu smjesu moglo biti povezano upravo s procesom pečenja (Braadbaart et al. 2016).

Na peludnom dijagramu Bokanjačkog blata vidljiv je antropogeni utjecaj na okoliš koji se intenzivira u brončanom dobu tek od otprilike 1300. g. pr. Kr. Isto tako, ondje je vidljivo kako je maslina prisutna od ranijih prapovijesnih vremena, ali joj se udio značajno povećava tek tijekom antike (Grüger 1996; Šoštarić 2005: 386). Najranije dokumentirana uporaba maslina (*Olea europaea*) na istočnom Jadranu nedvojbeno je posvjedočena nedavnim otkrićem velike količine koštunica masline tijekom podvodnih istraživanja na lokalitetu Turanj – Ričul (otočić Ričul, blizu mjesta Turanj). U istraženim slojevima danas potopljenog naselja iz srednjeg brončanog doba nađena je, uz razne arhitektonske strukture, velika količina pokretne građe uključujući keramičko posuđe, koštane i alatke od glačanog kamena, žrvnjeva za mljevenje žitarica i dr., kao i veća količina koštunica masline (*Olea europae*) i divlje trešnje (*Prunus avium*) (Ilkić et al. 2015; Čelhar et al. 2017; Parica 2021: 78–85). Koštunice maslina pronađene su u slojevima u unutrašnjosti naselja, u blizini temelja bedema, i radikarbonskom analizom provedenom na jednoj koštunici datirane u vremenski okvir od 1450. do 1291. g. pr. Kr. (Parica 2021: 82–84). Iz kasnog brončanog doba poznati su podaci o pronađenim ostatcima koštunica maslina na gradini

the occurrence of various types of plant and animal inclusions in clay mixtures, such as bird and animal dung, hair, wool, cut grass, straw, milk, blood, plant juices, crushed shells and bones, but waterfowl droppings, cattle and horse dung were used most (cf. also Amicone et al. 2021: 1). The advantage of adding animal coprolites to pottery paste is that they enhance its plasticity and improve the drying and firing processes, and the resulting object is lighter, because a large part of the organic material burns and disappears during firing (Amicone et al. 2021: 1). Potters used to collect organic remains such as dung, chaff, straw, hair and ash in their immediate vicinity. Therefore, such finds are important sources of information on certain activities, such as farming practices, exploitation of natural resources and animal husbandry (van Doosselaere, Hayes 2007: 105; Amicone et al. 2021: 1). We can also mention that research conducted in the territory of the Mediterranean has confirmed that, in certain sites, byproducts of olive processing were used as fuel, and thus their inclusion in clay paste could be linked to the process of firing (Braadbaart et al. 2016).

The pollen diagram of the Bokanjačko Blato lake shows an anthropogenic influence on the environment which intensified in the Bronze Age, starting from around 1300 BC. Likewise, it can be seen in it that olive had been present since earlier periods of prehistory, but its proportion increased significantly during classical antiquity (Grüger 1996; Šoštarić 2005: 386). The earliest recorded use of olives (*Olea europaea*) in the eastern Adriatic was unambiguously attested by the recent discovery of a large quantity of olive pits during the underwater excavation at the Turanj – Ričul site (the islet of Ričul, near the village of Turanj). The investigated layers of a Middle Bronze Age settlement, now submerged, contained various architectural structures, and also a large amount of movable material, including ceramic ware, tools made of bones and polished stone, grindstones for grinding cereals etc., as well as a large quantity of olive (*Olea europae*) and wild cherry (*Prunus avium*) pits (Ilkić et al. 2015; Čelhar et al. 2017; Parica 2021: 78–85). The olive pits were discovered in layers located inside the settlement, close to the rampart foundations, and the radiocarbon analysis conducted on one of them dated it to the period between 1450 and 1291 BC (Parica 2021: 82–84). Data are available on the discovered remains of olive pits from the Late Bronze Age at

Čauševica blizu Nadina (Huntley 1996: 225). Na zapadnoj obali Jadrana detektirani su nalazi drveta masline, ali i tragovi ulja na keramici, koji svjedoče preradi masline tijekom brončanog doba. Na nalazištu Coppa Nevigata, na apulskoj obali poluotoka Gargano, putem antrakotomske analize potvrđena je prisutnost masline (*Olea europaea*) u vrijednosti preko 40 % u analiziranim uzorcima karboniziranog drveta (Fiorentino, D'Oronzo 2012), a kemijskom analizom keramike iz 18. st. pr. Kr. utvrđeni su tragovi ulja (Evans, Recchia 2003). Ipak, ovdje se radi o najranijim pojavama koje su najvjerojatnije bile potaknute kontaktima s egejskim civilizacijama, dok za period od 13. do 9. st. pr. Kr., koji je bio ključan u kultivaciji masline, nema konkretnih arheobotaničkih dokaza. Nadalje, peludni dijagrami pokazuju veće koncentracije masline tek početkom prvog tisućljeća pr. Kr., a tijekom 2. polovice 1. tisućljeća pr. Kr. maslina se pronalazi van svog originalnog prostora rasprostiranja što sugerira kako je kultivacija tada već bila dovršena (Caracuta 2020). S obzirom da se područje Nadina nalazi izvan pretpostavljenog areala divljih maslina (Zohary et al. 2012: 119), a da najnovija, gore spomenuta istraživanja dokumentiraju sve više nalaza maslina iz brončanog i željeznog doba i na istočnoj obali Jadrana, vjerujemo da nalaz iz Nadina pripada kultiviranoj formi maslina – manjim površinama maslinika u široj okolici i/ili proizvodu kojim se trgovalo.

Osim male količine maslina, u Nadinu nisu otkriveni ostaci drugih biljaka iz skupine uljarica, poput recimo lana (*Linum usitatissimum*), podlanka (*Camelina sativa*) ili maka (*Papaver somniferum*), niti pregledom keramike, niti karpološkom analizom (Knežić 2022). Spomenute biljne vrste lakše bi se očuvale u vidu indirektnog biljnog ostatka odnosno otiska nego u karboniziranom stanju jer njihove sjemenke sadrže dobar udio ulja i veća je vjerojatnost da će izgorjeti nego se očuvati. Takva situacija upućuje na pretpostavku kako zajednica nije koristila biljna ulja kao primarnu masnoću već, vjerojatnije, životinjsku mast kao jednostavniju i ekonomičniju varijantu koju je omogućavala druga grana gospodarstva Liburna – stočarstvo.

Iz promatranog naseobinskog konteksta (SJ 419) u kojem su dokumentirani analizirani keramički predmeti s biljnim primjesama koji pripadaju jednoj većoj skladišnoj posudi

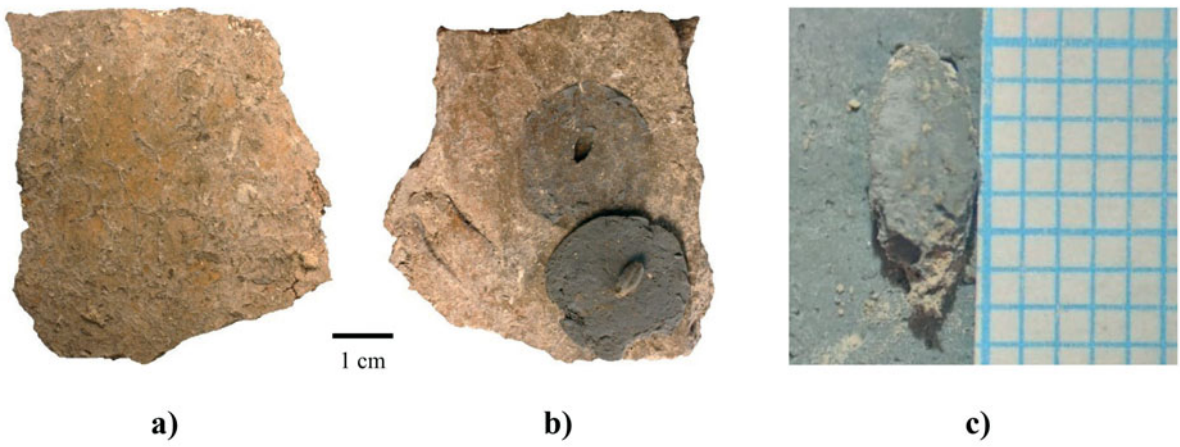
the Čauševica hillfort, near Nadin (Huntley 1996: 225). On the western Adriatic coast, olive wood has been detected among the finds, but also traces of oil on pottery, testifying to the processing of olives in the Bronze Age. At the site of Coppa Nevigata, on the Apulian coast of the Gargano peninsula, an antracotomic analysis confirmed the presence of olives (*Olea europaea*), making up over 40% of the analysed samples of carbonized wood (Fiorentino, D'Oronzo 2012), while a chemical analysis of pottery from the 18th century BC identified traces of oil (Evans, Recchia 2003). However, those are the earliest incidences, most probably stimulated by contact with the Aegean civilizations, while there is no specific archaeobotanical evidence for the key period of olive cultivation between the 13th and 9th century BC. Moreover, the pollen diagrams indicate higher concentrations of olives only in the beginning of the 1st millennium BC; and, in the second half of the 1st millennium BC, olives could be found outside their original distribution area, which suggests that their cultivation had been completed by then (Caracuta 2020). In view of the fact that Nadin is located outside the presumed distribution area of wild olives (Zohary et al. 2012: 119), and that the latest explorations, mentioned above, have been recording an ever-increasing number of finds of olives originating from the Bronze and Iron Ages also on the eastern Adriatic coast, we believe that the olive discovered in Nadin is of a cultivated type of olive coming from small olive groves in the wider surroundings of Nadin, and/or a product that was traded.

Except for the small quantity of olives, no remains of other oleaginous plants have been found in Nadin, such as flax (*Linum usitatissimum*), false flax (*Camelina sativa*) or opium poppy (*Papaver somniferum*), either during the pottery inspection, or during the carpological analysis (Knežić 2022). Such plant species would have been more easily preserved as indirect plant remains, that is, imprints, rather than as carbonized remains, since their seeds contain a significant amount of oil, which increases the probability of their being burnt, rather than preserved. This situation suggests that the community did not use plant oils as their primary source of fat, but rather, more probably, animal fat as a simpler and more economical variant that was provided by the other branch of the Liburnian economy – cattle farming.

In the examined settlement context (SU 419), in which the analysed pottery containing plant

potječe još jedna posuda većeg volumena, debljih stijenki i istovjetne pretpostavljene funkcije. Iz njih iščitavamo sastav korišten za izradu tog tipa posuđa, a to su glina, mineralne i biljne primjese. No, već ove dvije skladišne posude iz istog konteksta pokazuju da su postojale varijacije u smjesi. Ono što ih povezuje je glina s izrazito malom količinom mineralnih primjesa u odnosu na ostalo posuđe iz istog sloja koje tipološki možemo odrediti u kategoriju lonaca i većih zdjela, dakle oblika koji se primarno vezuju uz kuhinjsko i stolno posuđe, a koje na makroskopskoj razini pokazuje izrazito dominantniju količinu mineralnih primjesa. U strukturi potonjih, makroskopski otisci biljnih ostataka su iznimni i pojedinačni, kao npr. jedan otisak pšena nepljevičastog ječma (*Hordeum vulgare* var. *nudum*) na jednom fragmentu lonca smeđe boje s unutarnje strane čijoj je pojavi vjerojatniji uzrok slučajnost, a ne namjerno dodavanje smjesi u vidu primjesa (sl. 45). Ovo je lijep primjer spleta okolnosti prilikom izrade kuhinjske i stolne keramike za koju se zaljepilo pšeno, a za koju možemo pretpostaviti kako je bila izrađena unutar dijela naselja koje je služilo i u druge svrhe, poput npr. gumna ili za pripremu hrane (Renfrew 1973: 15). S druge strane, razlika među dvjema skladišnim posudama većih dimenzija tipa *pithos/dolia* počiva upravo na biljnim primjesama koje su kod jedne prisutne (sl. 46: a), a kod druge izostaju (sl. 46: b). Druga posuda, pak, ima u glinenoj smjesi ve-

temper has been recorded, belonging to a large storage vessel, another large-volume vessel has been found. Its wall is rather thick, and it is assumed that it was used for the same purpose. The two vessels have been used to determine the composition of the paste used for the production of wares of this type, which included clay, mineral and plant inclusions. However, the two storage vessels from the same context already display variations in the clay mixture. What they have in common is a clay with a very small quantity of mineral inclusions, if compared to other wares discovered in the same layer, which can be determined typologically as pots and larger bowls, that is, types primarily associated with kitchenware and tableware, in which, at the macroscopic level, the level of mineral inclusions is much more dominant. In their structure, macroscopic imprints of plant remains are very rare and individual: for example, an imprint of a naked barley (*Hordeum vulgare* var. *nudum*) grain on the inner wall of a brown potsherd, which is probably the result of coincidence, rather than of deliberate adding of inclusions to the paste (Fig. 45). This is a nice example of the interplay of circumstances during the making of kitchenware and tableware, with a grain attached to it, allowing us to assume that the pottery was made in a part of the settlement that was also used for other purposes: for example, for cereal threshing or for food preparation (Renfrew 1973: 15). On the other hand, the difference between the two large storage vessels of the *pithos/dolia* type is precisely in the plant tem-



Sl. 45 — Keramički ulomak kuhinjske posude na kojoj je na unutrašnjoj stijenci ustanovljen jedan otisak pšena ječma (*Hordeum vulgare*) iz kojeg je napravljen silikonski odljev u pozitivu (snimila: D. Knežić)
Fig. 45 — Sherd of a ceramic kitchenware on which an imprint of a barley (*Hordeum vulgare*) grain has been identified and used to produce a silicone cast in positive (photo by: D. Knežić)

Sl. 46 — Ulomci oboda dviju skladišnih posuda većih dimenzija tipa *pitos/dolija* od kojih: a) sadrži veće količine namjerno dodavanih organskih primjesa; b) ne sadrži organske primjese nego glinovite pelete (snimio: L. Bogdanić)
Fig. 46 — Sherds of rims of two large storage vessels of the *pithos/dolium* type, a) containing large quantities of deliberately added organic inclusions; b) containing not organic inclusions but clay pellets (photo by: L. Bogdanić)

ću količinu glinovitih peleta[10] koji mogu biti sastavni dio glinovite smjese ili se slučajno u njoj nalaze kao posljedica nedovoljno izmiješane smjese (usp. Kudelić 2016).

Primjese organskog podrijetla daju posebna svojstva keramici tijekom oblikovanja i sušenja, a u konačnici ju čine nešto laganijom što je uočeno prilikom primarne inspekcije i usporedbe fragmenata skladišnih posuda s i bez organskih primjesa pri čemu je ona prva naočigled lakša (sl. 47).[11] Takva činjenica bi zasigurno posebno došla do izražaja u slučaju kada bi se masivne skladišne posude radile od smjese gline i mineralnih primjesa. No, iste nisu detektirane u znatnijoj mjeri kako na promatranim, tako i na većoj količini pronađenih ulomaka skladišnih posuda u drugim slojevima, što indirektno potvrđuje kako se u smjesu za izradu ovog tipa posuda nije običavalo dodavati mineralne primjese jer bi one povećale težinu, a sigurno i utjecale na lomljivost takvih

per that is present in one vessel (Fig. 46: a) but not in the other (Fig. 46: b). In turn, the second vessel contains a large quantity of clay pellets[10] in its pottery paste, which may be an integral part of the clay mixture, or may have ended up in it accidentally, as a consequence of insufficiently-worked paste (cf. Kudelić 2016).

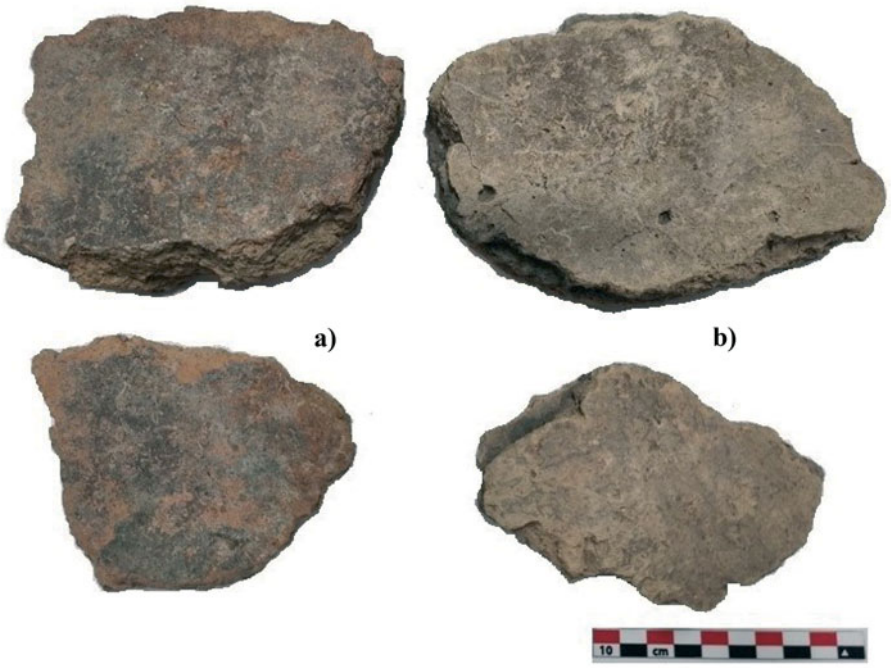
Inclusions of organic origin provide pottery with special properties during its shaping and drying, and they also make it lighter, which was observed during the primary inspection and comparison of fragments of storage vessels with and without organic temper; the former is evidently lighter (Fig. 47).[11] This fact would certainly came to the fore when massive storage vessels were produced from mixtures of clay and mineral inclusions. However, such inclusions have not been detected in any significant quantity in the analysed sherds, nor in the large number of sherds of storage vessels recovered from other layers. This fact indirectly confirms that it was not customary to add

10 Da je riječ o glinovitim peletima, a ne o grogu potvrđeno je nakon provedenih analiza na University College u Londonu. Usmeno priopćenje: Maja Miše i Courtney Allardice, kojima na ovom mjestu iskreno zahvaljujemo na podacima.

11 Za provjeru navedenog, odabrana su četiri uzorka, po dva od svake posude približno istih dimenzija. Vaganjem je utvrđeno kako keramički ulomak bez organskih primjesa dimenzija 15 x 11 x 3 cm ima težinu od 583 g, dok ulomak s organskim primjesama dimenzija 16 x 12,3 x 2,5 cm ima težinu od 566 g, manji ulomak bez organskih primjesa dimenzija 11 x 8,5 x 3 cm ima težinu od 316 g, dok ulomak s organskim dodacima dimenzija 11 x 9 x 3 – 3,5 cm teži 243 g.

10 The fact that these are clay pellets rather than grog was confirmed by the analyses conducted at University College London. Oral communication by Maja Miše and Courtney Allardice, to whom we are sincerely grateful for the data provided.

11 In order to verify this, four samples of approximately the same dimensions were selected, two from each vessel. The weighing established that the weight of the potsherd with no organic temper, of 15 x 11 x 3 cm, was 583 g, while the weight of the sherd with organic temper, of 16 x 12.3 x 2.5 cm, was 566 g. The smaller sherd with no organic temper, of 11 x 8.5 x 3 cm, weighed 316 g, while the sherd with organic inclusions, of 11 x 9 x 3–3.5 cm, weighed 243 g.



Sl. 47 — Izvagani ulomci dvije različite posude i vizualna usporedba njihovih veličina: a) veći (gore) i manji (dolje) ulomak skladišne posude bez organskih primjesa; b) veći (gore) i manji (dolje) ulomak skladišne posude s organskim primjesama (snimila: D. Knežić)
Fig. 47 — Weighed sherds of two different vessels and a visual comparison of their size: a) larger (upper) and smaller (lower) sherd of the storage vessel without organic temper; b) larger (upper) and smaller (lower) sherd of the storage vessel with organic temper (photo by: D. Knežić)

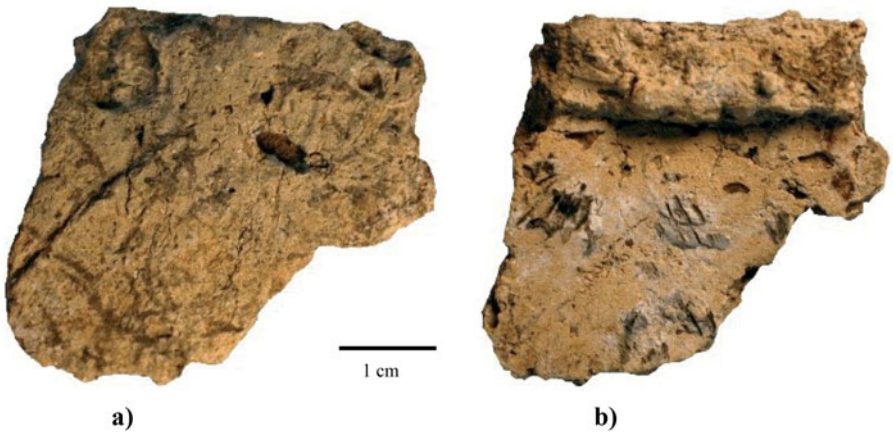
velikih i krutih posuda. Izgleda kako su velike posude iz sloja 419 služile isključivo u skladišne svrhe što je vidljivo prema izboru primjesa koje za razliku od groga ili litoklasta nemaju kvalitetu provođenja topline (Skibo 2013: 43; Miloglav 2016: 33).

Organske primjese uobičajeno se nalaze kao dodatak u smjesi keramičkih posuda većih dimenzija, u ćerpičima i opeci ili kao strukturni dio kućnog lijepa, koji je služio za oblaganje unutarnjih i vanjskih zidova građevina (Ayyad et al. 1991; Lempiäinen, Levkovskaya 1994; Willcox, Tengberg 1995; Willcox, Fornite 1999; Tsetlin 2003; Newton 2004; Bonnaire 2005; 2016; Bonnaire, Tengberg 2007; van Doosselaere, Hayes 2007; Hovsepyan, Willcox 2008; Ryan 2011: 294–295; Dumpe, Stivrins 2015; Henn et al. 2015; Henn, Pál 2015; Tolar et al. 2016; Dzhanfezova 2021; Šoštarić, Vilović 2021). Jedan analizirani ulomak kućnog lijepa vrlo svijetlo smeđe boje (10YR 7/3) manjih dimenzija iz istovjetnog konteksta (SJ 419) u Nadinu potvrđuje navedeno (sl. 48): na vanjskoj stijenki ulomka definirani su otisak sitnozrne žitarice (*Panicum/Setaria* sp.) i otisak sjemenke porodice trava (*Poaceae*) (sl. 49).

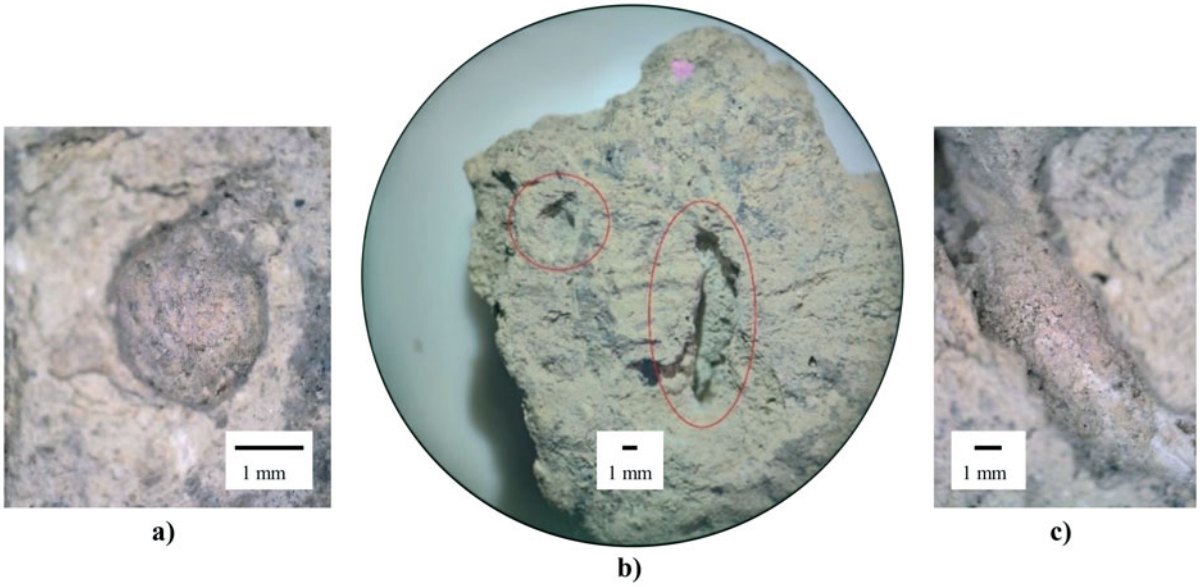
Nadalje, miješanje slame sa zemljom omogućava keramici homogenost teksture i struk-

mineral inclusions to the clay mixture used to make this type of ware, since they would increase its weight, and certainly also impact the fragility of such large, rigid vessels. It would appear that large vessels from stratum 419 were used only for storage purposes, which is also visible from the selection of inclusions that, unlike grog or lithoclast, have no heat-conduction properties (Skibo 2013: 43; Miloglav 2016: 33).

Organic inclusions are regularly found as temper in the clay mixture of large-sized pottery vessels, and of mud bricks, and as a structural part of the house daub that was used to coat the inside and outside walls of buildings (Ayyad et al. 1991; Lempiäinen, Levkovskaya 1994; Willcox, Tengberg 1995; Willcox, Fornite 1999; Tsetlin 2003; Newton 2004; Bonnaire 2005; 2016; Bonnaire, Tengberg 2007; van Doosselaere, Hayes 2007; Hovsepyan, Willcox 2008; Ryan 2011: 294–295; Dumpe, Stivrins 2015; Henn et al. 2015; Henn, Pál 2015; Tolar et al. 2016; Dzhanfezova 2021; Šoštarić, Vilović 2021). The analysed fragment of house daub – very light brown (10YR 7/3) and of small dimensions – discovered in the same context (SU 419) in Nadin has confirmed all of the above (Fig. 48): the imprint of a small-grained cereal (*Panicum/Setaria* sp.) and the imprint of a seed from the grass family (*Poaceae*) have been identified on the outer wall of the fragment (Fig. 49).



Sl. 48 — Manji keramički fragment ulomka kućnog lijepa iz stratigrafske jedinice 419 s vidljivim otiscima biljnog podrijetla (snimila: D. Knežić)
Fig. 48 — Small fragment of ceramic house daub from stratigraphic unit 419 with visible imprints of organic origin (photo by: D. Knežić)



Sl. 49 — Otisci: a) sitnozrne žitarice (cf. *Panicum/Setaria* sp.); b) na fragmentu kućnog lijepa iz SJ 419; c) trava (*Poaceae*) (snimila: D. Knežić)
Fig. 49 — Imprints: a) of a small-grained cereal (cf. *Panicum/Setaria* sp.); b) on a fragment of house daub from stratigraphic unit SU 419; c) of grasses (*Poaceae*) (photo by: D. Knežić)

ture kakvu ne bi imala da slama nije fermentirala. Egipatski arhitekt, H. Fathy (1973: 36) gradio je starom tehnikom i koristio prirodne materijale poštujući tradiciju egipatske baštine. U svom radu iz 1973. godine donosi opis procedure za pripremu smjese namijenjene proizvodnji glinene opeke. U detalje opisuje gradnju kuće od blata, odnosno gline, u selu Gourna u blizini Luksora u Egiptu. Standardni proces izrade tzv. *Gourna opeke* je miješanje

Furthermore, the mixing of straw with soil makes it possible for the pottery to have a homogeneous texture and such structure that would not be possible had the straw not fermented. The Egyptian architect, H. Fathy (1973: 36), built using the old technique and natural materials, thus respecting the tradition of Egyptian heritage. In his paper published in 1973, he describes the procedure for the preparation of a mixture used to produce clay bricks. He describes in detail the construction of a

obične zemlje s mjesta gradnje s pijeskom iz pustinje, uz dodatak slame i vode. Zemlja i pijesak se miješaju u omjeru 1/3 volumena. Na 1 m^3 te smjese dodaje se još 45 kg slame i sve se pomiješa s vodom. Nakon toga se ostavlja dva dana kako bi se slama natopila i fermentirala. Fermentacijom slame nastaju mliječne kiseline koje opeku čine jačom i manje poroznom, odnosno krućom kako ne bi mogla upijati okolne tekućine. Zbog vodonepropusnosti takvih glinenih materijala oni se mogu koristiti za čuvanje tekućina ili proizvodnju soli, kao i u građevini za oblaganje kuća te jama koje na taj način postaju svojevrsni silosi (Newton 2004).

O prednostima proizvoda napravljenih od glinene smjese kojoj su dodavane biljne primjese svjedoči i zrakoprazna keramička ambalaža namijenjena duljem čuvanju svježeg voća. U Afganistanu postoji tradicionalna metoda čuvanja voća svježim do pola godine pod nazivom *kangina* koja se održala do danas. Naime, u ambalažu napravljenu od gline i biljnih primjesa u obliku pogače zatvara se voće poput grožđa koje u tim uvjetima, pomoću pasivno kontrolirane atmosfere, ostaje svježe od jeseni do kraja zime. To je moguće zbog živih stanica koje se nalaze na grožđu unutar ambalaže. Te stanice koriste kisik i proizvode CO_2 i vodu, a spora izmjena plinova kroz specifični glineni omotač osigurava dovoljno kisika koje održava voće svježim, dok visoka koncentracija CO_2 spriječava metabolizam i rast gljivica (Dharni 2022).

ZAKLJUČAK

Arheobotaničkom analizom keramičkih ulomaka iz jednog odabranog naseobinskog konteksta starijeg željeznog doba identificirano je sveukupno 13 svojti od kojih najviše pripada taksonomskoj kategoriji vrste. Unutar definiranih ekoloških kategorija najviše taksona pripada žitaricama, krupnozrnim potom sitnozrnim, a uz njih su nađene drvenaste vrste i trave. Pronađeni su indirektni biljni ostaci u obliku otisaka pšena, stabljike (s nodijem), vlati, klasa, klasića, baze pljeve, rahisa, pljevice, osja, potom koštice te mineralizirani biljni nalazi i jedan karbonizirani.

Od žitarica su determinirani ječam (*Hordeum vulgare*) i dvoredni ječam (*Hordeum*

mud house (that is, clay house) in Gourna village, near Luxor, Egypt. The standard process of making the so-called Gourna brick includes mixing plain soil from the construction site with desert sand, and adding straw and water. The soil and sand are mixed in a volume ratio of 1:3. In addition, 45 kg of straw are added to 1 m^3 of such mixture, and all of it is combined with water. The mixture is then left for two days for the straw to be saturated and ferment. The straw fermentation produces lactic acids that make the brick stronger and less porous, which means harder and resistant to absorbing surrounding liquids. The watertightness of such clay materials makes them suitable for storing liquids and the production of salt, and also for construction purposes such as the coating of houses and pits that can thus become a kind of silo (Newton 2004).

The advantages of products made of clay paste with plant temper is further evidenced by airtight ceramic containers used to store fresh fruit for a protracted period of time. In Afghanistan, fruit is kept fresh for up to six months using a traditional method called *kangina* that has been preserved up to the present. Fruit such as grapes is closed in containers shaped like scones, made of clay and plant temper. Under such conditions, using a passively controlled atmosphere, fruit can stay fresh from autumn till the end of winter. This is made possible by living cells present on grapes inside such packaging. They use oxygen and produce CO_2 and water, and the slow exchange of gases through the specific clay envelope supplies sufficient oxygen to keep the fruit fresh, while the high concentration of CO_2 prevents its metabolism and fungal growth (Dharni 2022).

CONCLUSION

A total of 13 taxa have been identified by the archaeobotanical analysis of potsherds from a selected Early Iron Age settlement context. Most of them belong to the taxonomic category of species. Within the defined ecological categories, the majority of taxa belong to cereals, primarily large-grained and then also small-grained, with woody (ligneous) plants and grasses that were discovered with them. Indirect plant remains have been found, consisting of imprints of grain, stem (with nodus), leaf, ear, spikelet, glume base, rachis, glumelle, awn and pit, as well as mineralized plant remains and one that was carbonized.

The identified cereals include barley (*Hordeum vulgare*) and two-rowed barley (*Hordeum vulgare* subsp. *distichum*), wheat (*Triticum* sp.),

vulgare subsp. _distichum_), pšenica (_Triticum_ sp.), tvrda pšenica (_Triticum durum_ s.l.), dvozrna pšenica (_Triticum dicoccum_), proso (_Panicum miliaceum_), klipasti muhar (_Setaria italica_). U glinenoj smjesi nađeni su i neki drugi biljni ostaci poput divljih trava (_Poaceae_) te drvenastih vrsta masline (_Olea europaea_) i drijena (cf. _Cornus mas_) što ukazuje na činjenicu da u keramičkoj smjesi ne treba očekivati isključivo ostatke od obrade žitarica već se tu mogu pronaći i neke druge biljne vrste prisutne u okolišu. Općenito se organske primjese dodaju u glinenu smjesu za izradu keramike kako bi osigurali karakteristična svojstva glinene smjese – bolju povezanost, lakše modeliranje, brže sušenje i pečenje, sprječavanje pucanja, veću čvrstoću, vodonepropusnost te manju težinu konačnog produkta. Takve karakteristike uklapaju se u potrebe zajednice za kvalitetnim spremanjem i dugoročnim čuvanjem velike količine namirnica, posebno u uvjetima veće vlažnosti kakvi su neizbježni u hladnijem dijelu godine kada skladištenje igra ključnu ulogu u opskrbi zajednice hranom. Iz dobivenih podataka kako ove, tako i provedene karpološke analize na lokalitetu vidimo kako je kultivacija žitarica bila prakticirana, a vršidba žitarica koje su stavljane u glinenu smjesu najvjerojatnije rađena u blizini naselja, kao i sama smjesa za keramiku kako bi ju bilo praktičnije koristiti _in situ_. Liburni su dio otpada od vršidbe žitarica koristili na način da su ga dodavali glinenoj smjesi kako bi postigli željene kvalitete, u smislu velikih, čvrstih, dugotrajnih, ali i nešto lakših, s obzirom na dimenzije, keramičkih proizvoda.

Nadalje, pregledom drugih keramičkih ulomaka iz istog sloja primjećeno je kako oni nisu sadržavali planski dodavane organske primjese u većim količinama. Doduše, na pojedinim ulomcima pronađeni su otisci biljnog podrijetla, no samo u iznimnim slučajevima i pojedinačno što se može definirati kao koincidencija bez svjesne namjere da se biljnim materijalom dodaje smjesi za izradu te vrste posuđa. Prema tome, vidimo kako su keramički predmeti iz proučavanog konteksta podijeljeni na one u čiju su smjesu dodavane organske primjese i na one u kojima one izostaju. Samo je nekolicina ukupnog keramičkog repertoara sadržavala organske primjese, a on je ograničen na posude isključivo skladišne namije-

durum wheat (*Triticum durum* s.l.), emmer (*Triticum dicoccum*), broomcorn millet (*Panicum miliaceum*), and foxtail millet (*Setaria italica*). Some other plant remains have also been found in the clay paste, such as wild grasses (*Poaceae*) and ligneous species – olive (*Olea europaea*) and cornelian cherry (cf. *Cornus mas*) – indicating that remains not only of cereal processing can be found in the clay mixture, but also of some other plant species that were present in the environment. Generally, organic temper is added to the clay paste for pottery production to obtain some specific characteristics of the paste, such as better compactness, easier modelling, quicker drying and firing, prevention of breakage, more strength, water tightness and lower weight of the final product. Such characteristics correspond to the community's needs for high-quality storage and long-term keeping of large quantities of food, especially under humid conditions that were unavoidable in the colder part of the year, when storage played an important part in the community's food supply. The data obtained by this analysis, and by the carpological analysis conducted on the site, demonstrate that cereals were cultivated, and that cereals that were added to the clay paste were probably threshed in the vicinity of the settlement, where the pottery paste was probably also prepared, to be used *in situ*, which was more practical. The Liburni used part of the waste created by cereal threshing in such a way that they added it to the clay mixture to obtain the desired qualities reflected in pottery products that were large, strong and durable, but also somewhat lighter (in view of their dimensions).

Furthermore, the inspection of other pottery sherds recovered from the same layer has revealed that they did not contain large quantities of deliberately-added organic inclusions. Truth to be told, imprints of plant origin have been found on some sherds, but these were exceptional individual cases which can be defined as coincidence and not a result of any deliberate intention to add plant material to the pottery clay paste. Thus, we can separate pottery from the examined context into pottery containing organic temper in its mixture, and pottery not containing such temper. Only a small part of the total ceramic repertoire contained organic temper, and it was limited to vessels exclusively used for storage purposes and construction material – in this case, house daub. However, storage vessels did not *have* to contain plant inclusions, as evidenced by the

ne i na građevinski materijal, u ovom slučaju kućni lijep. Ipak, skladišne posude nisu *a priori* morale sadržavati biljne primjese što potvrđuje druga takva posuda iz istog konteksta koja sadrži isključivo glinovite pelete. No, obje skladišne posude odlikuje izostanak znatnije količine mineralnih primjesa vjerojatno potaknuto njihovom namjenom i shodnim preferiranim tehničkim karakteristikama. Ekonomske prakse zajednice uključivale su kultivaciju žitarica poput pšenice i ječma te prosa i klipastog muhara. Na marginama šumskih predjela van naselja i dalje je bilo prisutno ubiranje plodova drvenastih biljaka poput drijena, a ostaci masline najvjerojatnije ukazuju na početke kultivacije i/ili trgovinsku razmjenu. Ostaci od vršidbe žitarica, ali i neki drugi biljni dijelovi sekundarno se iskorištavaju u izradi keramičkih proizvoda.

Analiza biljnih ostataka na glinenim medijima daje nam samo fragmente ondašnje vegetacije jer je rekonstrukcija okoliša na temelju tih podataka manjkava za sve one biljne vrste koje nisu bile namijenjene korištenju kao primjesa u izradi keramičkih predmeta. No ipak, identifikacijom svojti inkorporiranih u keramiku, u kombinaciji s rezultatima provedenih kaproloških analiza, dobili smo uvid u poljoprivredne prakse zajednice, nove spoznaje o utilizaciji biljnih vrsta i spoznaje o tehnologiji vršidbe žitarica te izradi glinenih predmeta s primjesama organskog podrijetla. Biljke su nesumnjivo imale važnu ulogu u prapovijesnim zajednicama, ponajprije kao hrana, a onda i kao samostalni ili dio utilitarnog predmeta. Arheobotaničke analize poput identifikacije biljnih makroostataka na glinenim medijima osvjetljavaju takve spoznaje zbog čega treba težiti njihovom provođenju na arheološkim lokalitetima kako bi dobili sveobuhvatniju sliku života zajednica u prošlosti.

Konačno, ovakve analize glinenih medija iznimno su korisne ondje gdje nije moguće provesti klasičnu makrobotaničku analizu sedimenta jer se iz određenog razloga poput kiselosti tla ili erozije ne pojavljuju biljni ostaci. Još jedna prednost ove vrste analize jest to što je glineni materijal ekstenzivno prikupljan na svim istraživanim lokalitetima od postanka arheološke znanosti, za razliku od uzoraka sedimenta koji obiluju biljnim zapisom, ali sve do popularizacije flotacijske metode i standardizacije arheobotaničkih analiza nisu uzorkovani na istraži-

second vessel of this type, which contained only clay pellets. Still, both storage vessels are characterized by the lack of any significant quantity of mineral inclusions, which was probably prompted by their function and corresponding preferred technical characteristics. The community's economic practices included cultivation of cereals such as wheat and barley, and broomcorn millet and foxtail millet. Fruits of ligneous plants such as cornelian cherry continued to be picked on the edges of forest areas outside the settlement, while the discovered olive remains probably indicate the beginning of its cultivation and/or trading. The remains of cereal threshing, and also some other plant elements, were used secondarily in the production of pottery.

The analysis of plant remains on clay media provides us only with a fragmented picture of the vegetation of the time, since the reconstruction of the contemporary environment on the basis of such data lacks all those plant species that were not used as temper in the pottery production. However, the identification of taxa included in pottery, combined with the results of the conducted carpological analyses, has provided us with insight into the farming practices of the community, and new information about the way in which plant species were utilized, as well as information on the technology of cereal threshing and the making of clay objects with organic temper. There is no doubt that plants played an important role in prehistoric communities, primarily as food, and also as self-standing utilitarian objects or parts of them. Archaeobotanical analyses such as the identification of plant macroremains on clay media shed light on such information, and thus we should endeavour to conduct them at archaeological sites with a view to obtaining a more comprehensive picture of the life of past communities.

Finally, such analyses of clay media are very useful in places in which a classical macrobotanical sediment analysis is not possible, because plant remains are not present in it for various reasons, such as soil acidity or erosion. Another advantage of this type of analysis is that clay material has been collected extensively at all excavated archaeological sites ever since the emergence of archaeological science, unlike samples of sediment, which is abundant in plant record but was not sampled at the excavated sites before the flotation method became popular and archaeobotanical analyses were standardized. Therefore, if we take into consideration the longevity of pottery,

vanim nalazištima. Stoga, ako uzmemo u obzir dugotrajnost predmeta od keramike bilo bi poželjno provesti arheobotaničke analize keramičkih ulomaka s biljnim primjesama s nalazišta iz željeznog doba na području istočnog Jadrana radi dobivanja sveobuhvatnijeg korpusa podataka vezanih uz poljoprivredne, ekonomske i ekološke prilike ondašnjih zajednica. Tim više što je taj period s aspekta arheobotanike gotovo u potpunosti neistražen. Ovakvi nalazi važni su u kontekstu osvjetljavanja spoznaja o okolišnim i ekonomskim prilikama željeznodobnih zajednica u Liburniji za koje nedostaju ove vrste podataka.

it would be desirable to conduct archaeobotanical analyses of pottery sherds with plant temper recovered from the Iron Age sites in the eastern Adriatic region, with a view to obtaining a more comprehensive collection of data relating to the agricultural, economic and environmental circumstances of the communities of the period. Even more so if we know that, from the point of view of archaeobotany, that period is almost completely unexplored. Findings of this kind are important to gain knowledge on the environmental and economic circumstances of the Iron Age communities in Liburnia, for which such data are missing.

Prijevod Translation TAMARA LEVAK POTREBICA
Lektura Proofreading ANDY G. TOMLINSON

IZVOR SOURCE

Dio Cassius, Ῥωμαικὴ ἱστορία / *Roman History*, Loeb Classical Library, Vols. 5 (Books 46–50), 6 (Books 51–55), 7 (Books 56–60), LCL 82, 83, 175, Harvard University Press, 1917, 1924.

INTERNETSKI IZVORI INTERNET SOURCES

Dharni, A. 2022, Viral video shows ancient grape preservation technique used in Afganistan, https://www.indiatimes.com/trending/human-interest/grape-preservation-in-clay-pots-in-afghanistan-567366.html (13. 09. 2022.)

Digital Plant Atlas – https://www.plantatlas.eu/

Flora Croatica Database – https://hirc.botanic.hr/fcd/

LITERATURA BIBLIOGRAPHY

Akeret, Ö., Jacomet, S. 2010, *Identification of Archaeological Plant Macrofossils (seeds und fruits)*, MSc course script, Integrative Prehistory and Archeological Science (IPAS), Basel University, Basel.

Amblard, S., Pernès, J. 1989, The identification of cultivated pearl millet (*Pennisetum*) amongst plant imprints on pottery from Oued Chebbi (Dhar Oualata, Mauritania), *African Archaeological Review*, Vol. 7(1), 117–126. https://doi.org/10.1007/BF01116840

Amicone, S., Morandi, L. F., Gur-Arieh, S. 2021, 'Seeing Shit': Assessing the Visibility of Dung Tempering in Ancient Pottery Using an Experimental Approach, *Environmental Archaeology*, Vol. 26(4), 423–438. https://doi.org/10.1080/14614103.2020.1852758

Andonova, M. 2021, Ancient basketry on the inside: X-ray computed microtomography for the non-destructive assessment of small archaeological monocotyledonous fragments: examples from Southeast Europe, *Heritage Science*, Vol. 9(1), 158. https://doi.org/10.1186/s40494-021-00631-z

Ayyad, S., Krzywinski, K., Pierce, R. 1991, Mudbrick as a bearer of agricultural information: An archaeopalynological study, *Norwegian Archaeological Review*, Vol. 24(2), 77–91. https://doi.org/10.1080/00293652.1991.9965535

Batović, Š. 1968, Istraživanje ilirskog naselja u Radovinu, *Diadora*, Vol. 4, 53–74.

Batović, Š. 1970, Istraživanje liburnskog naselja u Ninu 1969. godine, *Diadora*, Vol. 5, 33–49.

Batović, Š. 1974, Ostava iz Jagodnje Gornje u okviru zadnje faze liburnske kulture, *Diadora*, Vol. 7, 159–245.

Batović, Š. 1980, Istraživanje prapovijesti u Bribiru, *Diadora*, Vol. 9, 55–94.

Batović, Š. 1987, Liburnska grupa, in: *Praistorija jugoslavenskih zemalja. V: Željezno doba*, Benac A. (ed.), Akademija nauka i umjetnosti Bosne i Hrecegovine, Centar za balkanološka ispitivanja, Sarajevo, 339–390.

Batović, A., Batović, Š. 2013, *Helenistički grobovi iz Nadina u okviru V. (zadnje) faze liburnske kulture. Građa za povijest Liburna, IV.–I. st. prije Krista*, Posebna izdanja 2, Arheološki muzej Zadar, Matica Hrvatska Zadar, Grad Benkovac, Zadar – Benkovac.

Batović, Š., Chapman, J. 1987a, Istraživanje Gradine u Nadinu, *Obavijesti Hrvatskog arheološkog društva*, Vol. XIX(2), 28–32.

Batović, Š., Chapman, J. 1987b, Nadin / Gradina. Naselje od starijeg željeznog doba do 17. stoljeća, *Arheološki pregled*, Vol. 27 (1986), 72–74.

Batović, Š., Čondić, N. 2005, Istraživanja arheoloških nalazišta na trasi autoceste Biljane – Nadin – Rašteviće, *Obavijesti Hrvatskog arheološkog društva*, Vol. XXXVII(3), 74–91.

Bender Jørgensen, L., Grömer, K. 2012, The archaeology of textiles – Recent advances and new methods / Arheologija tekstila – Suvremena dostignuća i novije metode, *Portal: Godišnjak Hrvatskoga restauratorskog zavoda*, Vol. 3, 45–68.

Boaretto, E., Wu, X., Yuan, J., Bar-Yosef, O., Chu, V., Pan, Y., Liu, K., Cohen, D., Jiao, T., Li, S., Gu, H., Goldberg, P., Weiner, S. 2009, Radiocarbon dating of charcoal and bone collagen associated with early pottery at Yuchanyan Cave, Hunan Province, China, *Proceedings of the National Academy of Science of the USA*, Vol. 106(24), 9595–9600. https://doi.org/10.1073/pnas.090053910

Bonnaire, E. 2005, *Les empreintes végétales dans les briques crues de construction. Identification des céréales utilisées comme dégraissant*, Mémoire de Maîtrise, Université Paris 1 Panthéon-Sorbonne, Paris.

Bonnaire, E. 2006, *Études des empreintes et des phytolithes des céréales utilisées comme dégraissant: applications sur du torchis de Kovačevo (Bulgarie)*, Mémoire de Master 2, Université Paris 1 Panthéon-Sorbonne, Paris.

Bonnaire, E. 2011, Les empreintes végétales dans la terre à bâtir. Identification des céréales utilisées comme dégraissant, in: *Les cultures constructives de la brique crue. Archéologie, architecture, histoire, ethnographie, lexicographie, sciences des matériaux,* Actes du colloque international des 16 et 17 mai 2008, Université de Toulouse 2 – Le Mirail, de Chazelles C. A., Klein A., Pousthomis N. (eds.), Échanges transdisciplinaires sur les constructions en terre crue 3, Editions de l'Espérou, Montpellier, 473–476.

Bonnaire, E. 2014, Use of crop-processing by-products for tempering in earthen construction techniques, in: *Plants and People. Choices and Diversity through Time*, Chevalier A., Marinova E., Peña-Chocarro L. (eds.), Early Agricultural Remnants and Technical Heritage (EARTH): 8,000 Years of Resilience and Innovation 1, Oxbow Books, Oxford, 282–286.

Bonnaire, E. 2016, Les murs ont des glumelles... Étude du dégraissant végétal de la terre à bâtir, indices de techniques et de savoirs-faires, in: *L'usage de la terre à bâtir en France non méditerranéenne durant la Protohistoire: du petit mobilier à l'architecture*, Actes de la journée d'étude de l'Association pour la promotion des recherches sur l'âge du bronze (APRAB), 1er mars 2013, Musée d'Archéologie Nationale, 1er mars 2013, Issenmann R., Nicolas T. (eds.), Bulletin de l'APRAB Supplément 2, Université de Bourgogne, Dijon, 107–114.

Bonnaire, E., Tengberg, M. 2007, Eléments pour l'identification des empreintes végétales dans la terre à bâtir, *Cahier des thèmes transversaux ArScAn*, –Vol. VII (2005–2006), 80–85.

Bougard, E. 2003, Ceramic in the Upper Paleolithic, in: *Prehistoric Pottery. People, pattern and purpose*, Gibson A. (ed.), Prehistoric Ceramics Research Group: Occasional Publication 4, British Archaeological Reports International Series 1156, Archaeopress, Oxford, 29–34.

Braadbaart, F., Marinova, E., Sarpaki, A. 2016, Charred olive stones: experimental and archaeological evidence for recognizing olive processing residues used as fuel, *Vegetation History and Archaeobotany*, Vol. 25(5), 415–430. https://doi.org/10.1007/s00334-016-0562-2

Budja, M. 2016. Ceramics among Eurasian hunter-gatherers: 32 000 years of ceramic technology use and the perception of containment, *Documenta Praehistorica*, Vol. XLIII, 61–86. https://doi.org/10.4312/dp.43.2

Cappers, R. T. J., Bekker, R. M. 2013, *A manual for the identification of plant seeds and fruits*, Groningen Archaeological Studies 23, Barkhuips publishing, University of Groningen Library, Groningen.

Cappers, R. T. J., Bekker, R. M., Jans, J. E. A. 2006, *Digitale Zadenatlas van Nederland (Digital seed atlas of the Netherlands)*, Barkhuips publishing, University of Groningen Library, Groningen.

Caracuta, V. 2020, Olive growing in Puglia (southeastern Italy): A review of the evidence from the Mesolithic to the Middle Ages, *Vegetation History and Archaeobotany*, Vol. 29(5), 595–620. https://doi.org/10.1007/s00334-019-00765-y

Chapman, J., Shiel, R., Batović, Š. 1996, *The Changing Face of Dalmatia. Archaeological and Ecological Studies in a Mediterranean Landscape*, Reports of the Research Committee of the Society of Antiquaries of London 54, Leicester University Press, London.

Chi, Z. 2002, The discovery of early pottery in China, *Documenta Praehistorica*, Vol. XXIX, 29–35. https://doi.org/10.4312/dp.29.3

Craig, O. E., Saul, H., Lucquin, A., Nishida, Y., Taché, K., Clarke, L., Thompson, A., Altoft, D. T., Uchiyama, J., Ajimoto, M., Gibbs, K., Isaksson, S., Heron, C. P., Jordan, P. 2013, Earliest evidence for the use of pottery, *Nature*, Vol. 496(7445), 351–354. https://doi.org/10.1038/nature12109

Cree, J. E. 1908, Notice of a Prehistoric Kitchen Midden and Superimposed Mediaeval Stone Floor found at Tusculum, North Berwick, *Proceedings of the Society of Antiquaries of Scotland*, Vol. 42, 253–294. https://doi.org/10.9750/PSAS.042.253.294

Čače, S. 1993, Prilozi povijesti Liburnije u 1. stoljeću prije Krista, *Radovi Zavoda za povijesne znanosti Hrvatske akademije znanosti i umjetnosti u Zadru*, Vol. 35, 1–35.

Čelhar, M., Borzić, I. 2016, Gradina u Zemuniku Donjem – Nalazi željeznog i rimskog doba, in: *Zemunik u prostoru i vremenu*, Faričić J., Dundović Z. (eds.), Sveučilište u Zadru, Zadar, 69–117.

Čelhar, M., Borzić, I., Zaro, G. 2023, Pottery as an Indicator of trade Dynamics and Cultural Contacts in the Eastern Adriatic, in:*Sessions 4–5, Single Contributions*, Proceedings of the 19th International Congress of Classical Archaeology, Cologne/Bonn 2018, Bentz M., Heinzelmann M. (eds.), Archaeology and Economy in the Ancient World 54, Propylaeum, Heidelberg, 301–315.

Čelhar, M., Parica, M., Ilkić, M., Vujević, D. 2017, A Bronze Age underwater site near the islet of Ričul in northern Dalmatia (Croatia), *SKYLLIS: Zeitschrift für maritime und limnische Archäologie und Kulturgeschichte*, Vol. 17(1), 21–34.

Čelhar, M., Zaro, G. 2016, Nadin–Gradina, *Hrvatski arheološki godišnjak*, Vol. 12 (2015), 543–545.

Čelhar, M., Zaro, G. 2023a, Nadin–Gradina: Razvoj grada / Nadin-Gradina: The Evolution of the City, *Archaeologia Adriatica*, Vol. 17 (in press).

Čelhar, M., Zaro, G. 2023b, Nadin–Gradina, *Hrvatski arheološki godišnjak*, Vol. 16 (2019) (in press).

Čondić, N., Vuković, M. 2017, *U temeljima grada. Iz arheoloških slojeva liburnskog Zadra / In the City's Foundations. The Archaeological Layers of the Liburnian Zadar,* Katalozi i monografije 27, Arheološki muzej Zadar, Zadar

Domić Kunić, A. 2018, Sisak od Strabona do Diona Kasija – Povijesni izvori o Segestici Augustovog doba / Sisak from Strabo to Cassius Dio – historical sources on Augustan Aegestica, in: *Segestika i Siscija – Od ruba Imperija do provincijskog središta / Segestica and Siscia – From the periphery of the Empire to a provincial center*, Drnić I. (ed.), Musei Archaeologici Zagrabiensis Catalogi et Monographiae 16, Arheološki muzej u Zagrebu, Zagreb, 23–61.

Drnić, I., Radović, S., Reed, K., Zavodny, E. 2020, Proizvodnja i priprema hrane u sisačkom željeznodobnom naselju / The production and preparation of food at the Iron Age settlement in Sisak, in: *Segestika i Siscija – naselje s početka povijesti / Segestica and Siscia – a settlement from the beginning of history*, Drnić I. (ed.), katalog izložbe, Arheološki muzej u Zagrebu, Zagreb, 55–81.

Dumpe, B., Stivrins, N. 2015, Organic inclusions in Middle and Late Iron Age (5th–12th century) hand-built pottery in present-day Latvia, *Journal of Archaeological Science*, Vol. 57, 239–247. https://doi.org/10.1016/j.jas.2015.03.008

Dzhanfezova, T. 2020, 'Organic Temper' and the Early Neolithic Pottery Production: Interpretational Challenges, *Acta Archaeologica*, Vol. 91(2), 61–87. https://doi.org/10.1111/j.1600-0390.2020.12228.x

Dzhanfezova, T. 2021, Exploring the Broad Spectrum: Vegetal Inclusions in Early Neolithic Eastern Balkan Pottery, *Open Archaeology*, Vol. 7(1), 1138–1159. https://doi.org/10.1515/opar-2020-0200

Evans, J., Recchia, G. 2003, Pottery function: trapped residues in Bronze Age pottery from Coppa Nevigata (Southern Italy), *Scienze dell'Antichità*, Vol. 11 (2001–2003), 187–201.

Fathy, H. 1973, *Architecture for the Poor. An Experiment in Rural Egypt*, University of Chicago Press, Chicago – London.

Filipović, D., Meadows, J., Corso, M. D., Kirleis, W., Alsleben, A., Akeret, Ö., Bittmann, F., Bosi, G., Ciută, B., Dreslerová, D., Effenberger, H., Gyulai, F., Heiss, A. G., Hellmund, M., Jahns, S., Jakobitsch, T., Kapcia, M., Klooß, S., Kohler-Schneider, M., Kroll, H., Makarowicz, P., Marinova, E., Märkle, T., Medović, A., Mercuri, A. M., Mueller-Bieniek, A., Nisbet, R., Pashkevich, G., Perego, R., Pokorný, P., Pospieszny, Ł., Przybyła, M., Reed, K., Rennwanz, J., Stika, H. P., Stobbe, A., Tolar, T., Wasylikowa, K., Wiethold, J., Zerl, T. 2020, New AMS ^{14}C dates track the arrival and spread of broomcorn millet cultivation and agricultural change in prehistoric Europe, *Scientific Reports*, Vol. 10(1), 13698. https://doi.org/10.1038/s41598-020-70495-z

Fiorentino, G., D'Oronzo, C. 2012, Analisi dei macroresti vegetali: strategie agronomiche, alimentazione e caratteristiche del paleoambiente a Coppa Nevigata nel corso dell'età del Bronzo, in: *Coppa Nevigata e l'area umida alla foce del Candelaro durante l'età del Bronzo*, Cazzella A., Moscoloni M., Recchia G. (eds.), Claudio Grenzi Editore, Edizioni del Parco, Foggia, 327–338.

Frahm, E. 2014, Scanning Electron Microscopy (SEM): Applications in Archaeology, in: *Encyclopedia of Global Archaeology*, Smith C. (ed.), Springer, New York, 6487–6495. https://doi.org/10.1007/978-1-4419-0465-2_341

Grabowski, R. 2014, *Cereal husbandry and settlement: expanding archaeobotanical perspectives on the southern Scandinavian Iron Age*, Unpublished PhD Thesis, Umeå Universitet, Sweden.

Grüger, E. 1996, Vegetational change, in: J. Chapman, R. Shiel, Š. Batović, *The Changing Face of Dalmatia. Archaeological and Ecological Studies in a Mediterranean Landscape*, Reports of the Research Committee of the Society of Antiquaries of London 54, Leicester University Press, London, 33–43.

Hamshaw Thomas H. 1912, On some methods in palaeobotany, *New Phytologist*, Vol. XI(4), 109–114.

Harvey, E. L., Fuller, D. Q. 2005, Investigating crop processing using phytolith analysis: the example of rice and millets, *Journal of Archaeological Science*, Vol. 32(5), 739–752. https://doi.org/10.1016/j.jas.2004.12.010

Hastorf, C. A. 1988, The use of paleoethnobotanical data in prehistoric studies of crop production, processing, and consumption, in: *Current paleoethnobotany. Analytical methods and cultural interpretations of archaeological plant remains*, Hastorf C. A., Popper V. S. (eds.), University of Chicago Press, Chicago, 119–144.

Heiss, A. G., Jakobitsch, T., Wiesinger, S., Trebsche, P. 2021, Dig out, Dig in! Plant-based diet at the Late Bronze Age copper production site of Prigglitz-Gasteil (Lower Austria) and the relevance of processed foodstuffs for the supply of Alpine Bronze Age miners, *PLoS ONE*, Vol. 16(3), e0248287. https://doi.org/10.1371/journal.pone.0248287

Helbæk, H. 1940, Studies on Prehistoric and Anglo-Saxon Cultivated Plants in England, *Proceedings of the Prehistoric Society*, Vol. 6, 176–178. https://doi.org/10.1017/S0079497X00020478

Helbæk, H. 1953, Early crops in southern England, *Proceedings of the Prehistoric Society*, Vol. 18(2), 194–233. https://doi.org/10.1017/S0079497X00018326

Henn, T., Jacomet, S., Nagy, D. U., Pál, R. W. 2015, Desiccated diaspores from building materials: methodological aspects of processing mudbrick for archaeobotanical studies and first results of a study of earth buildings in southwest Hungary, *Vegetation History and Archaeobotany*, Vol. 24(3), 427–440. https://doi.org/10.1007/s00334-014-0499-2

Henn, T., Pál, R. W. 2015, Evaluation of desiccated and deformed diaspores from natural building materials, *Ethnobiology Letters*, Vol. 6(1), 10–24. https://doi.org/10.14237/ebl.6.1.2015.229

Hillman, G. C. 1984a, Interpretation of archaeological plant remains: the application of ethnographical methods from Turkey, in: *Plants and Ancient Man. Studies in palaeoethnobotany*, Proceedings of the Sixth Symposium of the International Work Group for Palaeoethnobotany Groningen, May 30 – June 3 1983, van Zeist W., Casparie W. A. (eds.), A. A. Balkema, Rotterdam, 1–41.

Hillman, G. C. 1984b, Traditional husbandry and processing of archaic cereals in recent times: the operations, products and equipment which might feature in Sumerian texts, Part I: the glume wheats, *Bulletin on Sumerian Agriculture*, Vol. 1, 114–152.

Hillman, G. C. 1985, Traditional husbandry and processing of archaic cereals in recent times: the operations, products and equipment that might feature in Sumerian textes, Part II: The free-threshing cereals, *Bulletin on Sumerian Agriculture*, Vol. 2, 1–31.

Hjelmqvist, H. 1955, *Die älteste Gesichte der Kulturplflanzen in Schweden / The oldest history of cultivated plants in Sweden*, Opera Botanica 1(3), Almqvist & Wiksells, Stockholm.

Hjelmqvist, H. 1982, Arkeologisk botani - något om metoder och mål, *Svensk Botanisk Tiaskrifi*, Vol. 76(4), 229–240.

Hopf, M. 1964, Untersuchung der Getreidereste im Hüttenlehm aus Danilo, in: J. Korošec, *Danilo in danilska kultura*, Univerzitetna založba, Ljubljana, 107–108.

Hopf, M. 1965, Untersuchungen aus dem botanischen Labor am RGZM. II. Getreidekorn–Abdrücke als Schmuckelemente in neolithischer Keramik?, *Jahrbuch des Römisch–Germanischen Zentralmuseums Mainz*, Vol. 12, 183–184. https://doi.org/10.11588/jrgzm.1965.0.35917

Hovsepyan, R., Willcox, G. 2008, The earliest finds of cultivated plants in Armenia: evidence from charred remains and crop processing residues in pisé from the Neolithic settlements of Aratashen and Aknashen, *Vegetation History and Archaeobotany*, Vol. 17(Suppl. 1), 63–71. https://doi.org/10.1007/s00334-008-0158-6

Huntley, J. 1996, The plant remains, in: J. Chapman, R. Shiel, Š. Batović, *The Changing Face of Dalmatia. Archaeological and Ecological Studies in a Mediterranean Landscape*, Reports of the Research Committee of the Society of Antiquaries of London 54, Leicester University Press, London, 225.

Iizuka, F., Ferguson, J. R., Izuho, M. 2022a, Late Pleistocene pottery production and exchange: Provenance studies of hunter-gatherer wares from southern Kyushu, Japan by neutron activation analysis, *PLoS ONE*, Vol. 17(3), e0265329. https://doi.org/10.1371/journal.pone.0265329

Iizuka, F., Izuho, M., Wada, K., Barnard, H., Vandiver, P., Morisaki, K., Wendt, C., Aldenderfer, M. 2022b, Of the sea and volcano: A petrographic provenance investigation of locally produced and imported ware of Pre-Younger Dryas Tanegashima Island, Japan, *Quaternary International*, Vol. 608–609, 88–111. https://doi.org/10.1016/j.quaint.2020.10.009

Ilkić, M., Čelhar, M., Parica, M., Vujević, D. 2015, Otočić Ričul, podmorje, *Hrvatski arheološki godišnjak*, Vol. 11 (2014), 497–498.

Jessen, K. 1951, Oldtidens korndyrkning i Danmark, *Viking*, Vol. XV, 15–37.

Jones, G. E. M. 1984, Interpretation of archaeological plant remains: Ethnographic models from Greece, in: *Plants and Ancient Man. Studies in palaeoethnobotany*, Proceedings of the Sixth Symposium of the International Work Group for Palaeoethnobotany Groningen, 30 May – 3 June 1983, van Zeist W., Casparie W. A. (eds.), A. A. Balkema, Rotterdam, 43–61.

Karavanić, S., Kudelić, A., Mareković, S. 2015, Brončanodobni tragovi prehrane na Kalniku – sačuvani u vatri, *Cris*, Vol. XVII(1), 116–127.

Keally, C. T., Taniguchi, Y., Kuzmin, Y. V., Shewkomud, I. Y. 2004, Chronology of the beginning of pottery manufacture in East Asia, *Radiocarbon*, Vol. 46(1), 345–351. https://doi.org/10.1017/S0033822200039643

Kirleis, W., Dal Corso, M., Filipović, D. 2022, Millet or what else? The wider context of the adoption of millet cultivation in Europe, in: *Millet or what else? The wider context of the adoption of millet cultivation in Europe*, Kirleis W., Dal Corso M., Filipović D. (eds.), Scales of transformation in prehistoric and archaic societies 14, Sidestone Press, Leiden, 9–24.

Knežić, D. 2022, *Arheobotanička analiza slojeva liburnskog naselja u Nadinu*, Unpublished MA Thesis, University of Zadar, Zadar.

Kohler-Schneider, M. 2001, *Verkohlte Kultur-und Wildpflanzenreste aus Stillfried an der March als Spiegel spätbronze Landwirtschaft im Weinviertel, Niederösterreich*, Verlag der Österreichischen Akademie der Wissenschaften, Wien.

Körber-Grohne, U. 1991, Identification methods, in: *Progress in old world palaeoethnobotany. A retrospective view on the occasion of 20 years of the International Work Group for Palaeoethnobotany*, van Zeist W., Wasylikowa K., Behre K.-E. (eds.), A. A. Balkema, Rotterdam, 3–24.

Kudelić, A. 2016, Eksperiment u arheologiji – priprema i sastav lončarske smjese / Experiment in archaeology – preparation and composition of clay paste, *Annales Instituti archaeologici*, Vol. XII, 207–211.

Kudelić, A. 2017, Karakterizacija lončarske smjese – makroskopska analiza keramike iz brončanog doba / Characterization of ceramic pastes – a macroanalysis of Bronze Age pottery, *Vjesnik Arheološkog muzeja u Zagrebu*, 3.s. Vol. L, 119–172.

Kukoč, S. 2006, Nadin – nekropola na SZ padini Gradine, *Hrvatski arheološki godišnjak*, Vol. 2 (2005), 307–309.

Kukoč, S. 2009, Nadin – liburnski kult mrtvih, istraživanja 2004.–2006., 2009. god. / Nadin – Liburnian Cult of the Dead, Research Campaigns 2004–2006, 2009, *Asseria*, Vol. 7, 11–79.

Kukoč, S., Batović, Š. 2005, Istraživanje grobnog humka iz željeznog doba u Nadinu, *Obavijesti Hrvatskog arheološkog društva*, Vol. XXXVII(1), 58–63.

Kukoč, S., Batović, Š. 2006, Iskapanje nekropole na sjeverozapadnoj padini Gradine u Nadinu, *Obavijesti Hrvatskog arheološkog društva*, Vol. XXXVIII(2), 65–72.

Kukoč, S., Čelhar, M. 2010, Iskapanje nekropole na sjeverozapadnoj padini Gradine u Nadinu godine 2009, *Obavijesti Hrvatskog arheološkog društva*, Vol. XLII(1), 34–42.

Kukoč, S., Čelhar, M. 2019, Nadin (*Nedinum*): prostorna koncepcija nekropole kod Liburna / Nadin (Nedinum): spatial concept of the Liburnian necropolis, *Vjesnik za arheologiju i histroiju dalmatinsku*, Vol. 112, 9–31.

Kuzmin, Y. V 2002, The earliest centres of pottery origin in the Russian Far East and Siberia: review of chronology for the oldest Neolithic cultures, *Documenta Praehistorica*, Vol. XXIX, 37–46. https://doi.org/10.4312/dp.29.4

Kuzmin, Y. V. 2010, The Neolithic of the Russian Far East and Neighbouring East Asia: Definition, Chronology, and Origins, *Bulletin of the Indo-Pacific Prehistory Association*, Vol. 30, 157–162. https://doi.org/10.7152/bippa.v30i0.9996

Kuzmin, Y. V., Vetrov, V. M. 2007, The earliest Neolithic complex in Siberia: the Ust-Karenga 12 site and its significance for the Neolithisation process in Euroasia, *Documenta Praehistorica*, Vol. XXXIV, 9–20. https://doi.org/10.4312/dp.34.2

Lempiäinen, T., Levkovskaya, G. 1994, Grain and seed imprints on ceramics from Vasilievskoye, Novgorod, Russia, *Annales Botanici Fennici*, Vol. 31(3), 191–196.

Lodwick, L. 2019, Agendas for Archaeobotany in the 21st Century: data, dissemination and new directions, *Internet Archaeology*, Vol. 53, https://doi.org/10.11141/ia.53.7

Magid, A., Krzywinski, K. 1995, The method of making positive casts of plant imprints in pottery: a field and laboratory manual, *Acta Paleobotanica*, Vol. 35(1), 121–132.

Mareković, S., Karavanić, S., Kudelić, A., Šoštarić, R. 2015, The botanical macroremains from the prehistoric settlement Kalnik–Igrišče (NW Croatia) in the context of current knowledge about cultivation and plant consumption in Croatia and neighboring countries during the Bronze Age, *Acta Societatis Botanicorum Poloniae*, Vol. 84(2), 227–235. https://doi.org/10.5586/asbp.2015.015

Mervel, M. 2019, Late Bronze Age stamp-seals with negative impressions of seeds from Eastern Hungary, *Dissertationes Archaeologicae*, Ser.3.Vol. 7, 21–28. https://doi.org/10.17204/dissarch.2019.21

Mihelić, S. 2002, Prilog poznavanju pretpovijesne zemljoradnje, *Vjesnik arheološkog muzeja u Zagrebu*, 3.s. Vol. XXXV, 249–264.

Miloglav, I. 2016, *Keramika u arheologiji – Lončarstvo vučedolske kulture na vinkovačkom području / Ceramics in Archaeology – Pottery of the Vučedol Culture in the Vinkovci Region*, Acta Musei Cibaliensis 7 (n.s. 5), Gradski muzej Vinkovci, Filozofski fakultet Sveučilišta u Zagrebu, Vinkovci – Zagreb. https://doi.org/10.17234/9789531757775

Mortimer, J. R. 1905, *Forty years' researches in British & Saxon burial mounds of East Yorkshire. Including Romano-British Discoveries, and a Description of the Ancient Entrenchments on a Section of the Yorkshire Wolds*, A. Brown & sons Limited, London.

Motuzaite Matuzeviciute, G., Mir-Makhamad, B., Tabaldiev, K. 2021, The first comprehensive archaeobotanical analysis of prehistoric agriculture in Kyrgyzstan, *Vegetation History and Archaeobotany*, Vol. 30(6), 743–758. https://doi.org/10.1007/s00334-021-00827-0

de Moulins, D. 2007, The weeds from the thatch roofs of medieval cottages from the south of England, *Vegetation history and archaeobotany*, Vol. 16(5), 385–398. https://doi.org/10.1007/s00334-006-0035-0

Nakazawa, Y., Naganuma, M., Tsutsumi, T. 2022, The emergence and transmission of early pottery in the Late-Glacial Japan, *Quaternary International*, Vol. 608–609, 75–87. https://doi.org/10.1016/j.quaint.2021.02.037

Newton, C. 2004, Plant tempering of Predynastic pisé at Adaïma in Upper Egypt: Building material and taphonomy, *Vegetation History and Archaeobotany*, Vol. 13(1), 55–64. https://doi.org/10.1007/s00334-003-0025-4

Nye, S. 1996, The plant remains, in: J. Chapman, R. Shiel, Š. Batović, *The changing face of Dalmatia. Archaeological and ecological studies in a Mediterranean landscape*, Reports of the Research Committee of the Society of Antiquaries of London 54, Leicester University Press, London, 240–242.

Parica, M. 2021, *Prapovijesne maritimne konstrukcije Dalmacije i Kvarnera / Prehistoric maritime structures in Dalmatia and Kvarner*, Sveučilište u Zadru, Zadar.

Peña-Chocarro, L. 1999, *Prehistoric agriculture in southern Spain during the Neolithic and the Bronze Age. The application of ethnographic models*, British Archaeological Reports International Series 818, Archaeopress, Oxford.

Potrebica, H. 2013, *Kneževi željeznog doba*, Meridijani, Zagreb.

Potrebica, H. 2019, Kaptolska skupina i Požeška kotlina / The Kaptol Group and the Požega Valley, *Arheološki vestnik*, Vol. 70, 487–515.

Reddy, S. N. 2003, *Discerning Palates of the Past. An Ethnoarchaeological Study of Crop Cultivation and Plant Usage in India*, International Monographs in Prehistory, Ethnoarchaeological Series 5, Berghahn, New York – Oxford.

Reed, K., Balen, J., Drnić, I., Essert, S., Kalafatić, H., Mihaljević, M., Zavodny, E. 2022, Unearthing millet in Bronze and Iron Age Croatia, in: *Millet or what else? The wider context of the adoption of millet cultivation in Europe*, Kirleis W., Dal Corso M., Filipović D. (eds.), Scales of transformation in prehistoric and archaic societies 14, Sidestone Press, Leiden, 95–106.

Reed, K., Colledge, S. 2016, Plant economies in the Neolithic eastern Adriatic: archaeobotanical results from Danilo and Pokrovnik / Biljne ekonomije u neolitiku na istočnom Jadranu: rezultati arheobotaničkih istraživanja u Danilu i Pokrovniku, *Vjesnik za arheologiju i historiju dalmatinsku*, Vol. 109(1), 9–23.

Reed, K., Drnić, I. 2016, Iron Age diet at Sisak, Croatia: archaeobotanical evidence of foxtail millet (*Setaria italica* [L.] P. Beauv.), *Oxford Journal of Archaeology*, Vol. 35(4), 359–368. https://doi.org/10.1111/ojoa.12101

Renfrew, J. M. 1973, *Palaeoethnobotany. The prehistoric food plants of the Near East and Europe*, Methuen & Co Ltd, London.

Ryan, P. 2011, Plants as material culture in the near Eastern Neolithic: Perspectives from the silica skeleton artifactual remains at Çatalhöyük, *Journal of Anthropological Archaeology*, Vol. 30(3), 292–305. https://doi.org/10.1016/j.jaa.2011.06.002

Rye, O. S. 1976, Keeping your temper under control: Materials and the manufacture of Papuan pottery, *Archaeology and Physical Anthropology in Oceania*, Vol. 11(2), 106–137.

Sarauw, G.F. L. 1899, De ældeste Spor af Sædarternes Dyrkning i Sverige, *Förhandlingar Vid det 15 skandinaviska Naturforskaremötet i Stockholm*, Stockholm.

Sestier, C., Martineau, R., Chenu, E., Elias, A., Goydadin, R., Ladmiral, E. 2003, Imaging vegetal inclusions in porous clayey materials and ceramics, by impregnation with fluorescent polymers, in: *Understanding people through their pottery*, Proceedings of the 7th European Meeting on Ancient Ceramics (EMAC'03), October 27–31, 2003, Lisbon, Instituto tecnológico e nuclear, Prudêncio M. I., Dias M. I., Waerenborgh J. C. (eds.), Trabalhos de arqueologia 42, Instituto português de arqueologia, Lisboa, 251–260.

Sestier, C., Martineau, R., Couvercelle, J. P. 2007, Etude des inclusions végétales dans les archéomatériaux argileux, par imprégnation de polymères, *Cahier des thèmes transversaux ArScAn*, Vol. VII (2005–2006), 94–95.

Skibo, J. M. 2013, *Understanding Pottery Function*, Springer, New York. https://doi.org/10.1007/978-1-4614-4199-1

Stevens, C. J. 2003, An Investigation of Agricultural Consumption and Production Models for Prehistoric and Roman Britain, *Environmental Archaeology*, Vol. 8(1), 61–76. https://doi.org/10.1179/env.2003.8.1.61

Šoštarić, R. 2001, Karbonizirani biljni ostaci iz prapovijesnog lokaliteta u Novoj Bukovici na položaju Sjenjak / Carbonized plant remains of the prehistoric locality in Nova Bukovica on the site Sjenjak, *Prilozi Instituta za arheologiju u Zagrebu*, Vol. 18, 79–82.

Šoštarić, R. 2003, *Vegetacijske promjene u postglacijalu u Hrvatskoj*, Unpublished PhD Thesis, University of Zagreb, Zagreb.

Šoštarić, R. 2005, The development of postglacial vegetation in coastal Croatia, *Acta Botanica Croatica*, Vol. 64(2), 383–390.

Šoštarić, R., Potrebica, H., Brigić, A. 2007, Neposredno datiranje botaničkih uzoraka u arheološkom kontekstu – biljni ostaci s prapovijesnog lokaliteta Kaptol-Gradci kod Požege (Hrvatska) / Direct Dating of Botanical Samples in an Archaeological Context – Plant Remains from the Prehistoric Site of Kaptol-Gradci near Požega (Croatia), *Prilozi instituta za arheologiju u Zagrebu*, Vol. 24, 79–88.

Šoštarić, R., Potrebica, H., Šaić, N., Barbir, A. 2016, Prilog poznavanju halštatskih pogrebnih običaja – arheobotanički nalazi tumula 13 i 14 iz Kaptola kraj Požege / A Contribution to the Understanding of Hallstatt Burial Customs – Archaeobotanical Evidence from Tumuli 13 and 14 at the Site of Kaptol, near Požega, *Prilozi Instituta za arheologiju u Zagrebu*, Vol. 33, 307–315.

Šoštarić, R., Potrebica, H., Hršak, J., Essert, S. 2017, Archaeobotanical components of grave goods in prehistoric tumuli 6 and 7 at the archaeological site of Kaptol-Gradci, near Požega (Croatia), *Acta Botanica Croatica*, Vol. 76(2), 183–190. https://doi.org/10.1515/botcro-2017-0004

Šoštarić, R., Potrebica, H., Bonić Babić, R., Martinović, M., Novak, T. 2020, Grobnice halštatskih kneževa na lokalitetu Kaptol – Čemernica: Arheobotanički nalazi iz tumula III i XI / Graves of Hallstatt Princes at Kaptol – Čemernica: Archaeobotanical Material from Tumuli III and XI, *Prilozi Instituta za arheologiju u Zagrebu*, Vol. 37, 195–209. https://doi.org/10.33254/piaz.37.7

Šoštarić R., Vilović, T. 2021, Plant Macro-Remains and Traces of Leaves from Virje and Hlebine, in: *Interdisciplinary Research into Iron Metallurgy along the Drava River in Croatia–The TransFER Project*, Sekelj Ivančan T., Karavidović T. (eds.), Archaeopress, Oxford, 212–226.

Tolar, T., Jacomet, S., Velušček, A. 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*, Vol. 25(3), 291–301. https://doi.org/10.1007/s00334-015-0549-4

Toyne, J. M., Čelhar, M., Nystrom, K. C. 2021, Liburnian lunches: New stable isotope data for the Iron Age community of Nadin-Gradina, Croatia, *International Journal of Osteoarchaeology*, Vol. 32(1), 241–257. https://doi.org/10.1002/oa.3059

Tsetlin, Y. B. 2003, Organic tempers in ancient ceramics, in: *Ceramics in the Society, Proceedings of the 6th European Meeting on Ancient Ceramics*, Di Pierro F. S., Serneels V., Maggetti M. (eds.), Department of geosciences, mineralogy and petrography, University of Fribourg, Fribourg, 289–306.

Valent, I., Sekelj Ivančan, T., Šoštarić, R. 2021, In which part of the year did iron smelting occur in the Drava valley? in: *Ruralia XIII: Seasonal Settlement in the Medieval and Early Modern Countryside*, Dikson P. (ed.), Sidestone Press, Leiden, 287–294.

van der Veen, M. 1992, *Crop husbandry regimes: an archaeobotanical study of farming in northern England 1000 BC–AD 500*, Collis, Sheffield.

van der Veen, M. 1999, The economic value of chaff and straw in arid and temperate zones, *Vegetation history and Archaeobotany*, Vol. 8(3), 211–224. https://doi.org/10.1007/BF02342721

van Doosselaere, B., Hayes, E. 2007, Exploitation des ressources organiques dans les productions céramiques à Koumbi Saleh (sud-est mauritanien, VIIe-XVIIe siècles), *Cahier des thèmes transversaux ArScAn*, Vol. VII (2005–2006), 105–111.

Wilkes, J. 1969, *Dalmatia, History of the Provinces of the Roman Empire*, Harvard University Press, Cambridge.

Wilkinson, T. J., Murphy, P. L. 1995, *The archaeology of the Essex coast, volume I: The Hullbridge Survey*, East Anglian Archaeology Report 71, Essex County Council Archaeology Section, Chelmsford.

Willcox, G., Fornite, S. 1999, Impressions of wild cereal chaff in pisé from the 10th millennium uncal B.P. at Jerf el Ahmar and Mureybet: northern Syria, *Vegetation History and Archaeobotany*, Vol. 8(1–2), 21–24. https://doi.org/10.1007/BF02042838

Willcox, G., Tengberg, M. 1995, Preliminary report on the archaeobotanical investigations at Tell Abraq with special attention to chaff impressions in mud brick, *Arabian Archaeology and Epigraphy*, Vol. 6, 129–138.

Wu, X., Zhang, C., Goldberg, P., Cohen, D., Pan, Y., Arpin, T., Bar-Yosef, O. 2012, Early Pottery at 20,000 years Ago in Xianrendong Cave in China, *Science*, Vol. 336, 1696–1700.

Zaro, G., Čelhar, M. 2018, Landscape as legacy in northern Dalmatia, in: *Landscapes of Southeastern Europe*, Mirošević L., Zaro G., Katić M. (eds.), Lit Verlag, Zürich, 49–67.

Zaro, G., Gusar, K., Čelhar, M. 2020, On the Edge of Empires: Exploring an Ottoman Legacy on the Venetian Frontier, *Journal of Field Archaeology*, Vol. 45(3), 188–208.

Zavodny, E. 2017, Arheologija prehrane i okoliša tijekom brončanog i željeznog doba u Lici / Archaeology of diet and enviroment during the Bronze Age and Iron Age of Lika, in: *Japodi, zaboravljeni gorštaci / Iapodes – The forgotten highlanders*, Bakarić L. (ed.), Arheološki muzej u Zagrebu, Zagreb, 147–152.

Zavodny, E., Culletona, B. J., McClure, S. B., Kennetta, D. J., Balen, J. 2017, Minimizing risk on the margins: Insights on Iron Age agriculture from stable isotope analyses in central Croatia, *Journal of Anthropological Archaeology*, Vol. 48, 250 – 261.

Zohary, D., Hopf, M., Weiss, E. 2012, *Domestication of Plants in the Old World: The origin and spread of domesticated plants in Southwest Asia, Europe, and the Mediterranean Basin*, Oxford University Press, New York.