Primerjava različnih metod vzorčenja in priprave arheobotaničnih vzorcev z eneolitskih kolišč Strojanova voda in Maharski prekop na Ljubljanskem barju

Comparison of different sampling and treatment methods in order to reconstruct plant economies at the Eneolithic pile-dwellings of Strojanova voda and Maharski prekop at Ljubljansko barje

Tjaša TOLAR

Izvleček

V članku so predstavljeni rezultati arheobotaničnih raziskav s kolišč Strojanova voda in Maharski prekop. Gre za eneolitski kolišči iz okvirno sredine 4. tisočletja pr. n. št. z jugovzhodnega dela Ljubljanskega barja. Metodološka pristopa arheobotaničnih raziskav na koliščih se precej razlikujeta. Na Strojanovi vodi je vzorčenje potekalo leta 2012 z odvzemom stratigrafskih stolpcev sedimenta ter pripravo in pregledovanjem arheobotaničnih vzorcev z nežno metodo mokrega sejanja manjših količin sedimenta v laboratoriju. Maharski prekop je bil vzorčen leta 2005 s površinskim odvzemom večjih količin sedimenta iz kulturne plasti in pripravo vzorcev z grobo metodo spiranja na terenu ter pregledovanjem posušenih frakcij s sit. Rezultati obeh raziskav ponudijo nekaj skupnih zaključkov o prehranskih navadah eneolitskih koliščarjev. Nabirali so užitne rastlinske dele v naravi, predvsem gozdne sadeže in oreške, gojili so enozrno in dvozrno pšenico, ječmen, grah, mak in lan, morda tudi oljno ogrščico. Na Strojanovi vodi izstopajo številni strti ostanki semen/plodov rdečega drena, sicer rastline z neužitnimi plodovi, namembnost tega še raziskujemo. Rastlinski ostanki so nam v pomoč tudi pri rekonstrukciji okoljskih razmer v neposredni bližini kolišč.

Ključne besede: Slovenija, eneolitik, kolišča, arheobotanika, metode dela, rastlinska prehrana, okoljska vegetacija, datacija

Abstract

The results of archaeobotanical research at the pile-dwellings of Strojanova voda and Maharski prekop are presented. The Eneolithic sites are located at the south-eastern part of Ljubljansko barje marshes, Slovenia and are dated to around the mid-4th millennium BC. The methodological approaches to archaeobotanical research at the two sites vary considerably. At Strojanova voda, profile sampling was carried out in 2012. Waterlogged archaeobotanical samples were treated and examined with fine wet sieving in the laboratory. At the Maharski prekop, the samples were surface sampled in 2005. Large quantities of sediment samples from the cultural layer were rough washed over sieves on the field; organic fractions caught on the sieves were dried and then examined. In addition to methodological applications, some common conclusions about the nutrition habits of the Eneolithic pile-dwellers can be made on the basis of the results of both studies. In addition to gathering edible wild plants, especially forest fruits and nuts, the inhabitants also grew einkorn, emmer, barley, peas, opium poppy and flax, and possibly also turnip. At Strojanova voda, numerous remains of crushed red dogwood seeds/fruits were found. Red dogwood is a plant with inedible fruits, the purpose of which is still being explored. Plant remains also contribute to the reconstruction of ecological conditions in the immediate vicinity of pile-dwellings.

Keywords: Slovenia, Eneolithic, pile-dwellings, archaeobotany, methods, plant nutrition, environment, dating

UVOD

Da so mokrotna in ilovnata tla Ljubljanskega barja prava zakladnica (arheo)bioloških ostankov, je leta 1875 spoznal prvi izkopavalec slovenskih kolišč Dragotin Dežman. Poleg lončenine je naletel še na živalske kosti in vertikalno zabite kole in jih natančneje raziskal. Tako je že leta 1875 objavil prve arheobotanične podatke. Identificiral je dva tipa lesenih pilotov, starejše, topolove z okroglim prerezom ter mlajše, klane hrastove. Poleg lesa omenja še najdbe semen, kot so lešniki, drnulje in vodni oreški (Deschmann 1875; 1876; 1878). Za njim je v letih 1907–1908 Walter Šmid raziskoval novoodkrito kolišče pri Notranjih Goricah. Poleg številnih arheoloških najdb je tudi on natančneje pregledal kole iz hrastovega, topolovega in jelševega lesa (Schmid 1910). Kot pomemben mejnik uveljavitve naravoslovnih ved v arheologiji štejemo leto 1953, ko je raziskovalno delo na Ljubljanskem barju začel arheolog Josip Korošec. Ta je k raziskovanju koliščarske naselbine pri Blatni Brezovici in Založnice pritegnil še raziskovalce drugih ved (Korošec 1953; 1954; 1955). Tako je biolog (palinolog) Alojz Šercelj obdelal palinološki profil (Šercelj 1955) in opravil ksilotomske analize ter določil vrste lesa (Šercelj 1955), geolog in paleontolog Ivan Rakovec je analiziral kostne ostanke (npr. Rakovec 1955; 1958). Leta 1970 se je na Ljubljanskem barju začelo novo obdobje intenzivnih arheoloških izkopavanj, vodila jih je Tatjana Bregant. V tem času so prvič pridobili pomembne podatke o notranji organiziranosti prazgodovinske koliščarske naselbine. Kolišče Maharski prekop so raziskovali v letih 1970 (Bregant 1974a), 1972–1974 (Bregant 1974b; 1975; 1976) in 1976–1977, na skupni površini 1208 m^2 (Bregant 1996). Poleg velike izkopavalne površine so te raziskave izredno pomembne tudi zato, ker so vzporedno z arheološkimi opravili številne naravoslovne raziskave (prim. Drobne 1974a; 1974b; 1975; Osterc 1975; Stritar 1975; Šercelj 1974; 1975; 1976; Culiberg, Šercelj 1978; 1980; Šercelj, Culiberg 1978; 1980). Arheološko-biološke raziskave kolišč z Ljubljanskega barja so leta 1995 doživele nov zagon. Inštitut za arheologijo ZRC SAZU je v sodelovanju z dendrokronološkim laboratorijem Oddelka za lesarstvo Biotehniške fakultete v Ljubljani naredil pomemben korak naprej. Začele so se prve dendrokronološke raziskave na arheoloških najdiščih Slovenije. Na dobro ohranjenih barjanskih najdiščih Založnica (Čufar, Levanič, Velušček 1997; Velušček, Čufar 2003), Hočevarica in Spodnje mostišče 1 in 2 (Čufar, Levanič, Velušček 1998), Stare gmajne in Črešnja pri Bistri (Velušček et al. 2004) je bil vzorčen les iz drenažnih jarkov. Da bi pridobili več arheološkega lesa za dendrokronološke raziskave, so bila ponovno prekopana že raziskana območja na najdiščih Parte (Čufar, Levanič, Velušček 1997; Velušček, Čufar, Levanič 2000), Blatna Brezovica in Maharski prekop (za vse glej tudi Velušček, Čufar 2002; Čufar et al. 2009; 2010; 2015; Čufar, Velušček, Kromer 2013; Velušček 2013). Po evropskem zgledu so spirali sediment iz celotne kulturne plasti (prim. Velušček [ur.] 2004; 2006; 2009) in sistematično zbrali ves arheološki material, tako keramiko kot biološke (rastlinske in živalske) makroostanke. Po več kot 10-letnem uspešnem delu arheobioloških raziskav na koliščih z Ljubljanskega barja (npr. Velušček [ur.] 2004; 2006; 2009) se je metodologija vzorčenja in priprave arheobotaničnih vzorcev z mokrih tal toliko dopolnila, da lahko rezultate naravoslovnih raziskav z mokrotnih najdišč primerjamo z rezultati tujih tovrstnih raziskav (npr. Toškan, Dirjec 2004; 2006; Andrič et al. 2008; 2009; 2010; Tolar et al. 2010; 2011; Toškan 2012; 2013; Tolar, Jacomet, Velušček 2016).

V članku so predstavljeni rezultati najnovejših analiz arheobotaničnih makroostankov z dveh eneolitskih kolišč z jugovzhodnega dela Ljubljanskega barja (to sta kolišči Strojanova voda in Maharski prekop). Zanima nas, ali prinašata raziskavi različne interpretativne možnosti o gospodarstvu (prehranskih navadah) in vegetaciji v bližnji okolici raziskanih kolišč ter tudi o trajanju poselitve raziskanega območja, v odvisnosti od uporabljene metodologije dela (tj. načina vzorčenja za arheobotanične raziskave in obdelave vzorcev v laboratoriju). Raziskava poleg interpretacije o prehrani in uporabi rastlinskega materiala tedaj naseljenih ljudi in domačih živali ter o neposrednem okolju, ki je obdajalo dve sosednji, a ne tudi sočasni naselbini, nazorno pokaže, da se ne samo s pregledovanjem z vodo prepojenih organskih vzorcev (Tolar et al. 2010), ampak tudi z globljim vzorčenjem lahko doseže več rezultatov, ki pomembno prispevajo k arheološki (predvsem poselitveni) interpretaciji raziskovanega območja.

RAZISKAVE NA NAJDIŠČIH STROJANOVA VODA IN MAHARSKI PREKOP

Strojanova voda

Najdišče ob istoimenskem odvodnem jarku na jugovzhodnem delu Ljubljanskega barja je leta 1875 odkril D. Dežman (Deschmann 1876). Leta 1953 so ga s sondiranji zadeli tudi izkopavalci Sekcije za arheologijo SAZU (Jesse 1954). Na najdbe s Strojanove vode so kasneje naleteli še Davorin Vuga (1977), Anton Velušček (1997) in Andrej Knific (Velušček, Čufar 2008). Do leta 2008 je bilo tako pridobljenih več kot 70 fragmentov keramike (Velušček, Čufar 2008, 36, sl. 6). Najdbe s Strojanove vode je mogoče korelirati z najdbami s Hočevarice in Gornjega mostišča in jih lahko opredelimo v skupino najdišč *horizonta keramike z brazdastim vrezom*, ki jih postavljamo v čas druge četrtine 4. tisočletja pr. n. št. (Velušček 2004; Velušček, Čufar 2008; Čufar et al. 2015).

Leta 2012 je bil ob poglabljanju in čiščenju jarka Strojanova voda opravljen arheološki nadzor z dokumentiranjem in vzorčenjem, ki ga je vodil A. Velušček z Inštituta za arheologijo ZRC SAZU. Glavni namen je bilo vzorčenje vertikalno zabitih kolov za dendrokronološke raziskave, hkrati so bile pobrane vse arheološke najdbe (npr. kosi keramike, žrmelj in živalskih kosti), ki so med poglabljanjem struge prišle na dan. Dendrokronološke raziskave so omogočile absolutno datiranje časa gradbenih aktivnosti na najdišču Strojanova voda, z najmlajšo braniko na datiranem lesu, nastalo leta 3586 pr. n. št.[1] (Čufar et al. 2015).

Maharski prekop

Nedaleč stran (pribl. 200 m severozahodno) od najdišča Strojanova voda leži nekoliko mlajše kolišče Maharski prekop. Leta 1953 so ga odkrili člani Sekcije za arheologijo pri SAZU (Jesse 1954). Obsežnejše arheološke raziskave so se na Maharskem prekopu začele leta 1970 in so s prekinitvami trajale vse do leta 1977 (Bregant 1996; Velušček 2001). Kasneje so najdbe s tega območja raziskovali še Hermann Parzinger (1984), A. Velušček (Velušček 2001; 2013; Velušček, Čufar 2008), Dimitrij Mlekuž (Mlekuž, Budja, Ogrinc 2006; Mlekuž et al. 2012) in drugi. Velušček keramiko z Maharskega prekopa uvršča v posebno skupino keramike, imenovano *kulturna skupina Stare gmajne*, to je v čas druge polovice 4. tisočletja pr. n. št. (Velušček 2009a, 28). V obdobju izkopavanj T. Bregant je bilo narejenih tudi nekaj paleobotaničnih raziskav, v večini t. i. ksilotomskih analiz oz. identifikacij lesnih vrst (Šercelj 1974; 1975; Šercelj, Culiberg 1978). Poleg vertikalno zabitih kolov Šercelj navaja okrasne predmete, kot so koščene in kamnite jagode, lesen držaj, šilo, veslo, košari podoben pleten predmet in deske. Prepoznal je kole dveh dimenzij, večjega premera za nosilno funkcijo, ki so bili v večini hrastovi, in kole manjšega premera, večinoma jelševi, s funkcijo valobrana oz. neke vrste zaščitne ograje ob naselbini. Prepoznal je, da so bile v osrednjem delu kolišča, kjer je bila potrebna večja nosilnost, uporabljene odpornejše vrste lesa (hrast, jesen, jerebika), medtem ko so na zunanjih delih kolišča, kjer ni bila potrebna tako velika nosilnost, prevladovale manj odporne vrste: jelša, leska, vrba, javor, glog (Bregant[2] 1974b, 43; 1975, 20; Šercelj, Culiberg 1978). Čeprav žitnih makroostankov ni odkril, je poljedelsko aktivnost dokazoval z žrmljami in pelodom žitaric v kulturni plasti. V zvezi z nabiralniškim gospodarstvom navaja gozdne jagode (*Fragaria*), maline (*Rubus*), pasje zelišče (*Solanum*) in lesko (*Corylus*). Pelodna analiza iz kulturne plasti je pokazala vegetacijo, značilno za odprto pokrajino, pašnike in obrobje močvirij (ali obrežje). Ugotavlja, da pogosteje zastopane vrste v pelodnem zapisu niso enako močno zastopane med rastlinskimi makroostanki (kot so les, semena, plodovi) iz kulturne plasti. To razlaga z načrtno izbiro, selekcijo in prinašanjem dobrin (pa čeprav v bližnji okolici kolišča ne ravno pogostih vrst) iz narave v naselbino. Tudi skromna zastopanost v naravi sicer že precej razširjene bukve (*Fagus sylvatica*) med ostanki vertikalno zabitih nosilnih kolov dokazuje ta pojav (vse po Šercelj 1975). Že takrat so opravili radiometrične datacije rastlinskih makroostankov, da bi določili absolutno starost kolišča. Vrednosti median se gibljejo med 3872 in 2991 cal BC (Bregant 1975). Opravljena je bila tudi pedološka analiza tal v kulturni plasti, pri čemer je bilo med drugim ugotovljeno, da je debelina kulturne plasti od 40 do 60 cm (povišana prisotnost fosforja v tleh, ki naj bi odseval skoncentrirano prisotnost kostnih ostankov in fekalij; po Šercelj 1975).

Leta 2005 je ekipa Inštituta za arheologijo ZRC SAZU ponovno izkopala les vertikalno zabitih kolov za dendrokronološke raziskave. Zastavljene

[1] To naj bi bilo okvirno leto zadnjega posekanega drevesa, katerega ostanek smo vključili v raziskavo in ga je bilo mogoče tudi sinhronizirati (Čufar, os. komunikacija).

[2] T. Bregant povzema po: Šercelj 1974; 1975.

so bile štiri daljše sonde, s katerimi je bil pokrit velik del območja, ki ga je raziskovala T. Bregant (Velušček, Čufar 2008). Rezultati dendrokronoloških raziskav kažejo, da je naselbina živela manj kot sto let, in sicer v obdobju po Hočevarici (torej tudi po Strojanovi vodi) in pred poselitvijo sosednjega (pribl. 170 m zahodno) kolišča Spodnje mostišče (Velušček, Čufar 2002; 2008; Čufar et al. 2015, sl. 3). Po najnovejših izsledkih naj bi bila starost zadnje (tj. najmlajše)[3] branike dendrokronološko raziskanih kolov na kolišču Maharski prekop 3489 pr. n. št. (Čufar et al. 2010; 2015; Čufar, Velušček, Kromer 2013). V približno istem obdobju se je z območjem najdišča Maharski prekop ukvarjala skupina z Oddelka za arheologijo Filozofske fakultete v Ljubljani pod vodstvom Mihaela Budje. Terenske raziskave so usmerili v lidarsko snemanje, vrtanje vrtin in radiokarbonsko datiranje z namero, da pojasnijo razvoj holocenske krajine in človekove dejavnosti v njej. Mlekuž in sodelavci (Mlekuž, Budja, Ogrinc 2006; Mlekuž et al. 2012) ugotavljajo, podobno kot pred njimi že T. Bregant (1975), da so se na območju Maharskega prekopa dogajali kompleksnejši dogodki, močno odvisni od poplavne aktivnosti reke Iščice. Ugotavljajo, da je bilo to območje zato večkrat poseljeno, tudi v času pred dendrokronološko določeno naselbinsko fazo, ki so jo določili K. Čufar in sodelavci 2010 (Mlekuž, Budja, Ogrinc 2006; Mlekuž et al. 2012; glej tudi Andrič 2009; Velušček 2009b; 2013), čeprav doslej na tem območju še ni bila odkrita keramika, ki bi utemeljevala poselitev ok. 4400–4000 pr. n. št. (Bregant 1974a; 1974b; 1975; Velušček, Čufar 2008; Velušček 2009b; 2013), ampak je dokumentirana poselitev po letu 3500, kar se ujema z dendrokronološkimi rezultati (Čufar et al. 2010; 2015).

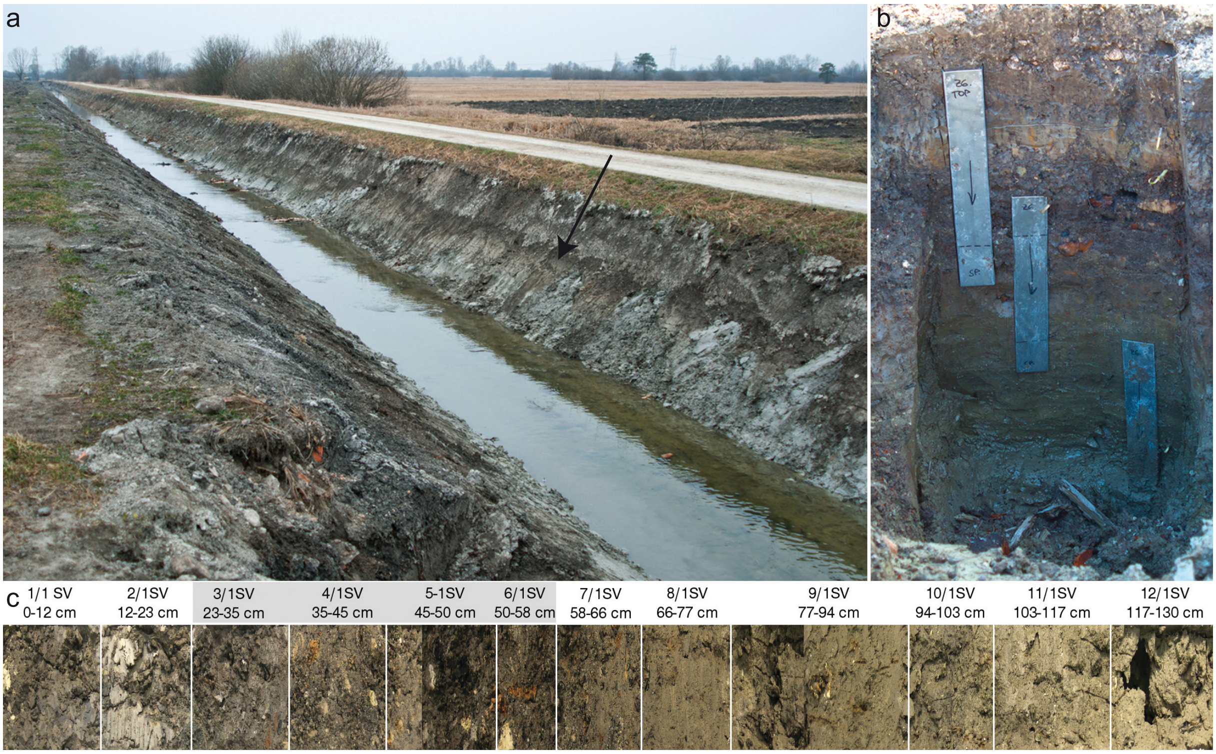
MATERIAL IN METODE DELA

Strojanova voda

V okviru arheološkega nadzora leta 2012 sta bila iz profila očiščenega jarka odvzeta stratigrafska stolpca sedimenta za arheobotanične raziskave (profil 1 in profil 2). Profila sta bila drug od drugega oddaljena pribl. 50 m, dolga sta bila 130 cm. Profil 1 je bil v celoti prepojen z vodo, organski in dobro ohranjen, medtem ko je bil profil 2 v zgornjem delu preperel in razpadajoč, najverjetneje žganinski in zato s slabše ohranjenimi organskimi ostanki. Oba profila sta bila arheobotanično raziskana (poročilo dostopno v arhivu IzA ZRC SAZU). Ker je profil 2 kazal znake precejšnje degradiranosti, še zlasti v domnevni arheološki kulturni plasti, smo v raziskavo splošne arheobotanične slike s tega območja vključili le profil 1. Prvi predmet prispevka je tako arheobotanična analiza 130 cm dolgega sedimentnega stolpca, ujetega v profil 1, odvzetega iz globine 288,09–289,39 m n. m. (*sl. 1*). Stratigrafski stolpec sedimenta smo vzorčili s tribobimi škatlami dim. 7 × 7 × 50 cm (*sl. 1b*) in ga v laboratoriju natančno opisali in pregledali. Glede na morfološke značilnosti je bil razdeljen na 12 sekvenc (*sl. 1c*), oštevilčene so zaporedno od najvišje (najmlajše, sekv. 1) proti najnižji (najstarejši, sekv. 12). Meje med njimi so bile subjektivno določene na podlagi sedimentne zgradbe in barve. Za kulturno plast so bile vizualno opredeljene sekvence 6–3/1SV (skupno 35 cm; *sl. 1c*).

Uporabljene so bile standardne metode za obdelavo in pripravo z vodo prepojenih vzorcev sedimenta z mokrotnih arheoloških najdišč (po npr. Kenward, Hall, Jones 1980; Hosch, Zibulski 2003). Iz vsake sekvence posebej so bili izmerjeni volumni vzorcev sedimenta pred mokrim sejanjem in po njem. Tako je bilo na koncu rezultate mogoče pretvoriti v koncentracije rastlinskih makroostankov v litru sedimenta. Vzorci (skupno 8,25 litra sedimenta) so bili nežno mokro sejani skozi dve siti s standardnim premerom por 2,00 in 0,355 mm. Do analize pod stereomikroskopom *Leica* s 6,3- do 50-kratno povečavo so bili hranjeni v vodnem in hladnem mediju. Izločeni, prešteti in identificirani so bili vsi ostanki plodov, semen, zrn, žitnih plev, perikarpov jabolk in želodov, iglic ter spor iz družine alg Characaceae. Količina (število) identificiranih rastlinskih makroostankov je bila preračunana v koncentracijo v litru sedimenta. Pri identifikaciji je bila uporabljena standardna literatura, to so identifikacijski ključi za rastlinske makroostanke (npr. Berggren 1969; 1981; Anderberg 1994; Cappers, Bekker, Jans 2006; Jacomet 2006a) in referenčna zbirka semen, plodov, lesa in oglja pri IzA ZRC SAZU. Poimenovanje rastlinskih vrst sledi objavam Zohary, Hopf (2000) za kulturne rastline, Binz, Heitz (1990) za nabirane in naravne rastline, z dopolnitvijo *Male flore Slovenije* (Martinčič et al. 1990).

[3] Najmlajša branika naj bi nastala v letu, ko je bilo posekano zadnje drevo, katerega ostanek je bil zajet v raziskavo. Pri tem je treba upoštevati, da v raziskavo niso zajeta vsa posekana drevesa, uporabljena pri gradnji ali obnovi kolišča, in še tista, ki so zajeta, niso vsa sinhronizirana, torej upoštevana (Čufar, os. komunikacija).



Sl. 1: Strojanova voda, 2012. Poglobljen, očiščen odvodni jarek. – **a:** Puščica označuje ohranjeno kulturno plast koliščarske naselbine. – **b:** Sedimentni stolpec iz profila jarka (profil 1) za arheobotanične analize. – **c:** Sedimentni stolpec, razdeljen na 12 sekvenc (1/1SV do 12/1SV). Sekvence 6–3 (sivo) so bile predhodno vizualno opredeljene kot kulturna plast.
Fig. 1: Strojanova voda, 2012. Deepened and cleaned drainage ditch. – **a**: The arrow shows the preserved cultural layer of the pile-dwelling settlement. – **b**: Sedimentary (stratigraphic) column from the profile of the ditch for archaeobotanical analyses (Profile 1). – **c**: The column of sediment is divided into 12 sequences (1/1SV – 12/1SV). Sequences 6–3 (shaded) were initially visually determined as a cultural layer. (Foto / Photo: D. Veranič, D. Valoh)

Maharski prekop

Leta 2005 sta bili hkrati z zbiranjem lesa za dendrokronološke raziskave (prim. Velušček, Čufar 2008, 40) na severozahodnem delu domnevne razširjenosti kolišča Maharski prekop izkopani manjši sondi (vsaka obsega 1 m^2 in pribl. globino 150 cm). Iz obeh je bil vzorčen sediment iz kulturne plasti (na globini 288,95–289,30 m n. m.) za arheobiološke (vključujoč botanične) raziskave (*sl. 2*).

Iz zahodnega profila izkopane sonde 2/b je Maja Andrič odvzela 160 cm dolg sedimentni stolpec za palinološke in sedimentološke raziskave[4] (*sl. 2*).

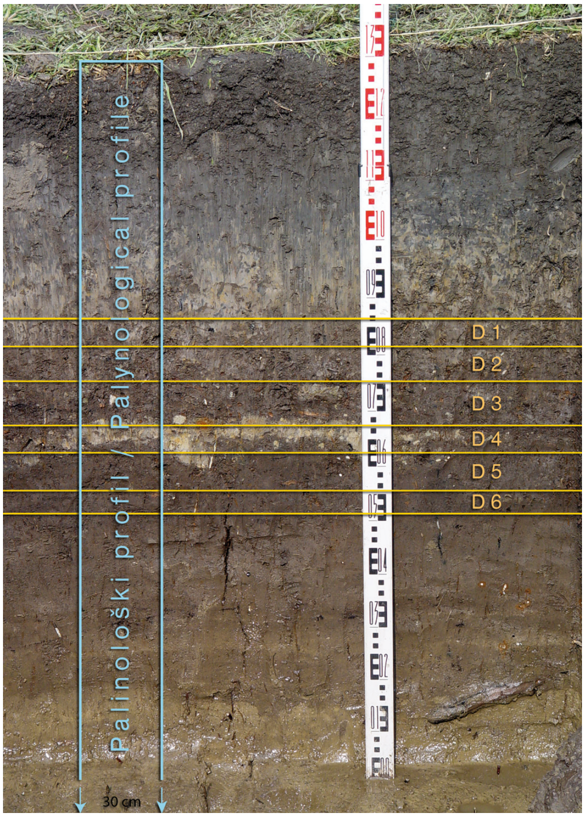
Vzorci sedimenta za arheobiološke raziskave so bili odvzeti stratigrafsko iz domnevne kulturne plasti iz obeh izkopanih sond. Zbirani so bili sistematično (površinsko) plast za plastjo, od najmlajše poglobitve D1 do najstarejše D6 (*sl. 2*). Ker je bil palinološki profilni stolpec odvzet in analiziran iz sonde 2/b (glej op. 4), je v prispevku obravnavana arheobotanična analiza ostankov iz arheološko dokumentirane kulturne plasti (D6–D1; *sl. 2*) iz te iste sonde 2/b.

V nasprotju z arheobotanično raziskavo na najdišču Strojanova voda je bila na Maharskem prekopu uporabljena drugačna metodologija dela (od vzorčenja na terenu do priprave vzorcev v laboratoriju ter posledično identifikacije in štetja).

Iz sonde 2/b je bilo skupno zbranega in mokro presejanega pribl. 360 litrov sedimenta iz 35 cm dolge sekvence kulturne plasti. Pribl. 60 litrov sedimenta iz vsake poglobitve je bilo mokro sejano skozi dve siti, velikosti premera por 3,00 in 1,00 mm. Po spiranju so bile frakcije s sit zaradi lažjega pregledovanja in hranjenja posušene na zraku.[5] Izločeni in prešteti so bili vsi identificirani

[4] M. Andrič, *Stare gmajne settlement and the vegetation of Ljubljansko barje in the 4th mill. cal BC* (v pripravi).

[5] Za kritično oceno metod dela v letu 2005 glej Tolar et al. 2010.



Sl. 2: Maharski prekop, 2005. Zahodni profil sonde 2/b. Označeno: mesto odvzema palinološkega stratigrafskega stolpca sedimenta (palynological profile; glej op. 4) in stratigrafska pozicija odvzetih vzorcev sedimenta iz 35 cm dolge sekvence arheološko dokumentirane kulturne plasti za arheobiološke raziskave (poglobitve D1–D6).
Fig. 2: Maharski prekop, 2005. Western profile of the archaeological Trench 2/b. The location where the palynological stratigraphic column was taken is marked (palynological profile; see fn. 4) and the stratigraphic location of the surface sampled sediment samples from a 35 cm long sequence of archaeologically documented cultural layer that was collected for archaeobiological research (Deepenings D1–D6). (Foto / Photo: M. Andrič)

rastlinski makroostanki (semena, plodovi, zrna, perikarpi, pleve), ki so se ujeli na velikem situ (3,00 mm) in prestali sušenje. Ostanki z manjšega sita (1,00 mm), prav tako samo tisti, ki so prestali sušenje na zraku, torej zogleneli ali s trdo lignificirano lupinico okoli semen, so bili zaradi številčnosti podvzorčeni. Rezultati (količina oz. število identificiranih makroostankov) so predstavljeni v absolutnih številih semen/plodov/plev in ne v koncentracijah v litru sedimenta. Koncentracij ni bilo mogoče izračunati, saj volumni vzorcev (tako nespranih sedimentnih kot tudi spranih vzorcev s sit in pregledanih podvzorcev) niso bili izmerjeni. Približni volumni vzorcev sedimenta (pribl. 360 litrov oz. pribl. 60 litrov iz vsake od šestih poglobitev) so bili ocenjeni šele po izkopavanju, glede na število in velikost veder, ki so se med izkopavanji polnila in na sitih praznila.

REZULTATI

Strojanova voda

Velika večina rastlinskih makroostankov s Strojanove vode (profil 1) je ohranjenih v nezoglenelem, z vodo prepojenem stanju. Identificiranih je bilo 61 različnih rastlinskih taksonov in relativno visoke koncentracije makroostankov (po Hosch, Zibulski 2003; Jacomet, Brombacher 2005), ki med sekvencami (12–1/1SV; glej *sl. 1*) variirajo. Najvišje koncentracije rastlinskih ostankov so določene v sekvencah 7–4/1SV (tj. v globini 288,73–289,04 m n. m.; *sl. 3; 4; 7*), kar se ne ujema popolnoma s predhodno vizualno opredelitvijo arheološke kulturne plasti (tj. sekv. 6–3/1SV; glej zgoraj in *sl. 1c*). V povprečju je bilo identificiranih 6448 rastlinskih makroostankov v litru sedimenta, kar pomeni dobro ohranjenost in arheobotanično bogat sediment (npr. Hosch, Jacomet 2004; Tolar et al. 2011).

Kulturne rastline in pleveli

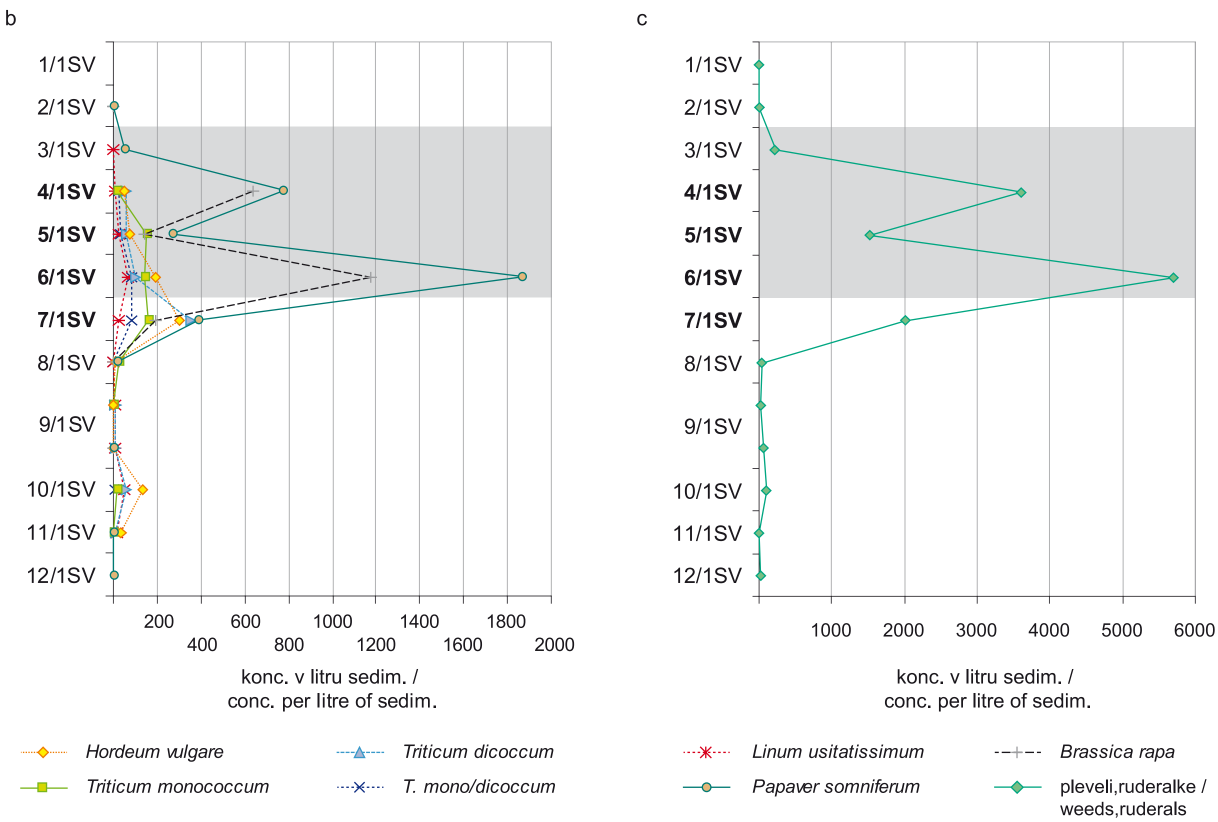
Med žiti prevladujejo ostanki dvozrne pšenice in ječmena z nepriraslimi plevami, ostankov enozrnice je občutno manj (*sl. 3a*). Med ostanki žit so v glavnem ohranjene nezoglenele, z vodo prepojene pleve, kot so odlomki rahisov in ogrinjalne pleve (za razlago glej Tolar 2016, 51). Zoglenela žitna zrna so redka.

Med oljnimi rastlinami imata najvišje koncentracije ohranjenih makroostankov mak in ogrščica (o uporabnosti in možnostih kultivacije te rastline glej Tolar 2016, 170). Ugotovljen je bil tudi lan (*sl. 3a*).

Prisotnost makroostankov šestih kulturnih rastlin (*sl. 3b*) ter enajstih plevelnih/ruderalnih taksonov (*sl. 3c*) – med pomembnejšimi npr. *Chenopodium album* (bela metlika), *Agrostemma githago* (nav. kokalj), *Veronica hederifolia* (bršljanovolistni jetičnik), *Silene* sp. (slizek), *Stellaria media* (nav. zvezdica), *Urtica dioica* (velika kopriva), *Fallopia convolvulus* (nav. slakovec), *Polygonum aviculare* (ptičja dresen), *Stachys* sp. (čišljak) – kažejo največji človekov vpliv v sekvencah 7–4/1SV, kar

Kulturne rastline / Cultivated plants	**Sekvenca / Sequence** (prim. *sl. 1* / cf. *Fig. 1*)											
	12/1 SV	11/1 SV	10/1 SV	9/1 SV	8/1 SV	**7/1 SV**	**6/1 SV**	**5/1 SV**	**4/1 SV**	3/1 SV	2/1 SV	1/1 SV
Hordeum vulgare naked (nav. ječmen)	-	30	136	6	10	**304**	**190**	**79**	**47**	-	-	-
Triticum monococcum (enozrna pšenica)	-	2	16	3	28	**155**	**140**	**149**	**18**	-	-	-
Triticum dicoccum (dvozrna pšenica)	-	10	60	18	-	**355**	**100**	**57**	**57**	-	-	-
Triticum mono/dicoccum (eno/dvozrna pšenica)	-	-	8	-	2	**85**	**80**	**35**	**29**	-	-	-
Linum usitatissimum (lan)	-	16	48	22	4	**25**	**64**	**26**	**11**	1	-	-
Papaver somniferum (mak)	4	2	-	2	16	**385**	**1860**	**267**	**768**	53	1	-
Brassica rapa (ogrščica)	-	-	-	4	2	**190**	**1170**	**144**	**632**	-	1	-

a



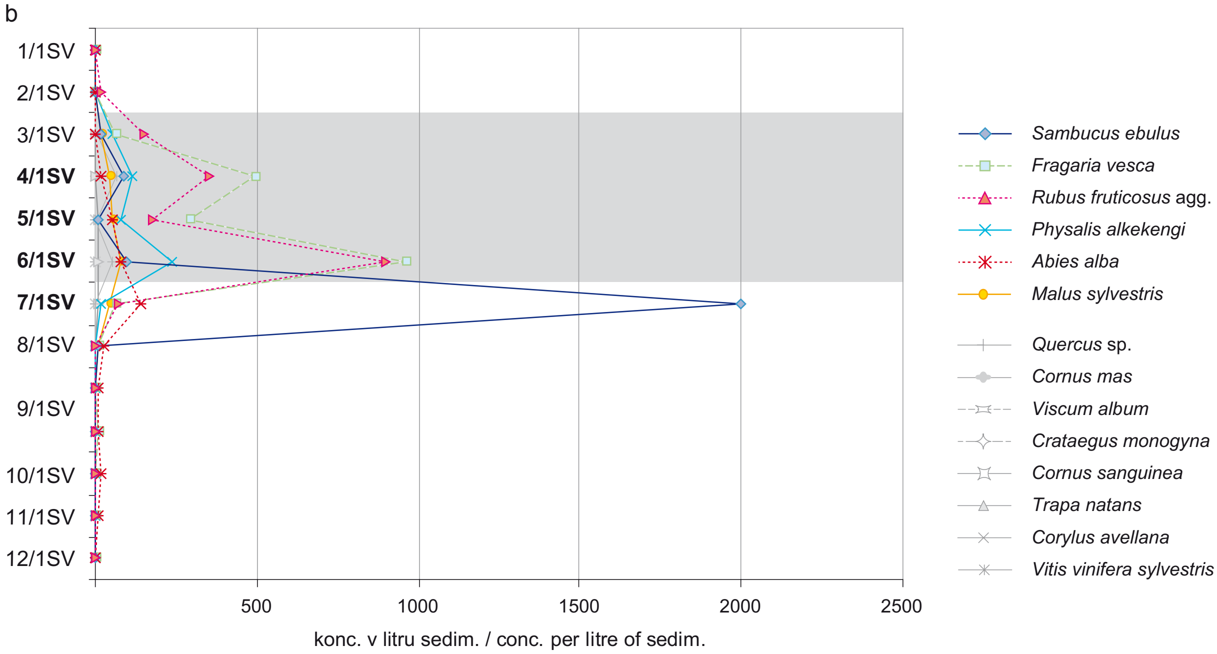
Sl. 3: Strojanova voda, profil 1. **a:** Preglednica koncentracij identificiranih rastlinskih makroostankov po sekvencah od 12/1SV do 1/1SV. – **b:** Grafični prikaz koncentracij makroostankov kulturnih ter – **c:** pomembnejših plevelnih in ruderalnih taksonov.
Sekvence **7–4** (**krepko**) so označene kot arheobotanično najbogatejše. Sekvence 6–3 (sivo) so bile predhodno vizualno opredeljene kot kulturna plast.
Fig. 3: Strojanova voda, Profile 1. – **a**: Table of concentrations of identified plant macroremains by Sequences 12/1SV to 1/1SV. – **b**: Graphical presentation of concentrations of macroremains of cultivated plants and – **c**: most important weed and ruderal plant taxa.
Sequences **7–4/1SV** (**bold**) are marked as archaeobotanically the richest. Sequences 6–3/1SV (shaded) were initially visually determined as cultural layer.

predstavlja 31 cm stratigrafskega stolpca sedimenta. Ostanki teh antropogenih indikatorjev so, čeprav v manjših koncentracijah, prisotni že od sekvence 11 (z majhnim porastom v sekvenci 10) do 3/1SV (*sl. 3*), kar je skupno v 94 cm sedimentnega stolpca (glej *sl. 1*).

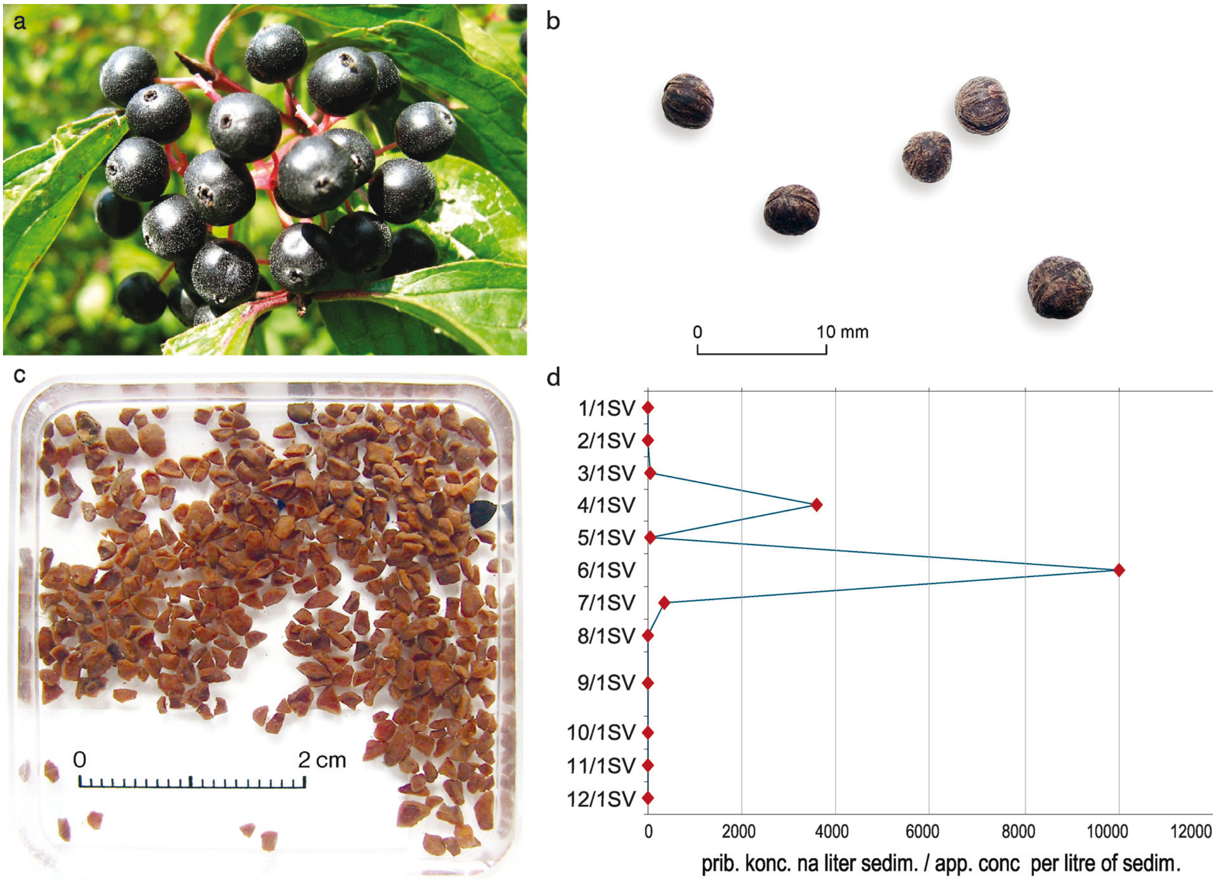
Nabirane rastline / Gathered plants	**Sekvenca / Sequence** (prim. *sl. 1* / cf. *Fig. 1*)											
	12/1 SV	11/1 SV	10/1 SV	9/1 SV	8/1 SV	**7/1 SV**	**6/1 SV**	**5/1 SV**	**4/1 SV**	3/1 SV	2/1 SV	1/1 SV
Sambucus ebulus (smrdljivi bezeg)	-	-	-	2	6	**2000**	**100**	**13**	**87**	20	-	-
Fragaria vesca (gozdna jagoda)	2	2	4	9	12	**66**	**962**	**289**	**489**	58	2	-
Rubus fruticosus agg. (robida)	-	-	4	4	4	**73**	**900**	**175**	**351**	152	21	-
Physalis alkekengi (volčje jabolko)	-	-	-	4	-	**20**	**240**	**83**	**118**	57	-	-
Abies alba (jelka)	2	8	16	15	28	**139**	**80**	**51**	**14**	2	-	-
Malus sylvestris (divja jablana)	2	-	4	1	6	**43**	**80**	**54**	**46**	15	-	-
Quercus sp. (hrast)	-	4	4	2	-	**1**	**52**	**4**	**73**	-	-	-
Cornus mas (rumeni dren)	-	-	-	-	-	**3**	**28**	**3**	**19**	2	-	-
Viscum album (bela omela)	-	-	-	1	1	**1**	**20**	**13**	**16**	2	-	-
Crataegus monogyna (enovrati glog)	-	-	-	-	-	**-**	**12**	**1**	**9**	-	-	-
Cornus sanguinea (rdeči dren)	-	-	-	-	-	**1**	**8**	**1**	**4**	-	-	-
Trapa natans (vodni orešek)	4	4	4	-	4	**7**	**8**	**6**	**3**	2	-	-
Corylus avellana (leska)	-	2	-	-	2	**1**	**4**	**1**	**4**	2	-	-
Vitis vinifera sylvestris (divja vinska trta)	-	-	-	-	-	**-**	**2**	**1**	**3**	-	-	-

a

b



Sl. 4: Strojanova voda, profil 1. – **a**: Preglednica koncentracij makroostankov najpogostejših identificiranih domnevno nabiranih taksonov po sekvencah od 12/1SV do 1/1SV. – **b**: Grafični prikaz koncentracij rastlinskih makroostankov najpogostejših nabiranih rastlin. Sekvence **7–4** (**krepko**) so označene kot arheobotanično najbogatejše. Sekvence 6–3 (sivo) so bile predhodno vizualno opredeljene kot kulturna plast.
Fig. 4: Strojanova voda, Profile 1. – **a**: Table of concentrations of macroremains of the most important presumably gathered plant taxa by Sequences 12–1/1SV. – **b**: Graphical presentation of concentrations of macroremains of the most commonly gathered plants. Sequences **7–4/1SV** (**bold**) are marked as archaeobotanically the richest. Sequences 6–3/1SV (shaded) were initially visually determined as cultural layer.



Sl. 5: – **a:** Rdeči dren, neužiten plod (oz. soplodje). – **b:** Rdeči dren. Semena z olesenelim endokarpom. – **c:** Številni fragmenti očitno strtih semen/plodov rdečega drena, ki so se ohranili v kulturni plasti kolišča Strojanova voda. – **d:** Približne koncentracije fragmentiranih ostankov rdečega drena v stratigrafskem stolpcu s Strojanove vode; stolpec sedimenta med sekvencami 7/1SV–4/1SV je vseboval največ antropogenih arheobotaničnih ostankov (prim. *sl. 3* in *4*).
Fig. 5: – **a**: Red dogwood, inedible fruit (or infructescense). – **b**: Red dogwood. Seeds with lignified endocarp. – **c**: Numerous fragments (parts) of apparently crushed seeds/fruits of red dogwood preserved in the cultural layer of the Strojanova voda pile-dwelling settlement. – **d**: Approximate concentrations of fragmented red dogwood fruits in a stratigraphic column from Strojanova voda; Sequences 7–4/1SV of the sedimentary column contained the highest concentrations of anthropogenic archaeobotanical remains (see *Figs. 3* and *4*). (Foto / Photo: T. Tolar, D. Valoh)

Nabirane rastline

Identificiranih je 20 domnevno nabiranih rastlinskih taksonov. Med ostanki z najvišjimi koncentracijami so smrdljivi bezeg, gozdna jagoda, robida volčje jabolko, jablana/hruška ter rumeni in rdeči dren. Številni so tudi odlomki lupinic semen/plodov taksonov z bolj kaloričnimi plodovi, kot so želodi, lešniki in vodni oreški, vendar ostanki sočnejših plodov prevladujejo (*sl. 4*). Vsi ostanki domnevno nabiranih rastlin so ohranjeni v nezoglenelem, z vodo prepojenem stanju. Razporeditev v sedimentnem stolpcu kaže največjo človekovo aktivnost, podobno kot jo kažejo kulturne in plevelne/ruderalne rastline, v sekvencah 7–4/1SV. Ostanki nabiranih rastlinskih taksonov, čeprav v nižjih koncentracijah, so prisotni vse od najgloblje, 12. sekvence (glej *sl. 4a*).

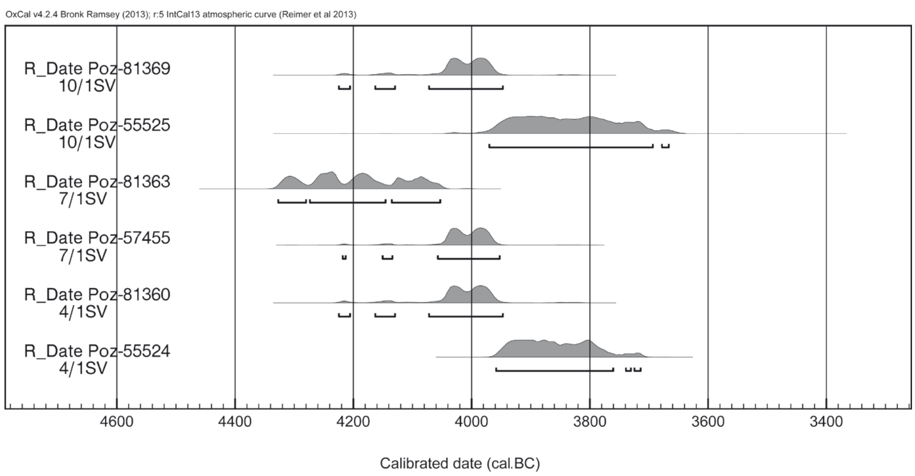
Zanimivi so številni odlomki semen/plodov rdečega drena (*Cornus sanguinea*), sicer neužitne rastline (*sl. 5a*), vendar več kot očitno uporabljene, kar dokazujejo strte koščice sicer proti trenju zelo odpornih semen/plodov (*sl. 5b,c*). Možna interpretacija je, da so jih uporabljali za pridobivanje soka, olja ali celo barve. Več o rezultatih eksperimenta bo objavljeno v posebnem članku.[6] Na *sl. 4* so za rdeči dren vključena samo cela semena/plodovi. Približne koncentracije strtih (tj. fragmentiranih) ostankov rdečega drena so prikazane na *sl. 5d*.

[6] T. Tolar, *Selective use of* Cornus sanguinea *L. (red dogwood) berries in Late Neolithic* (v pripravi).

Št. vzorca Sample No.	Sekvenca Sequence	Datiran material / Material dated	Datacija 14C / Conventinal radiocarbon age	Kalib. rezultat 2σ Calib. result 2σ	Mediana Median
Poz-81369	10/1SV	*Hordeum* /*Triticum* – odlomek rahisa / rachis frg.; – ostanek ogrinjalne pleve / glume bases frg.	5200±40 BP	4225–3948	4008 cal BC
Poz-55525	10/1SV	*Hordeum* – odlomek rahisa / rachis frg.	5040±70 BP	3971–3667	3865 cal BC
Poz-81363	7/1SV	*Hordeum* – odlomek rahisa / rachis frg.	5360±40 BP	4328–4054	4196 cal BC
Poz-57455	7/1SV	*Cornus sanguinea* – odlomek lupinice plodu / shell frg.	5200±35 BP	4219–3953	4005 cal BC
Poz-81360	4/1SV	*Cornus sanguinea* – odlomek lupinice plodu / shell frg.	5200±40 BP	4225–3948	4008 cal BC
Poz-55524	4/1SV	*Hordeum* – odlomek rahisa / rachis frg.	5050±40 BP	3959–3715	3865 cal BC

a

b



Sl. 6: Strojanova voda, profil 1. – **a:** Rezultati radiokarbonskih datacij rastlinskih makroostankov z najdišča. – **b:** Kalibracijske krivulje datacij (Poznan Laboratory; kalibracija s programom CALIB 7.00, Website; Stuvier, Reimer 1993).
Fig. 6: Strojanova voda, Profile 1. – **a**: Results of radiocarbon dating of plant macroremains from the site. – **b**: Calibration dating curves. (Poznan Laboratory; calibration programme CALIB 7.00, Website; Stuvier, Reimer 1993).

Radiokarbonske datacije makroostankov kulturnih in nabiranih rastlin

Nekaj fragmentiranih semen rdečega drena (*Cornus sanguinea*) in žitnih plev (*Hordeum vulgare*, *Triticum mono/dicoccum*) iz sekvenc 10, 7 in 4/1SV je bilo radiokarbonsko datiranih. Rezultati so prikazani na *sl. 6*.

Dataciji ostankov rdečega drena iz obeh sekvenc (7 in 4/1SV) kažeta enako starost: 4005 in 4008 cal BC (vrednosti median; *sl. 6*), čeprav sta vzorca ležala pribl. 31 cm drug pod drugim (glej *sl. 1c*). Ocene starosti žitnih makroostankov iz različnih globin ne kažejo takšne enotnosti v datacijah, niti ne vertikalne starostne sukcesije. Če pogledamo vseh šest kalibracijskih krivulj (*sl. 6b*), je dokaj jasno videti vsaj dve obdobji: 4225–3948 cal BC (razpon dva sigma za tri datacije: Poz-81369 [sekv. 10/1SV], -57455 [sekv. 7/1SV], -81360 [sekv. 4/1SV]) in 3971–3667 cal BC (razpon dva sigma za dve dataciji: Poz-55525 [sekv. 10/1SV], -55524 [sekv. 4/1SV]).

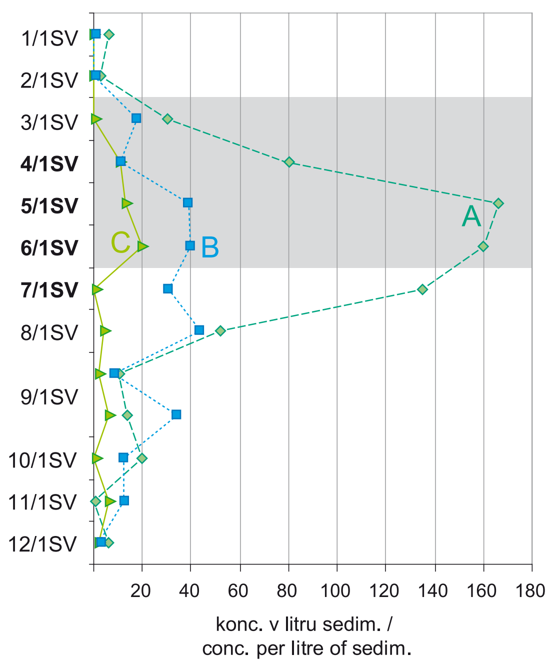
Okoljske razmere v času kolišča na Strojanovi vodi

Poleg ostankov kulturnih (tj. gojenih) in nabiranih rastlin ter plevelov oz. ruderalnih rastlin, ki so vse močno povezane s človekovim delovanjem, so odkriti še ostanki drugih, naravno rastočih rastlinskih vrst, skupno 24 taksonov. Zaradi njihove domnevne neuporabnosti najverjetneje niso bile gojene ali nabirane oz. namerno prinesene v naselbino, zato jih štejemo za naravno rastje, ki je uspevalo v neposredni bližini kolišča. Med njimi prevladujejo ostanki obrežnih oz. močvirskih (11 taksonov) in

a

Okoljske razmere / Ecological conditions	**Sekvenca / Sequence** (prim. *sl. 1* / cf. *Fig. 1*)											
	12/1 SV	11/1 SV	10/1 SV	9/1 SV	8/1 SV	**7/1 SV**	**6/1 SV**	**5/1 SV**	**4/1 SV**	3/1 SV	2/1 SV	1/1 SV
Obrežne/močvirne rastline / Lakeshore/Wetland Plants	6	-	20	24	52	**135**	**160**	**166**	**79**	30	3	6
Vodne rastline (brez: *Trapa natans*) / Water plants (without: *Trapa natans*)	2	12	12	42	44	**31**	**40**	**39**	**11**	18	-	-
Travniške rastline / Grassland plants	2	6	-	8	4	-	**20**	**13**	**11**	-	-	-

b



A = Obrežne/močvirne rastline / Lakeshore/Wetland Plants
B = Vodne rastline (brez *Trapa natans*) / Water plants (without *Trapa natans*)
C = Travniške rastline / Grassland plants

Sl. 7: Strojanova voda, profil 1. – **a:** Koncentracije in – **b:** grafični prikaz koncentracij rastlinskih makroostankov neprehranskih, domnevno naravnih (okoljskih) rastlin, razvrščenih v tri ekološke skupine (A–C) po sekvencah od 12/1SV do 1/1SV. Sekvence **7–4** (**krepko**) so označene kot arheobotanično najbogatejše. Sekvence 6–3 (sivo) so bile predhodno vizualno opredeljene kot kulturna plast.
Fig. 7: Strojanova voda, Profile 1. – **a**: Concentrations and – **b**: graphical presentation of the concentrations of presumably non-nutrition plant macroremains, i.e. wild plant taxa, classified into three ecological groups (A–C) by Sequences 12–1/1SV. Sequences **7–4/1SV** (**bold**) are marked as archaeobotanically the richest. Sequences 6–3/1SV (shaded) were initially visually determined as cultural layer.

vodnih rastlin (8 taksonov), medtem ko je ostankov travniških taksonov le za vzorec (4–5 taksonov) (*sl. 7*). Vsi ostanki semen/plodov so ohranjeni v z vodo prepojenem, nezoglenelem stanju.

Med najpogostejšimi obrežnimi oz. močvirnimi taksoni so *Alisma plantago aquatica* (trpotčasti porečnik), Cyperaceae (ostričevke), *Epilobium hirsutum* (dlakavi vrbovec), *Mentha aquatica* (vodna meta). Najvišje koncentracije njihovih ostankov (predvsem trpotčastega porečnika) so zabeležene v sekvencah 7–5 (4)/1SV, kar se ujema z antropogenimi rastlinskimi makroostanki (prim. *sl. 3; 4*).

Če ne upoštevamo ostankov vodnega oreška (*Trapa natans*), ki je bil gotovo ena izmed nabiranih rastlinskih vrst, so med vodnimi ostanki najpogostejši naslednji taksoni: Characeae (alge iz rodu zelenih alg Chara), *Oenanthe aquatica* (vodni sovec), *Ranunculus aquatilis* (vodna zlatica), *Potamogeton* sp. (dristavec). Drugače od obrežnih/močvirskih taksonov imajo vodni taksoni skozi celoten stratigrafski stolpec sedimenta približno enake koncentracije ohranjenih makroostankov, rahel upad je opazen v spodnjem in zgornjem delu stolpca (*sl. 7b*). Koncentracije ostankov obrežnih/močvirnih taksonov v sekvencah 8–3/1SV evidentno presegajo koncentracije ostankov vodnih taksonov, predvsem na račun trpotčastega porečnika. Ta velja za tipično rastlino, ki za svoje uspevanje potrebuje sončna do polsenčna, torej odprta rastišča z veliko vlage v tleh oz. tla s plitko vodo. Po arheobotaničnih rezultatih predvsem antropogenih ostankov je to ravno v obdobju največje človekove aktivnosti na tem najdišču (prim. *sl. 3; 4*). Ostanki naravnega rastja kažejo, da je bila naselbina locirana v neposredni bližini vode, na mokrotnih, najverjetneje tudi poplavnih tleh.

Skupino travniščnih rastlin predstavlja samo 4 do 5 taksonov, katerih makroostanki so zastopani z daleč najnižjimi koncentracijami (*sl. 7*). To potrjuje dejstvo, da v bližini eneolitskih kolišč ni bilo travnikov, značilnih za današnjo pokrajino Ljubljanskega barja (Tolar et al. 2011).

Skupina rastlin / Plant Group	Število taksonov / Number of Taxa	Poglobitev (m n. m.) (prim. *sl. 2*) / Depth (m a. s. l.) (cf. *Fig. 2*)					
		D6 (288,95–288,99)	D5 (288,99–289,06)	D4 (289,06–289,11)	D3 (289,11–289,19)	D2 (289,19–289,25)	D1 (289,25–289,30)
Kulturne rastline / Cultivated plants	4–5	309	369	155	169	95	43
Pleveli / Weeds, ruderals	9	27877	15342	1247	528	158	17
Nabirane rastline / Gathered plants	16	280	465	488	665	756	749
Pogojno nabirane rastline / Possibly gathered plants	8	77	33	4	8	3	1
Travniške rastline / Grassland plants	7	7	12	14	14	19	43
Močvirne, obrežne rastline / Wetland, lakeshore plants	11	449	178	66	75	122	268
Vodne rastline / Water plants	9	697	255	71	58	30	22
Nerazvrščeni taksoni / Not classified Taxa	7	77	33	4	4	3	1
SKUPAJ / SUM	72	29773	16687	2049	1521	1186	1144

Sl. 8: Maharski prekop, sonda 2/b. Število identificiranih rastlinskih taksonov iz posameznih ekoloških/gospodarskih skupin rastlin in absolutna števila (n) identificiranih rastlinskih makroostankov (plodovi, semena, zoglenele žitne pleve), ki pripadajo določeni skupini rastlin, ločeno po poglobitvah v kulturni plasti (od najstarejše D6 do najmlajše D1).
Fig. 8: Maharski prekop, Trench 2/b. Number of identified plant taxa from individual ecological/economical plant groups and absolute number (n) of identified plant macroremains (fruits, seeds, carbonized cereal chaff) belonging to a specific plant group, separated by depths (from the earliest D6 to the latest D1) in the cultural layer.

Maharski prekop

Prikazana drugačna metodologija ravnanja z arheološkimi vzorci, prepojenimi z vodo, je vzrok, da so se med rastlinskimi makroostanki, najdenimi leta 2005 na Maharskem prekopu, ohranili le odpornejši ali zogleneli. Ker ni podatka o volumnu organskih ostankov, ujetih na sitih in deležu pregledanih podvzorcev, ni mogoče izračunati koncentracij posameznih vrst semen/plodov, ki bi jih lahko primerjali med najdišči. Pa vendar, v primerjavi z arheobotaničnimi raziskavami na najdišču Strojanova voda je bilo na Maharskem prekopu (sonda 2/b) vzorčeno in pregledano mnogo več sedimenta iz kulturne plasti, saj je bilo vzorčenje sistematično površinsko in se je mokro sejala in pregledala celotna vizualno opredeljena domnevna kulturna plast. Skupno je bilo identificiranih 72 rastlinskih taksonov, v povprečju je bilo iz vsake poglobitve pobranih in identificiranih 8727 rastlinskih makroostankov (*sl. 8*).

Število ohranjenih rastlinskih makroostankov očitno z globino narašča, posebno v poglobitvah D5 in D6 (*sl. 8*). Arheobotanično najbogatejša plast (D6) je v spodnji, najgloblje izkopani plasti domnevno opredeljene kulturne plasti, zato se je treba vprašati, ali je morda pod njo še kaj ohranjenega, pa žal ne vzorčenega?

Kulturne rastline in pleveli

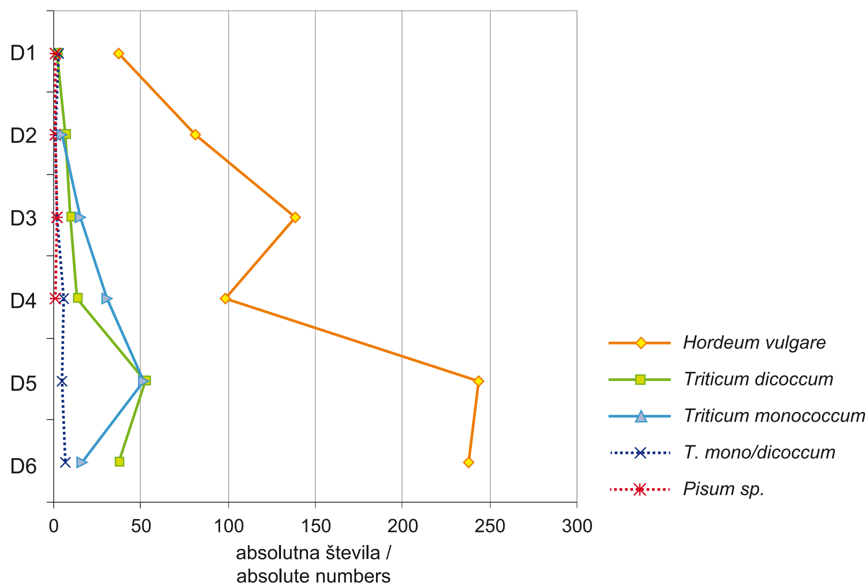
Identificirani so vsaj štirje taksoni kulturnih rastlin, med katerimi prevladujejo ostanki ječmena. Absolutna števila ostankov ostalih taksonov, enozrnice in dvozrnice ter graha, so značilno manjša (*sl. 9*). Med ostanki žit so v večini ohranjeni zoglenela zrna in odlomki rahisov ječmena, zato najverjetneje ostanki ječmena na tem najdišču številčno prevladujejo. Ostanki ogrinjalnih plev in rahisov obeh vrst pšenic (*Triticum* sp.) so najdeni oz. prepoznani v manjšem številu in samo v zoglenelem stanju, kar zopet vzbuja dvom o dejanski reprezentativnosti rezultatov in njihovi primerljivosti z rezultati z bližnjega najdišča Strojanova voda (prim. *sl. 3*) in/ali npr. z najdišča Stare gmajne (Tolar et al. 2011), kjer so odkriti in šteti tudi nezogleneli ostanki žitnih plev. Identificirana so bila tudi semena/plodovi oljne ogrščice, ki bi lahko bila peti takson kulturnih oz. gojenih rastlin (glej Tolar 2016, 170).

S sočasnih kolišč običajno odkriti ostanki ostalih taksonov z olji bogatimi semeni/plodovi, npr. maka in lanu (Pieroni 1999; Jacomet 2009; Kohler-Schneider, Cannepele 2009; Tolar et al. 2011) na najdišču Maharski prekop niso ohranjeni, najverjetneje zaradi neustreznih metod dela z vzorci. Je pa bilo na Maharskem prekopu odkritih

a

Kulturne rastline **Cultivated plants**	**Poglobitev** (prim. *sl. 2*) / **Depth** (cf. *Fig. 2*)					
	D6	**D5**	**D4**	**D3**	**D2**	**D1**
Hordeum vulgare naked (nav. ječmen)	238	244	98	139	81	37
Triticum monococcum (enozrna pšenica)	16	52	31	15	5	-
Triticum dicoccum (dvozrna pšenica)	37	53	13	10	7	2
Triticum mono/dicoccum (eno/dvozrna pšenica)	7	5	6	2	1	3
Brassica rapa (ogrščica)	11	15	6	1	-	-
Pisum sp. (grah)	-	-	1	2	1	1

b



Sl. 9: Maharski prekop, sonda 2/b. – **a:** Absolutna števila in – **b:** grafični prikaz absolutnih števil makroostankov kulturnih rastlin (zoglenela zrna in žitne pleve) iz kulturne plasti po poglobitvah od D6 do D1.
Fig. 9: Maharski prekop, Trench 2/b. – **a**: Absolute number and – **b**: graphical presentation of the absolute number of cultivated plant macroremains (carbonized grains and cereal chaff) collected from the cultural layer by Depths D6 to D1.

več zrn graha (*sl. 9*) kot na drugih koliščih, saj se grahova semena zaradi doslej še neznanih tafonomskih razlogov v z vodo prepojenem okolju ohranijo le redko oz. v malem številu in vedno le zoglenela (Jacomet 2006b; 2009; Tolar et al. 2011). Najverjetneje je bilo na Maharskem prekopu mogoče najti nekaj več zoglenelih grahovih semen, kot se jih običajno odkrije na koliščih v Sloveniji in drugje po Evropi (npr. Tolar et al. 2011; Kreuz, Marinova 2017), zaradi velike količine (pribl. 360 litrov) spranega in pregledanega sedimenta iz kulturne plasti.

Ostanke antropogenih taksonov (gojenih in plevelnih rastlin ter ruderalk) najdemo v vseh šestih poglobitvah na Maharskem prekopu (sonda 2/b), ki so bile arheološko opredeljene kot enotna kulturna plast. Najverjetneje so ohranjeni tudi v globljih plasteh (tj. pod vzorčenimi do globine 288,95 m n. m.), vendar žal niso bili vzorčeni.

Iz *slik 8* in *9* je razviden upad makroostankov kulturnih in plevelnih/ruderalnih taksonov od najgloblje plasti oz. poglobitve D6 proti najmlajši D1. Arheobotanični rezultati kažejo, da je sediment iz poglobitev D6 in D5 (z absolutne višine 288,95–289,06 m n. m.) arheobotanično najbogatejši, torej odložen v času največje človekove aktivnosti na tem območju.

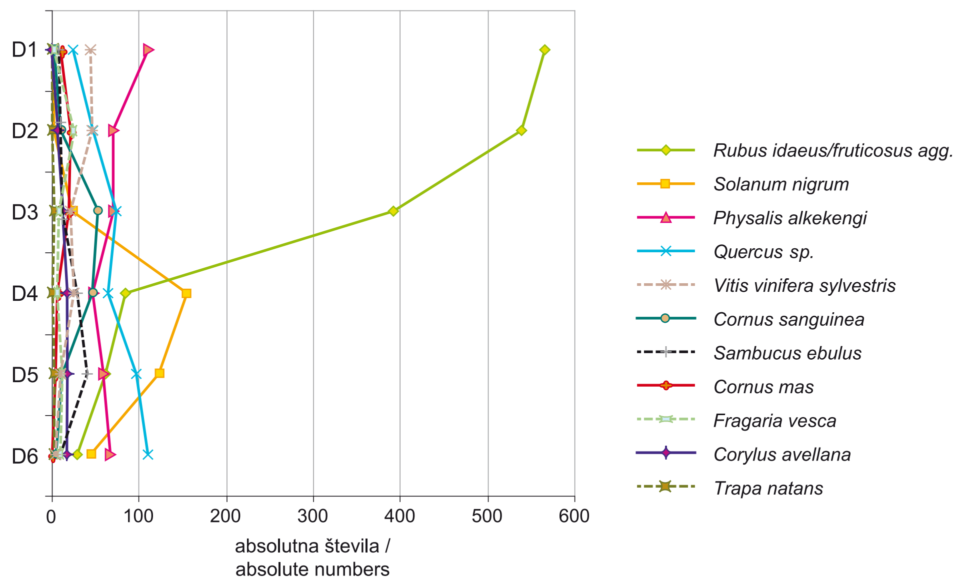
Nabirane rastline

Identificiranih je 16 domnevno nabiranih rastlinskih taksonov (*sl. 8; 10*). Najštevilčnejši so ostanki (semena/plodovi) malin/robid, volčjega jabolka, divje vinske trte, pasjega zelišča, želodov, rumenega in rdečega drena, lešnikov ter smrdljivega bezga (*sl. 10*).

a

Nabirane rastline / Gathered plants	**Poglobitev** (prim. *sl. 2*) / **Depth** (cf. *Fig. 2*)					
	D6	**D5**	**D4**	**D3**	**D2**	**D1**
Rubus idaeus/fruticosus (malina/robida)	28	61	85	392	538	566
Solanum nigrum (pasje zelišče)	43	122	154	22	1	2
Physalis alkekengi (volčje jabolko)	66	60	48	70	70	111
Quercus sp. (hrast)	91	78	45	56	29	5
Vitis vin. sylvestris (divja vinska trta)	4	10	24	21	45	43
Cornus sanguinea (rdeči dren)	3	12	46	52	9	2
Cornus mas (rumeni dren)	-	4	6	19	21	9
Sambucus ebulus (smrdljivi bezeg)	9	40	29	12	9	7
Fragaria vesca (gozdna jagoda)	9	12	5	7	25	2
Corylus avellana (leska)	18	17	17	12	6	-
Trapa natans (vodni orešek)	1	1	-	2	-	-

b



Sl. 10: Maharski prekop, sonda 2/b. – **a:** Absolutna števila in – **b:** grafični prikaz absolutnih števil makroostankov najpogostejših nabiranih rastlin iz kulturne plasti po poglobitvah od D6 do D1.
Fig. 10: Maharski prekop, Trench 2/b. – **a**: Absolute number and – **b**: graphical presentation of the absolute number of macroremians of the most important gathered plant taxa collected from the cultural layer by Depths D6 to D1.

Ker gre med nabiranimi rastlinami v večini za gozdne sadeže in oreške, ki imajo semena zaščitena s trdnejšo in lignificirano notranjo steno perikarpa (im. endokarp; glej Tolar 2016, 56), so makroostanki nabiranih rastlin v nasprotju z ostanki kulturnih rastlin z Maharskega prekopa v večini dobro ohranjeni tudi v nezoglenelem in posušenem stanju in zato reprezentativni in primerljivi z ostalimi najdišči.

Lignificirani, proti sušenju odporni makroostanki (semena/plodovi) nabiranih rastlin kažejo popolnoma drugačno sliko razporeditve makroostankov po poglobitvah (D6–D1), kot jo kažejo ostanki gojenih in ruderalnih taksonov. V vseh poglobitvah je število ohranjenih semen/plodov nabiranih rastlin približno enako oz. je pri nekaterih taksonih v zgornjih, mlajših plasteh (D2–D1) celo nekoliko večje kot v globljih, starejših plasteh (D6; *sl. 10*), kar je ravno nasprotno, kot kažejo ostanki gojenih rastlin in plevelov/ruderalk (*sl. 9*). Vzrok za ta pojav lahko pripišemo metodam dela in posledično tafonomiji rastlinskih makroostankov na Maharskem prekopu v letu 2005. Razlaga sledi v poglavju Diskusija.

Okoljske razmere v času kolišča na Maharskem prekopu

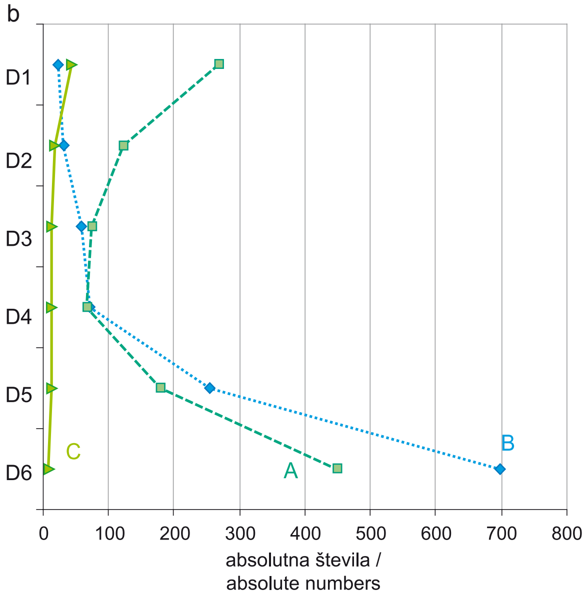
Poleg gojenih, nabiranih rastlin in plevelov/ruderalk so identificirani tudi drugi rastlinski taksoni (glej *sl. 8:* vrstice 5–7), ki nimajo prehranske ali

Okoljske razmere / Ecological conditions	**Poglobitev** (prim. *sl. 2*) **/ Depth** (cf. *Fig. 2*)					
	D6	**D5**	**D4**	**D3**	**D2**	**D1**
A	449	178	66	75	122	268
B	697	255	71	58	30	22
C	7	12	14	14	19	43

a

A = Obrežne/močvirne rastline / Lakeshore/Wetland Plants
B = Vodne rastline (brez *Trapa natans*) / Water plants (without *Trapa natans*)
C = Travniške rastline / Grassland plants

b



Sl. 11: Maharski prekop, sonda 2/b. – **a:** Absolutna števila in – **b:** grafični prikaz absolutnih števil makroostankov okoljskih rastlinskih taksonov, razvrščenih v tri ekološke skupine (A–C) iz kulturne plasti po poglobitvah od D6 do D1.
Fig. 11: Maharski prekop, Trench 2/b. – **a**: Absolute number and – **b**: graphical presentation of the absolute number of macroremains of wild plant taxa classified into three ecological groups (A–C) collected from the cultural layer by Depths D6 to D1.

kakšne druge uporabne vrednosti za človeka, zato jih štejemo med naravno rastje, ki je uspevalo v neposredni bližini naselbine. Sedemindvajset domnevno neprehranskih rastlinskih taksonov smo grupirali v 3 večje ekološke skupine, podobno kot na najdišču Strojanova voda (prim. *sl. 7*): obrežne oz. močvirne rastline, vodne rastline in travniščne rastline (*sl. 11*).

S *slike 11* je jasno razbrati, da absolutna števila ostankov vodnih in obrežnih/močvirskih taksonov občutno presegajo števila ostankov travniščnih taksonov. Podoben rezultat kažejo števila identificiranih taksonov iz posamezne ekološke skupine rastlin: 7 taksonov (kar je 26 %) pripada travniškemu rastju, vodnih taksonov je 9 (33 %), močvirskih oz. obrežnih pa 11 (41 %).

O porazdelitvi rastlinskih makroostankov po globinah (od D6 do D1), torej v času, ki ga prikazuje *sl. 11,* je na Maharskem prekopu težko govoriti zaradi nestandardnih metod dela. Ohranjeni in identificirani so predvsem taksoni z odpornejšimi semeni/plodovi. Med vodnimi taksoni so npr. v večjem številu ohranjeni ostanki le treh vrst: vodni sovec (*Oenanthe aquatica*), pritlikavi dristavec (*Potamogeton pusillus*) in nav. smrečica (*Hippuris vulgaris*), vse značilne za stoječe in počasi tekoče vode, tudi vodne jarke, smrečica pa tudi za plitvine, močvirja ter blatna poplavljena tla. Med močvirskimi taksoni po številčnosti semen/plodov prevladujeta dve vrsti: jezerski biček (*Schoenoplectus lacustris*) in plazeča zlatica (*Ranunculus repens*). Medtem ko prva uspeva ob bregovih stoječih in počasi tekočih voda, je druga pogostejša na vlažnih travniščih in ob jarkih. Zaključimo lahko, podobno kot pri najdišču Strojanova voda, da je bila naselbina na Maharskem prekopu postavljena blizu vode, na močvirnih oz. obrežnih, občasno poplavljenih tleh.

DISKUSIJA

Interpretacija in primerjava arheobotaničnih rezultatov z dveh eneolitskih kolišč z jugovzhodnega dela Ljubljanskega barja je težavna, ker je bila uporabljena različna metodologija dela. Kljub temu raziskavi prinašata nekaj zanimivih zaključkov. Kolišči sta bili večkrat raziskani, zadnje raziskave (tj. na Maharskem prekopu v letu 2005 in Strojanovi vodi v letu 2012) so vključevale tudi sistematične arheobotanične analize. Obe najdišči sta bili dendrokronološko in tipološko datirani. Kolišče Strojanova voda naj bi bilo poseljeno do okoli leta 3586 pr. n. št. (Čufar et al. 2015), kolišče Maharski prekop pa do okoli leta 3489 pr. n. št. (Čufar et al. 2010; 2015). Njuna neposredna okolica naj bi bila večkrat poseljena, saj je bilo v bližini odkritih več ostankov kolišč iz 5. in 4. tisočletja pr. n. št. (npr. Resnikov prekop, Gornje mostišče in Spodnje mostišče; prim. Čufar, Levanič, Velušček 1998; Čufar, Korenčič 2006; Velušček, Čufar 2008; Čufar et al. 2010; Čufar, Velušček, Kromer 2013), nedaleč stran pa tudi iz 3. tisočletja pr. n. št. (npr. Parte-Iščica; prim. Velušček, Čufar, Levanič 2000; Velušček, Čufar 2002; Čufar, Velušček, Kromer 2013).

V tabeli (*sl. 12*) so nanizani glavni – v večini razlikovalni – parametri med primerjanima najdiščema. Glavni razliki sta metodološke narave, tj. način (metoda) vzorčenja in priprava arheobotaničnih vzorcev. Absolutne višine območij vzorčenja raziskanih vzorcev se, zanimivo, skoraj popolnoma ujemajo, vendar je pri upoštevanju tega parametra potrebna pazljivost, saj vemo, da se je površina današnjega Ljubljanskega barja zaradi tektonskih, vodnih pa tudi človekovih aktivnosti večkrat spreminjala (prim. Melik 1946), o razlikah v nadmorskih višinah ter vplivu voda in vodostajev na raziskovanem območju piše tudi T. Bregant (1974b, 40; 1975). Velika razlika med raziskanima najdiščema je v tem, da je bilo na Strojanovi vodi vzorčenih 130 cm, na Maharskem prekopu pa le 35 cm sedimentnih plasti. V deseti vrstici v tabeli na *sl. 12* je lepo vidno, na kateri globini so arheobotanično najbogatejše plasti na Strojanovi vodi (tj. 288,73–289,04 m n. m.). Domnevno najbogatejše plasti na le pribl. 200 m oddaljenem Maharskem prekopu se, zanimivo, končajo na skoraj isti globini (tj. 289,06 m n. m.), vendar zaradi očitno ne dovolj globokega vzorčenja ne vključujejo vsega (tudi starejšega) arheobotaničnega zapisa pod njimi, torej ne zajemajo začetka odlaganja ostankov prehranskih rastlin. Do podobnega zaključka sta prišli že Marjeta Jeraj in Maja Andrič. Na najdišču Hočevarica je bilo npr. v sondi iz leta 1998 mogoče prepoznati ohranjenost ostankov kulturnih rastlin v **60 cm** debeli plasti, kolikor je bilo vzorčeno (Jeraj 2004a, 58; Jeraj, Velušček, Jacomet 2009, sl. 7), v bližnji vrtini se je pelod žitaric ohranil celo v **150 cm** dolgi sekvenci sedimenta, ujetega v 500 cm dolgo vrtino (Jeraj 2002, sl. 2; 2004b, sl. 4.8). Podobno je pelod žitaric v sondi 2/b iz leta 2005 na najdišču Maharski prekop ohranjen v **120 cm** debeli plasti, ujeti v 150 cm dolg profilni stolpec.[7] Obema raziskavama lahko pripišemo še tretjo, z enakimi ugotovitvami, kjer so makrofosili kulturnih rastlin z veliko zastopanostjo prisotni v **68 cm** dolgi sekvenci 130 cm dolgega stratigrafskega stolpca na Strojanovi vodi, v nižjih koncentracijah so tovrstni ostanki prisotni celo v **118 cm** dolgi sekvenci (tj. od sekv. 12 do 2/1SV; glej *sl. 3*). Navedene raziskave kažejo, da je z globljim vzorčenjem, kot ga predvideva arheološko sondiranje, mogoče zaznati morebitne vplive še starejših poselitev (tudi v bližnji okolici raziskanega kolišča). Sklepamo lahko, da na Maharskem prekopu niso bile vzorčene najstarejše arheobotanično bogate plasti v celoti.

Pomembna razlika je tudi količina tako vzorčenega materiala za raziskave, na Strojanovi vodi skupno le 8,25 litra, medtem ko je bilo z Maharskega prekopa raziskanih kar pribl. 360 litrov sedimenta iz kulturne plasti. Popolnoma neprimerno je torej primerjati absolutna števila najdenih semen/plodov v tako različnih volumnih pregledanega sedimenta (*sl. 12:* vrstici 8 in 9). S Strojanove vode imamo sicer podatke navedene v koncentraciji semen/plodov v litru sedimenta (*sl. 3; 4; 7*), medtem ko nam absolutna števila identificiranih rastlinskih makroostankov z Maharskega prekopa (*sl. 8–10*) ne povedo veliko. Edina mogoča primerjava arheobotaničnih rezultatov med tako različno metodološko obravnavanima najdiščema je število in raznolikost identificiranih rastlinskih taksonov (*sl. 12:* vrstici 12 in 13). Primerjamo lahko taksone med obema najdiščema (*sl. 13; 14*) in znotraj posameznega najdišča med sekvencami (Strojanova voda) oz. poglobitvami (Maharski prekop) stratigrafskega stolpca (glej poglavje Rezultati).

Zgornji del tabele (*sl. 13*) prikazuje prisotnost ostankov kulturnih, spodnji del pa nabiranih rastlinskih taksonov na obeh najdiščih. Čeprav je manj pregledanega sedimenta, je bila na Strojanovi vodi odkrita večina prehransko pomembnih rastlinskih taksonov, v primerjavi z Maharskim prekopom celo nekaj več kulturnih in nabiranih rastlin. V vzorcih z Maharskega prekopa manjkajo predvsem ostanki taksonov z manj odpornimi, nežnimi semeni/plodovi (npr. lan, mak, bela omela) in ostanki vegetativnih delov rastlin, ki so bile v naselbino domnevno prinesene za zimsko steljo oz. krmo, pa tudi za izolacijo (npr. iglice in lističi jelke, smreke, orlove praproti, bele omele; prim. Zibulski 2004; Tolar et al. 2011). Zaradi ohranjenih le proti sušenju odpornih in zoglenelih rastlinskih makroostankov se tudi grafična prikaza vertikalne razporeditve makroostankov kulturnih (*sl. 9b*) in najpogostejših nabiranih rastlin (*sl. 10b*) razlikujeta. Ker je bilo z Maharskega prekopa spranega bistveno več sedimenta iz kulturne plasti, je bilo mogoče najti 11 taksonov več (glej še *sl. 14*), predvsem tiste, ki so redkeje odkriti (verjetno tudi redkeje uporabljeni) in so zogleneli ali imajo odpornejšo in lignificirano steno semen/plodov (npr. grah, šipek, črni bezeg in nekaj prehransko nepomembnih taksonov, prim. *sl. 14*). Grah npr. na najdišču Strojanova voda ni bil odkrit najverjetneje zaradi tafonomskih razlogov (prim. Jacomet 2006b; Tolar 2016, 170) in premajhne količine pregledanega sedimenta (prim. Tolar et al. 2011, 218).

[7] M. Andrič (v pripravi), glej op. 4.

	PRIMERJAVA – Osnovni parametri **COMPARISON – Basic parameters**	**Strojanova voda** Profil / Profile 1	**Maharski prekop** Sonda / Trench 2/b
1	**Kulturna opredelitev s pomočjo tipologije lončenine** **Cultural determination with the help of pottery typology**	kultura keramike z brazdastim vrezom Culture of pottery with furrowed incisions	kulturna skupina Stare gmajne Stare gmajne cultural group
2	**Arheobotanična metoda vzorčenja** **Archaeobotanical sampling strategy**	stratigrafski stolpec sedimenta iz profila profile sampling	površinsko vzorčenje po poglobitvah (5 cm) surface sampling (5 cm depths)
3	**Arheobotanična metoda priprave vzorca** **Archaeobotanical sample treatment methods**	mokro sejanje s polflotacijo, ohranjanje v mokrem wet sieving with semi-flotation and storage in wet condition	spiranje, sušenje washing over and drying
4	**Velikost sita (Φ luknjic)** **Sieve mesh size (Φ of holes)**	2 mm in 0,355 mm 2 mm and 0.355 mm	3 mm in 1 mm 3 mm and 1 mm
5	**Absolutna višina območja vzorčenja** **Absolute altitude of the sampling area**	288,09–289,39 m n. m. 288.09–289.39 m a. s. l.	288,95–289,30 m n. m. 288.95–289.30 m a. s. l.
6	**Dimenzije vzorčenih plasti** **Dimensions of the sampled layers**	dolžina stratigrafskega stolpca: 130 cm length of the stratigraphic column: 130 cm	debelina vzorčenih plasti: 35 cm thickness of the sampled layers: 35 cm
7	**Ostanki kulturnih rastlin prisotni** **Remains of cultivated plants are present**	znotraj 94 cm stratigrafskega stolpca within 94 cm of stratigraphic column	znotraj 35 cm vzorčenih plasti (nižje plasti niso bile vzorčene) within 35 cm of sampled layers (lower layers were not sampled)
8	**Volumen analiziranega sedimenta** **Volume of the sediment samples**	8,25 litra 8.25 litres	pribl. 360 litrov aprox. 360 litres
9	**Številčnost rastlinskih makroostankov (MO) – semen/plodov/plev** **Quantity of plant macroremains (MR) – seeds/fruits/chaff**	povprečno 6448 MO v 1 litru sedimenta in averag. 6448 MR per 1 litre of sediment sample	povprečno 8727 MO iz vsake poglobitve in averag. 8727 MR from each depth
10	**Arheobotanično najbogatejše mesto vzorčenja** **Archaeobotanically the richest sampled layer**	**sekvenca: 7/1SV–4/1SV** 288,73–289,04 m n. m. **sequence: 7/1SV–4/1SV** 288.73–289.04 m a. s. l.	poglobitev: ?* + **D6–D5** ?* + 288,95 do 289,06 m n. m. (* nižje plasti niso bile vzorčene) depth: ?* + **D6–D5** ?* + 288.95 to 289.06 m a. s. l. (* lower layers were not sampled)
11	**Ohranjenost rastlinskih ostankov** **Preservation of plant remains**	večinoma nezogleneli, z vodo prepojeni mostly uncarbonised, waterlogged	žitni ostanki (zogleneli); odpornejša semena/plodovi (prepojeni z vodo, naknadno posušeni) cereal chaff (carbonised); more resistant, lignified seeds/fruits (non-carbonised, dried)
12	**Število identificiranih taksonov** **Number of identified taxa**	5–6 (kulturne rastline); 20 (nabirane rastline) 5–6 (cultivated plants); 20 (gathered plants)	4 (kulturne rastline); 16 (nabirane rastline) 4 (culitvated plants); 16 (gathered plants)
13	**Skupno število identificiranih taksonov** **Number of identified taxa**	61	72

Sl. 12: Primerjava izbranih osnovnih parametrov dveh eneolitskih kolišč: Strojanova voda in Maharski prekop.
Fig. 12: Comparison of selected basic parameters of the Eneolithic pile-dwellings: Strojanova voda and Maharski prekop.

O pomembnosti nekaterih rastlinskih taksonov v posameznih poglobitvah (D6–D1) na podlagi številčnosti najdb na Maharskem prekopu (npr. *sl. 9–11*) težko govorimo zaradi neprimerljive enote (tj. absolutnih števil) in zaradi nereprezentativnosti ostankov (tj. prevlada zoglenelih semen/plodov in žitnih plev ali tistih z odpornejšo, lignificirano steno). S *slik 9–11* je torej nemogoče z gotovostjo trditi, katera poglobitev na Maharskem prekopu je arheobotanično najbogatejša. Lignificirani (v večini nezogleneli) ostanki domnevno nabiranih rastlin, če izvzamemo semena/plodove robid/

Takson / Taxa	SV	MP
Hordeum vulgare naked (nav. ječmen)	●	●
Triticum monococcum (enozrna pšenica)	●	●
Triticum dicoccum (dvozrna pšenica)	●	●
Brassica rapa (ogrščica)	●	●
Linum usitatissimum (lan)	●	-
Papaver somniferum (mak)	●	-
Pisum sp. (grah)	-	●
Sambucus ebulus (smrdljivi bezeg)	●	●
Fragaria vesca (gozdna jagoda)	●	●
Rubus fruticosus agg. (robida)	●	●
Physalis alkekengi (volčje jabolko)	●	●
Malus sylvestris (divja jablana)	●	●
Quercus sp. (hrast)	●	●
Cornus mas (rumeni dren)	●	●
Cornus sanguinea (rdeči dren)	●	●
Trapa natans (vodni orešek)	●	●
Corylus avellana (leska)	●	●
Vitis vinifera sylvestris (divja vinska trta)	●	●
Viburnum lantana (dobrovita)	●	●
Prunus spinosa (črni trn)	●	●
Solanum sp. (razhudnik)	●	●
Picea abies (smreka)	●	-
Viburnum opulus (brogovita)	●	-
Pteridium aquilinum (orlova praprot)	●	-
Viscum album (bela omela)	●	-
Crataegus monogyna (enovrati glog)	●	-
Abies alba (jelka)	●	-
Rosa sp. (šipek)	-	●
Sambucus nigra/racemosa (črni/divji bezeg)	-	●

Sl. 13: Primerjava zastopanosti identificiranih prehransko pomembnih taksonov na najdiščih Strojanova voda (**SV**), profil 1, in Maharski prekop (**MP**), sonda 2/b.
Fig. 13: Comparison of the presence of the most important nutritious plant taxa at Strojanova voda (**SV**), Profile 1 and Maharski prekop (**MP**), Trench 2/b.

malin, ki močno odstopajo (prim. *sl. 10*) od ostalih, so približno enako številčni v vseh šestih poglobitvah. Medtem ko je ta slika drugačna pri zoglenelih ostankih kulturnih rastlin (prim. *sl. 9*) in nezoglenelih, lignificiranih ostankih prehransko nepomembnih taksonov (prim. *sl. 11*). Kulturne rastline kažejo, da sta zadnji poglobitvi D5 in D6 najbogatejši, zaradi česar se upravičeno sprašujemo o nezadostno globokem površinskem vzorčenju na Maharskem prekopu, vsaj ko gre za arheobotanične najdbe. Podobno sliko vidimo tudi pri nezoglenelih ostankih naravno rastočih, torej okoljskih rastlin (prim. *sl. 11*). Porast ostankov vodnih in močvirskih taksonov v D5 in D6 lahko razlagamo z večjim odlaganjem semen/plodov teh rastlin zaradi obstoja naselbine in hiš na kolih, v katere so se rastline zapletale in se zaradi ugodnih ekoloških razmer (npr. več fosforja, dušika) tam tudi razraščale. Povečan delež ostankov nekaterih vodnih in močvirskih rastlin je lahko tudi posledica človekovega delovanja, npr. prinašanja trstičja in vodnega oreška zaradi uporabnosti teh vrst. Če vseeno pogledamo absolutne višine območij vzorčenja z obeh kolišč (prim. *sl. 12*), čeprav, kot že rečeno, z zadržkom zaradi naravnih in antropogenih dejavnikov, ki bi lahko vplivali na verodostojnost tega podatka, lahko z zanimivostjo (po naključju ali pač ne?) ugotovimo, da so se v sedimentu dveh sosednjih kolišč, ki se je odlagal do nadmorske višine 289,04 oz. 289,06 m, ohranili ostanki kulturnih rastlin, torej dokazi človekovega delovanja. Medtem ko začetek tovrstnega človekovega vpliva na Strojanovi vodi lahko zasledimo pribl. 94 cm globlje, smo na Maharskem prekopu, glede na nadpovprečno bogatost arheobotaničnih ostankov v najgloblje izkopani plasti D6, lahko prepričani, da bi moral biti začetek zaznaven globlje od vzorčenih 35 cm (prim. tudi Jeraj 2002; 2004b in Andrič[8]). Tudi Šercelj (1975) in Bregant (1975, 48) na podlagi povišane vsebnosti fosforja v tleh sklepata na debelino kulturne plasti na najdišču Maharski prekop med 40 in 60 cm, čeprav je bila glede na prisotnost keramičnih najdb opredeljena med 30 in 45 cm (Bregant 1975, 9–11). Koliko dejansko je globoka kulturna plast (vsaj z vidika arheobotanike) na najdišču Maharski prekop, naj bo naloga prihodnjih raziskav. Ob tem je treba poudariti, da je bilo zaradi neprimernega ravnanja z vodo prepojenimi organskimi vzorci v letu 2005 večina nezoglenelih žitnih plev ter seveda lanenih in makovih ostankov uničenih in zato tudi neprepoznanih, iz česar sledi, da je moralo biti ohranjenih ostankov kulturnih rastlin v izkopanem mokrotnem sedimentu na Maharskem prekopu še več.

Zanesljivejši, čeprav količinsko skromnejši so rezultati s Strojanove vode (*sl. 3; 4; 7*), ki kažejo prisotnost kulturnih in nabiranih rastlin v zanesljivo 94 cm (tj. sekv. 11–3/1SV) stratigrafskega stolpca. Kot arheobotanično najbogatejšo plast je bilo mogoče določiti 31 cm dolgo sedimentno sekvenco med 7–4/1SV (289,04–288,73 m n. m.). V njej so bili ohranjeni ostanki vseh pomembnejših identificiranih kulturnih in nabiranih rastlinskih taksonov v najvišjih koncentracijah. V primerjavi s spektrom in deležem arheobotaničnih ostankov s kolišča Stare gmajne (Tolar et al. 2011, 212),

[8] M. Andrič (v pripravi), glej op. 4.

datiranega v obdobje ok. 3300 in 3100 pr. n. št. (Čufar et al. 2009; 2010; 2015; Čufar, Velušček, Kromer 2013), ki je bilo metodološko ustrezno arheobotanično raziskano kolišče z Ljubljanskega barja, gre na Strojanovi vodi za zelo podoben rezultat oz. nabor arheobotaničnih ostankov, predvsem kulturnih rastlin. Med nabiranimi taksoni je mogoče opaziti manjša odstopanja, kot npr. večji pomen rdečega drena in smrdljivega bezga na Strojanovi vodi. Vertikalna distribucija očitno strtih plodov rdečega drena (več tisoč fragmentov v litru sedimenta; *sl. 5*) se namreč popolnoma ujema z distribucijo ostankov ostalih antropogenih (gojenih, plevelnih/ruderalnih in domnevno nabiranih) taksonov (*sl. 3*), kar dodatno potrjuje zelo verjetno namensko uporabo domnevno neužitnega rdečega drena v času življenja v naselbini. Z najdišča na Strojanovi vodi je odkritih več ostankov kamnitih žrmelj (A. Velušček, os. komunikacija), ki dodatno potrjujejo aktivnost trenja semen/zrn.

Vertikalne distribucije tako gojenih, plevelnih/ruderalnih (*sl. 3*) kot tudi nabiranih (*sl. 4*) ostankov rastlinskih taksonov morda kažejo na nekajkratno (lahko celo do 3-kratno) povečano človekovo aktivnost, prepoznano v 68 cm sedimentnega stolpca na Strojanovi vodi (npr. v sekvencah 10, 7–6/1SV in 4–3/1SV). Takšna vertikalna distribucija makroostankov (*sl. 3–5*) je odprla vprašanje o morda večfaznosti poselitve na tem območju, bodisi na Strojanovi vodi, še verjetneje pa v njeni bližnji okolici. Teoretično bi tako lahko bili najstarejši ostanki iz sekvence 10/1SV zaradi manjših koncentracij posredno (z vetrom, vodo, ali odloženi pri zunajnaselbinskih aktivnostih) prineseni iz kakšnega drugega, starejšega kolišča v bližini.[9] Ostanke iz sekvenc 7–6/1SV bi lahko zaradi najvišjih koncentracij pripisali kar kolišču na Strojanovi vodi. V višje ležeči plasti je zaznati kratko prekinitev v odlaganju makroostankov in nato spet manjše in najmlajše povišanje koncentracij ostankov v sekvencah 4–3/1SV, ki bi lahko bile posledica ponovne naselitve Strojanove vode ali katerega od mlajših, morda še neodkritih kolišč v bližini. Do podobnih zaključkov o morebitni večfaznosti na kolišču Strojanova voda bi lahko prišli tudi na podlagi dendrokronoloških rezultatov, ki kažejo, da ima nekaj posameznih kolov z ohranjeno beljavo datum poseka okoli 3700 pr. n. št. in so tako starejši od večine v raziskavo zajetih

[9] O možni kontaminaciji s sosednjih kolišč govori tudi T. Bregant (1974b, 52, 54) v okviru raziskav na najdišču Maharski prekop.

Vodne rastline / Water plants	**SV**	**MP**
Ranunculus aquatilis (vodna zlatica)	●	●
Potamogeton sp. (dristavec)	●	●
Oenanthe aquatica (vodni sovec)	●	●
Nuphar luteum (rumeni blatnik)	●	●
Myriophyllum sp. (rmanec)	●	●
Hippuris vulgaris (nav. smrečica)	●	●
Chara sp. (hara, zelena alga)	●	●
Trapa natans (vodni orešek)	●	●
Potamogeton pusillus (pritlikavi dristavec)	-	●
Myriophyllum spicatum (klasasti rmanec)	-	●
Najas marina/intermedia (podvodnica)	-	●

Obrežne/Močvirne rastline Lakeshore/Wetland plants	**SV**	**MP**
Cladium mariscus (nav. rezika)	●	●
Schoenoplectus lacustris (jezerski biček)	●	●
Carex sp. (šaš)	●	●
Carex cf. trikarpelate (trikarpelatni šaš)	●	●
Carex cf. muricata (pairajev šaš)	●	●
Lycopus europaeus (nav. regelj)	●	●
Epilobium hirsutum (dlakavi vrbovec)	●	-
Verbena officinalis (nav. sporiš)	●	-
Mentha aquatica (vodna meta)	●	-
Alisma plantago-aquatica (trpotčasti porečnik)	●	-
Neckera crispa (mah, zavešček)	●	-
Alnus glutinosa (črna jelša)	-	●
Polygonum hydropiper (poprasta dresen)	-	●
Ranunculus cf. repens (plazeča zlatica)	-	●
Menyanthes trifoliata (nav. mrzličnik)	-	●
Sparganium sp. (ježek)	-	●

Travniščne rastline / Grassland plants	**SV**	**MP**
Poaceae (trava)	●	●
Daucus carota (nav. korenje)	●	-
Hypericum perforatum (šentjanževka)	●	-
Silene sp. (slizek, pokalica)	●	-
Ranunculus sp. (zlatica)	-	●
Ranunculus cf. *acris* (ripeča zlatica)	-	●
Rumex sp. (kislica)	-	●
Centaurea jacea (nav. glavinec)	-	●
Ajuga cf. *reptans* (plazeči skrečnik)	-	●
Leucanthemum sp. (ivanjščica)	-	●

Sl. 14: Primerjava zastopanosti identificiranih prehransko nepomembnih taksonov na najdiščih Strojanova voda (**SV**), profil 1, in Maharski prekop (**MP**), sonda 2/b. Taksoni so razvrščeni v tri ekološke skupine.
Fig. 14: Comparison of the presence of non-nutritious, wild plant taxa identified at Strojanova voda (**SV**), Profile 1 and Maharski prekop (**MP**), Trench 2/b. Taxa are grouped into three ecological groups.

dendrokronoloških vzorcev lesa iz gradbene faze, ki naj bi se zaključila okoli 3600 pr. n. št. (Čufar et al. 2015, sl. 3).

Pri poskusu reševanja vprašanja o večfaznosti smo radiokarbonsko datirali 6 vzorcev kulturnih oz. nabiranih rastlin (*sl. 6*) iz različnih globin arheobotanično najbogatejših 68 cm (tj. od sekvence 10–4/1SV). Dataciji ostankov rdečega drena iz sekvenc 7 in 4/1SV sta bili identični, 4005 in 4008 cal BC (mediana), kar lahko razlagamo, da sta se sekvenci (skupna debelina 31 cm) odlagali sočasno, torej so ostanke rdečega drena zapustili isti naseljenci. To datacijo z veliko natančnostjo podpre datacija žitnih ostankov iz sekvence 10/1SV (4008 cal BC), medtem ko datacije ostankov ječmena teh ne podprejo s tako veliko natančnostjo. Datirani ostanki ječmena iz sekvenc 10 in 4/1SV sicer kažejo, da gre za enotno obdobje, vendar nekoliko (morda pribl. 100 let) mlajše, kot ga prikazujejo ostanki rdečega drena in žit iz istih sekvenc. Mediane datacij obeh ječmenovih vzorcev kažejo čas okoli leta 3865 cal BC. Med omenjenimi šestimi datumi še najbolj izstopa šesta, najstarejša datacija, tj. datacija ostankov ječmena iz sekvence 7/1SV (Poz-81363), katere vrednost mediane kaže na leto 4196 cal BC. Razpon dva sigma te datacije (4328–4054 cal BC) se sicer deloma prekriva z razponom dva sigma mediane 4008 cal BC (4225–3948 cal BC), pridobljene iz vzorcev strtih ostankov rdečega drena (Poz-81360) (*sl. 6*), zato tu ne smemo izvzeti možnosti, da gre vseeno lahko za sočasnost, vendar gre verjetneje za ostanke iz različnih obdobij.

Zanimivo, vse navedene datacije ne kažejo tudi vertikalne časovne razporeditve, tako je npr. datacija ostankov ječmena iz sekvence 7/1SV (Poz-81363) najstarejša, datacija enakih ostankov iz sekvence 10/1SV (Poz-55525) pa najmlajša. Za ta pojav sta možni vsaj dve razlagi:

1. Ker si je večina datacij zelo blizu in se razponi dva sigma prekrivajo (*sl. 6*), lahko sklepamo, da gre za enotno, istodobno kulturno plast sedimenta, v kateri so se med delovanjem človeka, vode in narave rastlinski makroostanki bolj ali manj pogrezali in usedali vsaj 68 cm globoko.

2. Verjetnejša razlaga: znano je, da sta sedimentologija in hidrologija jugovzhodnega dela Ljubljanskega barja izredno zapleteni in lokalno še vedno nedodelani. Nekdanji vodni tokovi in pojav/izginotje jezera, ki so sicer deloma vidni tudi na lidarskem posnetku (npr. Mlekuž et al. 2012), kažejo, da je bilo to območje v preteklosti hidrološko aktivno (že Bregant 1975; kasneje pa tudi Turk 2006; Andrič 2006; 2009; Budja, Mlekuž 2008; Velušček 2009b), zato je mogoče, da so lahko ostanki kulturnih in nabiranih rastlin, ki smo jih datirali, na mesto odvzema stratigrafskega stolpca npr. z vodo, vetrom ali kako drugače prišli s katerega od sosednjih kolišč, ki jih na tem območju zagotovo ni bilo malo (prim. Velušček, Čufar 2008; Velušček 2013).

Ker gre za 6 datacij, pridobljenih na podlagi ostankov kulturnih oz. nabiranih nezoglenelih kopenskih rastlinskih taksonov, jim gre torej v grobem verjeti. Vendar nas pri tem zmoti nedavna kronološka opredelitev najdišča na podlagi prej omenjene dendrokronologije in tipologije lončenine (Čufar et al. 2015). Slednja je bila sicer določena na osnovi odlomkov keramike, odkritih naključno, torej nestratigrafsko. Raziskovalci (Čufar et al. 2015) kažejo vsaj 280 let mlajšo poselitev glavne gradbene faze, kot jo predvidevata vrednosti mediane dveh najmlajših od šestih datiranih ostankov. Čeprav vrednosti absolutnih datumov v dendrokronologiji in vrednosti median C14 niso popolnoma primerljive, smo to ugotovitev vseeno skušali interpretirati. Natančen topografski pregled lokacij dendrokronološko datiranih kolov s Strojanove vode in lokacija arheobotanično raziskanega profila1 dopuščata možnost, da večina dendrokronološko datiranih kolov v resnici izhaja iz mlajše poselitvene faze, kot kažejo radiokarbonski datumi ostankov kulturnih in nabiranih rastlin iz profila 1. Stratigrafski stolpec, imenovan profil 1, je bil namreč odvzet nekoliko stran (bolj proti vzhodu) od obeh večjih skupin dendrokronološko datiranih kolov (os. komunikacija A. Velušček; K. Čufar; arhiv IzA ZRC SAZU). Vzhodneje od profila 1 je veliko še nedatiranih kolov, pojavljajo se tudi v osrednjem in zahodnem delu. Vsi ti še neobjavljeni podatki (arhiv IzA ZRC SAZU) so lahko v prid hipotezi, da je bilo območje poseljeno že pred 3586 pr. n. št.,[10] na kar kažeta prej omenjena vzorca lesa s posekom okoli leta 3700 pr. n. št. (Čufar et al. 2015, sl. 3). Ob tem je treba upoštevati, da je za dendrokronološko datiranje na koliščih običajno primernih le okoli 10–20 % v raziskavo zajetih kolov (le ohranjeni koli, odkriti med izkopavanji; os. komunikacija K. Čufar; Čufar et al. 2015). Zaključimo lahko, da bi bilo za končno poselitveno sliko ob Strojanovi vodi potrebnih še veliko raziskav, ob predpostavki, da se je les iz različnih gradbenih faz ohranil do danes.

[10] Že omenjena dendrokronološko datirana najmlajša branika na Strojanovi vodi je nastala v letu 3586 pr. n. št. (Čufar et al. 2015)

Ko gre za rastlinske makroostanke naravnega rastja iz časa življenja kolišč (*sl. 14*), obe raziskavi, tako s Strojanove vode kot tudi z Maharskega prekopa, potrjujeta, da sta bili naselbini postavljeni na obrežnem ali močvirnem območju z možnimi občasnimi poplavami. Presežka nezoglenelih makroostankov naravnega rastja (predvsem vodnih in močvirskih taksonov) na obeh najdiščih se v grobem ujemata s presežki makroostankov kulturnih in nabiranih taksonov (prim. *sl. 7* in *11*), kar lahko razlagamo z ugodnimi ekološkimi razmerami za rast in razmnoževanje teh rastlin v neposredni bližini naselbine. Hkrati nam lahko vertikalna distribucija teh ostankov ponudi informacijo o okoljskih spremembah, tj. od bolj vlažnih in vodnih do bolj močvirnih oz. obrežnih razmer – in obrnjeno. Spremembe v hidroloških razmerah v zgodovini Ljubljanskega barja so bile večkrat dokazane tudi s sedimentološkega vidika (npr. Andrič 2009; Turk, Horvat 2009). Iz 4. tisočletja pr. n. št. so npr. znane hidrološke fluktuacije z območja okoli Alp (npr. več faz povišane jezerske gladine in poplavnih sunkov, najverjetneje v povezavi s klimatskimi spremembami ok. 3650–3370 pr. n. št.; npr. Haas et al. 1998; Magny 2004; Magny et al. 2006; Velušček et al. 2018). Za ugotavljanje možnih vplivov teh sprememb na okoljske razmere in posledično na poselitveno sliko Ljubljanskega barja v času kolišč bo potrebnih več takšnih in podobnih interdisciplinarnih raziskav.

ZAKLJUČEK

Jugovzhodni del Ljubljanskega barja je bil večkrat poseljen. Dve eneolitski kolišči, Strojanova voda in Maharski prekop, ki sta med seboj oddaljeni pribl. 200 metrov, smo skušali arheobotanično raziskati in primerjati. Različne metode dela so pripomogle k prepoznanju pomembnih, predvsem metodoloških zaključkov.

Stratigrafsko vzorčeno najdišče Strojanova voda nam je omogočilo vpogled v dlje trajajoče dogajanje na tem mestu. Ugotovili smo, da se je v času poselitve tega območja na mestu odvzema vzorca odložila vsaj 68 cm dolga sekvenca sedimenta, ki smo jo na podlagi kulturnih in nabiranih rastlinskih makroostankov radiokarbonsko datirali v obdobje med 4225 in 3667 cal BC (razponi dva sigma šestih datacij). Uspelo nam je potrditi prehranske navade koliščarjev, ki smo jih dognali že na eneolitskem kolišču Stare gmajne (Tolar et al. 2011). Gojili so enozrno in dvozrno pšenico ter ječmen, mak in lan, morda tudi oljno ogrščico. Po številčnosti domnevno nabiranih rastlinskih najdb na Strojanovi vodi izstopajo številni strti ostanki semen/plodov rdečega drena, namembnost tega še raziskujemo.

Arheobotanične analize na sosednjem kolišču Maharski prekop, ki je bilo drugače vzorčeno, so pokazale, da najverjetneje ni bila vzorčena celotna kulturna plast (vsaj kar se tiče prisotnosti arheobotaničnih ostankov), kar naj se pri prihodnjih sondiranjih upošteva. Vrstna pestrost makroostankov je podobna kot na najdišču Strojanova voda, le z dvema pomembnima razlikama v spektru kulturnih rastlin: na Strojanovi vodi sta prisotna lan in mak, na Maharskem prekopu grah. Razliko pripisujemo metodološkim in posledično tafonomskim dejavnikom. Zaključimo lahko, da je spekter kulturnih in nabiranih rastlin na obeh najdiščih dokaj značilen za eneolitske objezerske skupnosti v Sloveniji in tudi drugje okoli Alp (npr. Tolar et al. 2011). Podobno kot na drugih doslej raziskanih slovenskih koliščih niti tokrat nismo našli tetraploidne pšenice z nepriraslimi plevami (*Triticum durum/turgidum*), kar podpira hipotezo, da ta vrsta pšenice najverjetneje izvira iz centralne Evrope in ne, tako kot večina kultivarijev, iz jugovzhodne Evrope s širitvijo prek Balkana (Maier 1996; Jacomet 2007; Tolar et al. 2011; Tolar, Jacomet, Velušček 2016; Kreuz, Marinova 2017).

Metoda vzorčenja z odvzemom stratigrafskega stolpca sedimenta za arheobotanične raziskave rastlinskih makroostankov, ki je bila v pričujoči raziskavi v Sloveniji uporabljena prvič, se je dobro izkazala. Raziskava 130 cm dolgega sedimentnega stolpca s Strojanove vode je v nasprotju s 35 cm površinsko vzorčenim sedimentom iz kulturne plasti na Maharskem prekopu pokazala, da so ostanki kulturnih, nabiranih in plevelno/ruderalnih rastlin prisotni vsaj v 94 cm (posamične najdbe celo v 118 cm; glej *sl. 3; 4*) dolgem stolpcu sedimenta, kar je skladno palinološkim raziskavam na dveh drugih doslej raziskanih eneolitskih koliščih z Ljubljanskega barja (prim. Jeraj 2004b; Andrič[11]). Ugotavljamo, da je za arheobotanične raziskave na mokrotnih tleh nujno odvzeti čim globlje sedimentne vzorce, ki lahko pokažejo sliko časovno dlje trajajočega dogajanja na najdišču oz. v njegovi bližnji okolici.

Upoštevajoč dendrokronološko datacijo kolišča na Strojanovi vodi, ki jo podpira tudi tipološka

[11] M. Andrič (v pripravi), glej op. 4.

analiza keramike, in vseh šest radiokarbonskih datacij makroostankov kulturnih in nabiranih rastlin, odvzetih iz 68 cm debele arheobotanično bogate ("kulturne") plasti, lahko sklepamo, da je bilo območje ob Strojanovi vodi večkrat ali pa dlje časa poseljeno že pred naselitvijo, ki jo ugotavljajo trenutne dendrokronološke in tipološke raziskave (Čufar et al. 2015; A. Velušček, K. Čufar, os. komunikacija).

Tako na terenu (prim. Bregant 1975; Velušček 2009b) kot tudi na lidarskem posnetku (Mlekuž et al. 2012, sl. 1) je jasno vidna izjemno razgibana pretekla hidrološka aktivnost, ki bistveno otežuje oblikovanje končne interpretacije o dogajanju na tem delu Ljubljanskega barja. Podobno kot T. Bregant smo namreč prišli do zaključka, da je dejavnik vodà, nastal pred ali med življenjem v naselbini/-ah na raziskanem območju ali po njem, najverjetneje vplival tudi na distribucijo ostankov. Radiokarbonske datacije ostankov prehranskih rastlin s Strojanove vode kažejo na možno premeščanje (*sl. 6*). T. Bregant (1974b, 52, 54) na primer govori o možnostih plavljenja fragmentov keramike s kolišča Resnikov prekop ali z nekega še neodkritega kolišča podobne starosti na kolišče Maharski prekop, kar je bilo kasneje dokazano v okviru interdisciplinarnih raziskav na najdišču Resnikov prekop (Velušček [ur.] 2006). Govori tudi o možnosti, da je bilo območje Maharskega prekopa večkrat poseljeno, zapored drugo za drugim ali celo sočasno (Bregant 1975, 11). Tudi to bi lahko potrdile arheobotanične raziskave s Strojanove vode (glej *Diskusijo*).

Trenutni arheobotanični rezultati prispevajo le delček k mozaiku skrivnosti, zapisanih v tleh Ljubljanskega barja, za konkretne zaključke v zvezi s tem, predvsem kronološke pripadnosti vseh kolišč, njihovo število, zaporedje ali sočasnost obstoja, bo potrebnih več sondiranj in interdisciplinarnih raziskav na tem delu Ljubljanskega barja.

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

ANDRIČ, M. 2006, Ali lahko analiza pelodnega zapisa v kulturni plasti arheološkega najdišča pove, kakšna vegetacija je rasla v okolici? Primer: Resnikov prekop / Does Pollen Record in Archaeological ‚Cultural layer' tell Us what Vegetation was growing around the Settlement? Case Study: ‚Resnikov prekop'. – V / In: Velušček (ur. / ed.) 2006, 103–113.

ANDRIČ, M. 2009, Holocenske paleoekološke in paleohidrološke razmere na Ljubljanskem barju – prispevek k diskusiji / The Holocene palaeoecological and palaeohydrological conditions at Ljubljansko barje – a contribution to discussion. – *Arheološki vestnik* 60, 317–331.

ANDRIČ et al. 2008 = ANDRIČ, M., B. KROFLIČ, M. J. TOMAN, N. OGRINC, T. DOLENEC, M. DOBNIKAR, B. ČERMELJ 2008, Late Quaternary vegetation and hydrological change at Ljubljansko barje (Slovenia). – *Palaeogeography, Palaeoclimatology, Palaeoecology* 270, 150–165.

ANDRIČ et al. 2009 = ANDRIČ, M., J. MASSAFERRO, U. EICHER, B. AMMANN, M. C. LEUENBERGER, A. MARTINČIČ, E. MARINOVA, A. BRANCELJ 2009, A multi-proxy Late-glacial palaeoenvironmental record from Lake Bled, Slovenia. – *Hydrobiologia* 631, 121–141.

ANDRIČ et al. 2010 = ANDRIČ, M., A. MARTINČIČ, B. ŠTULAR, F. PETEK, T. GOSLAR 2010, Land-use changes in the Alps (Slovenia) in the fifteenth, nineteenth and twentieth centuries AD: a comparative study of the pollen records and historical data. – *The Holocene* 20/7, 1023–1037.

BERGGREN, G. 1969, *Atlas of Seeds and small fruits of Nortwest-European plant species (Sweden, Norway, Denmark, East Fennoscandia and Iceland) with morphological descriptions* 2. *Cyperaceae.* – Stockholm.

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

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

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

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

BREGANT, T. 1975, Kolišče ob Maharskem prekopu pri Igu – raziskovanja 1973. in 1974. leta (Der Pfahlbau am

Maharski-Kanal – Forschungen aus dem Jahren 1973 und 1974). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 4, 7–114.

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

BREGANT, T. 1996, Starejša, srednja in mlajša kamena doba ter bakrena doba / Early, Middle and Late Stone Ages, Copper Age. – V / In: B. Dirjec et al. (ur. / eds.), *Pozdravljeni prednamci! Ljubljana od prazgodovine do srednjega veka / Ancestral ecounters. Ljubljana from prehistory to the Middle Ages,* 18–45, Ljubljana.

BUDJA, M., D. MLEKUŽ 2008, Poplavna ravnica Ižice in prazgodovinska kolišča / The Ižica floodplain and "pile--dwellings" in prehistory. – *Arheološki vestnik* 59, 359–370.

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

CULIBERG, M., A. ŠERCELJ 1978, Ksilotomske in palinološke analize rastlinskih ostankov s kolišča na Partih pri Igu – izkopavanja leta 1977 (Xylotomische und palynologische Analysen der Pflanzenüberreste aus dem Pfahlbau Parti bei Ig – Ausgrabung 1977). – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 6, 95–100.

CULIBERG, M., A. ŠERCELJ 1980, Pelodne, ksilotomske in karpološke analize s kolišča na Partih (Palynologische, xsylotome und karpologische Analysen aus dem Pfahlbau auf Parti – Ausgrabungen 1979). – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 8, 89–95.

ČUFAR, K., T. KORENČIČ 2006, Raziskave lesa z Resnikovega prekopa in radiokarbonsko datiranje / Investigations of Wood from Resnikov Prekop and Radiocarbon Dating. – V / In: Velušček (ur. / ed.) 2006, 123–127.

ČUFAR, K., T. LEVANIČ, A. VELUŠČEK 1997, Dendrokronološke raziskave na kolišču Založnica in Parte (Dendrochronological investigations in the pile dwellings Založnica and Parte from the Ljubljana moor). – *Arheološki vestnik* 48, 15–26.

ČUFAR, K., T. LEVANIČ, A. VELUŠČEK 1998, Dendrokronološke raziskave na koliščih Spodnje mostišče 1 in 2 ter Hočevarica (Dendrochronological investigations in the pile dwellings Spodnje Mostišče 1 and 2 and Hočevarica from the Ljubljana moor, Slovenia). – *Arheološki vestnik* 49, 75–92.

ČUFAR, K., A. VELUŠČEK, B. KROMER 2013, Two decades of dendrochronology in the pile dwellings of the Ljubljansko barje, Slovenia. – V / In: N. Bleicher, H. Schlichtherle, P. Gassmann, N. Martinelli (ur. / eds.), *DENDRO - Chronologie -Typologie - Ökologie. Festschrift für André Billamboz zum 65. Geburtstag,* 35–40, Freiburg im Breisgau.

ČUFAR et al. 2009 = ČUFAR, K., A. VELUŠČEK, T. TOLAR, B. KROMER 2009, Dendrokronološke raziskave na koliščarskih naselbinah Stare gmajne in Blatna Brezovica / Dendrochronological research at the pile-dwelling settlements Stare gmajne and Blatna Brezovica. – V / In: Velušček (ur. / ed.) 2009, 177–196.

ČUFAR et al. 2010 = ČUFAR, K., B. KROMER, T. TOLAR, A. VELUŠČEK 2010, Dating of 4th millennium BC pile dwellings on Ljubljansko barje, Slovenia. – *Journal of Archaeological Science* 37, 2031–2039.

ČUFAR et al. 2015 = ČUFAR, K., W. TEGEL, M. MERELA, B. KROMER, A. VELUŠČEK 2015, Eneolithic pile dwellings south of the Alps precisely dated with tree-ring chronologies from the north. – *Dendrochronologia* 35, 91–98.

DESCHMANN, K. 1875, Die Pfahlbautenfunde auf dem Laibacher Moore. – *Verhandlungen der k. k. geologischen Reichsanhalt* 15, 275–284.

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

DESCHMANN, K. 1878, Über die vorjährigen Funde im Laibacher Pfahlbau. – *Mittheilungen der Anthropologischen Gesellschaft in Wien* 8, 1–20.

DROBNE, K. 1974a, Predhodno poročilo o živalskih ostankih s kolišča ob Maharskem prekopu pri Igu – raziskovanja leta 1970 (Vorläufige Mitteilung über im Jahre 1970 ausgegrabene Knochenreste aus dem Pfahlbau am Maharski-Kanal bei Ig im Laibacher Moor). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 3, 37–38.

DROBNE, K. 1974b, Predhodno poročilo o živalskih ostankih s kolišča ob Maharskem prekopu pri Igu, odkopanih v letu 1972 (Vorläufige Mitteilung über im Jahre 1972 ausgegrabene Knochenreste aus dem Pfahlbau am Maharski-Kanal bei Ig im Laibacher Moor). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 3, 73–75.

DROBNE, K. 1975, Živalski ostanki iz kolišča ob Maharskem prekopu iz let 1973 in 1974 (Tierreste aus dem Pfahlbau am Maharski-Kanal aus Grabungen 1973 und 1974). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 4, 135–141.

HAAS et al. 1998 = HAAS, J. N., I. RICHOZ, W. TINNER, L. WICK 1998, Synchronous Holocene climatic oscillations recorded on the Swiss Plateau and at timberline in the Alps. – *The Holocene* 8/3, 301–309.

HOSCH, S., S. JACOMET 2004, Ackerbau und Sammelwirtschaft. Ergebnisse der Untersuchung von Samen und Früchten. – V / In: S. Jacomet, J. Schibler, U. Leuzinger (ur. / eds.), *Die neolithische Seeufersiedlung Arbon Bleiche* 3. *Wirtschaft und Umwelt,* Archäologie im Thurgau 12, 112–157.

HOSCH, S., P. ZIBULSKI 2003, The influence of inconsistent wet-sieving procedures on the macroremains concentration in waterlogged sediments. – *Journal of Archaeological Science* 30, 849–857.

JACOMET, S. 2006a, *Bestimmung von Getreidefunden aus archäologischen Ausgrabungen. Identification of cereal remains from archaeological sites.* – Basel. [https://duw.unibas.ch/fileadmin/user_upload/duw/IPNA/PDF_s/PDF_s_in_use/Getreidebestimmung_D.pdf].

JACOMET, S. 2006b, Plant economy of the northern Alpine lake dwelling area – 3500-2400 cal B.C. – V / In: S. Karg, R. Baumeister, H. Schlichtherle, D. E. Robinson (ur. / eds.), *Economic and environmental changes during the 4th and 3rd Millennia B.C.* Proceedings of the 25th symposium of the AEA Sept. 2004 in Bad Buchau, Germany, Environmental Archaeology 11, 65–85.

JACOMET, S. 2007, Neolithic plant economies in the northern Alpine foreland (central Europe) from 5500–3500 BC cal. – V / In: S. Colledge, J. Conolly (ur. / eds.), *The* *origins and spread of domestic plants in southwest Asia and Europe,* 221–258, Walnut Creek.

JACOMET, S. 2009, Plant economies and village life in Neolithic lake dwellings at the time of the Alpine Iceman. – *Vegetation History and Archaeobotany* 18, 47–59.

JACOMET, S., C. BROMBACHER 2005, Reconstructing intra-site patterns in Neolithic lakeshore settlements: the state of archaeobotanical research and future prospects. – V / In: P. Della Casa, M. Trachsel (ur. / eds.), *WES'04 – Wetland Economies and Societies. Proceedings of the International Conference in Zürich, 10–13 March 2004,* Collectio Archaeologica 3, 69–94.

JERAJ, M. 2002, Archaeological evidence for early agriculture at Ljubljansko barje (Ljubljana moor), central Slovenia. – *Vegetation History and Archaeobotany* 11, 277–287.

JERAJ, M. 2004a, Paleobotanične raziskave na kolišču Hočevarica / Paleobotanical analyses of the Hočevarica pile dwelling. – V / In: Velušček (ur. / ed.) 2004, 56–64.

JERAJ, M. 2004b, *Archaeobotanical and palaeoecological reconstruction of the SW Ljubljana Moor (Ljubljansko barje), Slovenia*. – Neobjavljena doktorska disertacija / Unpublished PhD thesis, Fakulteta za znanosti o okolju, Univerza v Novi Gorici.

JERAJ, M., A. VELUŠČEK, S. JACOMET 2009, The diet of Eneolithic (Copper Age, Fourth mill. cal BC) pile dwellers and the early formation of the cultural landscape south of the Alps: a case study from Slovenia. – *Vegetation History and Archaeobotany* 18, 75–89.

JESSE, S. 1954, Poročilo o sondiranju v okolici Iga pri Ljubljani (Rapport sur les sondages à Ig près Ljubljana). – *Arheološki vestnik* 5/1, 95–111.

KENWARD, H. K., A. R. HALL, A. K. C. JONES 1980, A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged archaeological deposits. – *Science and Archaeology* 22, 3–15.

KOHLER-SCHNEIDER, M, A. CANNEPELE 2009, Late Neolithic agriculture in eastern Austria – archaeobotanical results from sites of the Baden and Jevišovice cultures (3600–2800 B.C.). – *Vegetation Histtory and Archaeobotany* 18, 61–74.

KOROŠEC, J. 1953, Nova kolišča na Ljubljanskem barju – poročilo (Neue Pfahlbauten von Ljubljansko barje (Laibacher Moor)). – *Arheološki vestnik* 4/2, 256–263.

KOROŠEC, J. 1954, Novi stratigrafski podatki kolišč na Ljubljanskem barju (Neue stratigraphische Pfahlbautenergebnisse am Laibacher Moor). – *Arheološki vestnik* 5/1, 5–21.

KOROŠEC, J. 1955, Oris predzgodovine Ljubljane (Precis de la Prehistorie de Ljubljana). – V / In: I. Rakovec (ur. / ed.), *Zgodovina Ljubljane* 1. *Geologija in arheologija* 2. *Arheologija,* 243–330, Ljubljana.

KREUZ, A., E. MARINOVA 2017, Archaeobotanical evidence of crop growing and diet within the areas of the Karanovo and the Linear Pottery Cultures: a quantitative and qualitative approach. – *Vegetation History and Archaeobotany* 26, 639–657.

MAGNY, M. 2004, Holocene climate variability as reflected by mid-European lake-level fluctuations and its probable impact on prehistoric human settlements. – *Quaternary International* 113, 65–79.

MAGNY et al. = MAGNY, M., U. LEUZINGER, S. BORTENSCHLAGER, J. N. HAAS 2006, Tripartite climate reversal in Central Europe 5600-5300 years ago. – *Quaternary research* 65, 3–19.

MAIER, U. 1996, Morphological studies of free-threshing wheat ears from a Neolithic site in southwest Germany, and the history of the naked wheats. – *Vegetation History and Archaeobotany* 5, 39–55.

MARTINČIČ et al. 1990 = MARTINČIČ, A., T. WRABER, N. JOGAN, V. RAVNIK, A. PODOBNIK, B. TURK, B. VREŠ 1990, *Mala flora Slovenije. Ključ za določanje praprotnic in semenk.* – Ljubljana.

MELIK, A 1946, *Ljubljansko mostiščarsko jezero in dediščina po njem.* – Dela 1. razreda SAZU 5.

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

MLEKUŽ et al. 2012 = MLEKUŽ, D., A. ŽIBRAT GAŠPARIČ, M. HORVAT, M. BUDJA 2012, Houses, pots and food: the pottery from Maharski prekop in context. – *Documenta Praehistorica* 39, 325–338.

OSTERC, V. 1975, Mineralna sestava in mikrostruktura keramike s kolišča ob Maharskem prekopu I (Mineralogie und Gefüge der Keramik aus dem Pfahlbau am Maharski-kanal auf dem Ljubljanaer Moor I). – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 4, 123–134.

PARZINGER, H. 1984, Die Stellung der Uferrandsiedlungen bei Ljubljana in äneolithischen und frühbronzezeitlichen Kultursystem der mittleren Donauländer (Mesto kolišč Ljubljanskega barja v eneolitiku in zgodnji bronasti dobi srednjega Podonavja). – *Arheološki vestnik* 35, 13–75.

PIERONI, A. 1999, Gathered Wild Food Plants in the Upper Valley of the Serchio River (Garfagnana), Central Italy. – *Economic Botany* 53, 327–341.

RAKOVEC, I. 1955, Geološka zgodovina Ljubljanskih tal (Geological history of the ground of Ljubljana and its surroundings). –V / In: I. Rakovec (ur. / ed.), *Zgodovina Ljubljane* 1. *Geologija in arheologija* 1. *Zemlja, geološka zgodovina Ljubljanskih tal*, 11–207, Ljubljana.

RAKOVEC, I. 1958, Bobri iz mostiščarske dobe na Ljubljanskem barju in iz drugih holocenskih najdišč v Sloveniji. – *Razprave 4. razreda SAZU* 4, 211–267.

SCHMID, W. 1910, Archäologischer Bericht aus Krain II. Der Pfahlbau von Notranje gorice am Laibacher Moor. – *Jahrbuch für Altertumskunde* 4, 90–110.

STRITAR, A. 1975, Pedološke raziskave kolišča ob Maharskem prekopu pri Igu – 1973. leta (Pedologische Forschungen vom Pfahlbau am Maharski-Kanal bei Ig im Jahre 1973). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 4, 142–144.

STUIVER, M., P. REIMER 1993, Extended ^{14}C database and revised CALIB 3.0 ^{14}C age calibration program. – *Radiocarbon* 35, 215–230.

ŠERCELJ, A. 1955, Še nekaj momentov k novim raziskovanjem na Ljubljanskem barju (Einige Momente betreffend die neuen Ausgrabungen am Moor von Ljubljana). – *Arheološki vestnik* 6/1, 141–145.

ŠERCELJ, A. 1974, Poročilo o ksilotomskih raziskavah kolišča ob Maharskem prekopu pri Igu - raziskovanja leta 1972 (Bericht über xylotomische untersuchung des Pfahlbaus am Maharski-Kanal, Ausgrabung 1972). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 3, 69–70.

ŠERCELJ, A. 1975, Analize makroskopskih in mikroskopskih rastlinskih ostankov s kolišča ob Maharskem prekopu, izkopavanja 1973. in 1974. leta (Die Analysen der pflanzlichen Makro- und Mikroreste vom Pfahlbau Maharski-Kanal, Grabung 1973 und 1974). – *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 4, 115–122.

ŠERCELJ, A. 1976, Palinološke in ksilotomske analize rastlinskih ostankov s kolišča v Notranjih Goricah (Die Palynologischen und Xylotomischen Analysen der Pflanzenreste von Pfahlbau Notranje Gorice – Untersuchungen im Jahre 1974). – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 5, 119–121.

ŠERCELJ, A., M. CULIBERG 1978, Ksilotomske analize lesa iz kolišča ob Maharskem prekopu – izkopavanja 1976 in 1977 (Xylotomische Analysen der Hölzer aus dem Pfahlbau am Maharski prekop – Ausgrabung 1976 und 1977). – *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji* 6, 103–107.

ŠERCELJ, A., M. CULIBERG 1980, Paleobotanične raziskave kolišča na Partih (Paläobotanische Untersuchungen des Pfahlbaus auf Parti – Ausgrabungen 1978). – *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 8, 83–88.

TOLAR, T. 2016, Arheobotanika. – V / In: M. Andrič, T. Tolar, B. Toškan, *Okoljska arheologija in paleoekologija.* – Ljubljana.

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

TOLAR et al. 2010 = TOLAR, T., S. JACOMET, A. VELUŠČEK, K. ČUFAR 2010, Recovery techniques for waterlogged archaeological sediments – a comparison of different treatment methods for samples from Neolithic lake shore settlements. – *Vegetation History and Archaeobotany* 19/1, 53–67.

TOLAR et al. 2011 = TOLAR, T., S. JACOMET, A. VELUŠČEK, K. ČUFAR 2011, Plant economy at a late Neolithic lake dwelling site in Slovenia at the time of the Alpine Iceman. – *Vegetation History and Archaeobotany* 20, 207–222.

TOŠKAN, B. 2012, Mali sesalci kot orodje za prepoznavanje paleookoljskega zapisa – vloga tafonomije ali drobni tisk, ki ga ne gre zanemariti (Small mammals as a tool to recognise the paleoenvironmental signature – the role of taphonomy or small print, which should not be overlooked). – V / In: M. Andrič (ur. / ed.), *Dolgoročne spremembe okolja* 1, Opera Instituti Archaeologici Sloveniae 25, 9–24.

TOŠKAN, B. 2013, Domače govedo v romaniziranem jugovzhodnoalpskem prostoru: arheozoološki pogled. – *Keria* 15/1, 35–72.

TOŠKAN, B., J. DIRJEC 2004, Hočevarica – analiza ostankov makrofavne / Hočevarica – an analysis of macrofauna remains. – V / In: Velušček (ur. / ed.) 2004, 76–132.

TOŠKAN, B., J. DIRJEC 2006, Veliki sesalci / Large mammals. – V / In: A. Gaspari (ur. / ed.), *Zalog pri Verdu. Tabor kamenodobnih lovcev na zahodnem robu Ljubljanskega barja / Zalog near Verd. Stone Age hunters' camp at the western edge of the Ljubljansko barje,* Opera Instituti Archaeologici Sloveniae 11, 165–188.

TURK, J. 2006, Ugotavljanje paleoekoloških sprememb na Ljubljanskem barju v holocenu na primeru sedimentov z Resnikovega prekopa (Determining the Palaeoecological Changes in the Ljubljansko Barje during the Holocene. Case Study: Sediments from Resnikov Prekop.) – V / In: Velušček (ur. / ed.) 2006, 93–98.

TURK, J., A. HORVAT 2009, Sedimentološka metoda ugotavljanja paleookoljskih razmer na Ljubljanskem barju, primer Starih gmajn / Sedimentological method for determination of palaeoenvironmental conditions at the Ljubljansko barje. Case study: Stare gmajne. – V / In: Velušček (ur. / ed.) 2009, 35–48.

VELUŠČEK, A. 1997, *Metodologija naselbinskih raziskovanj na barjanskih tleh* 2. – Neobjavljeno magistrsko delo / Unpublished Master thesis, Oddelek za arheologijo, Filozofska fakulteta Univerze v Ljubljani.

VELUŠČEK, A. 2001, *Srednja bakrena doba v osrednji Sloveniji.* – Neobjavljena doktorska disertacija / Unpublished PhD thesis, Oddelek za arheologijo, Filozofska fakulteta Univerze v Ljubljani.

VELUŠČEK, A. (ur. / ed.) 2004, *Hočevarica. Eneolitsko kolišče na Ljubljanskem barju / Hočevarica. An Eneolithic pile dwelling in the Ljubljansko barje.* – Opera Instituti Archaeologici Sloveniae 8.

VELUŠČEK, A. 2004, Interpretacija rezultatov absolutnega datiranja Hočevarice in absolutno datiranje horizonta keramike z brazdastim vrezom (HKBV) v Sloveniji / Interpretation of the results of absolute dating at Hočevarica and of the horizon of pottery with furrowed incisions (HKBV) in Slovenia). – V / In: Velušček (ur. / ed.) 2004, 290–295.

VELUŠČEK, A. (ur. / ed.) 2006, *Resnikov prekop, najstarejša koliščarska naselbina na Ljubljanskem barju / Resnikov prekop, the oldest Pile-Dwelling Settlement in the Ljubljansko barje.* – Opera Instituti Archaeologici Sloveniae 10.

VELUŠČEK, A. (ur. / ed.) 2009, *Koliščarska naselbina Stare gmajne in njen čas / Stare gmajne pile-dwelling settlement and its era.* – Opera Instituti Archaeologici Sloveniae 16.

VELUŠČEK, A. 2009a, Koliščarska naselbina Stare gmajne in njen čas / Stare gmajne pile-dwelling and its era. – V / In: Velušček (ur. / ed.) 2009, 11–34.

VELUŠČEK, A. 2009b, Ljubljansko barje, problemi razlage virov / The Ljubljansko barje, problems of interpretation. – *Arheološki vestnik* 60, 297–315.

VELUŠČEK, A. 2013, Datiranje arheološkega najdišča Maharski prekop na Ljubljanskem barju / Dating of the archaeological site Maharski prekop at the Ljubljansko barje. – *Arheološki vestnik* 64, 367–396.

VELUŠČEK, A., K. ČUFAR 2002, Dendrokronološke raziskave kolišč na Ljubljanskem barju - stanje 2001 (Dendrochronological investigation into the pile-dwelling settlements of the Ljubljana Marshes - the situation in 2001). – *Arheološki vestnik* 53, 59–67.

VELUŠČEK, A., K. ČUFAR 2003, Založnica pri Kamniku pod Krimom na Ljubljanskem barju – naselbina kulture Somogyvár-Vinkovci / Založnica near Kamnik pod Krimom on the Ljubljansko barje (Ljubljana moor) – a settlement of the Somogyvár-Vinkovci Culture. – *Arheološki vestnik* 54, 123–158.

VELUŠČEK, A., K. ČUFAR 2008, Novoopredeljeni najdišči keramike z brazdastim vrezom na Ljubljanskem barju / Newly determined sites with pottery with furrowed

incisions from the Ljubljansko barje. – *Arheološki vestnik* 59, 31–48.
VELUŠČEK, A., K. ČUFAR, T. LEVANIČ 2000, Parte-Iščica, arheološke in dendrokronološke raziskave / Parte-Iščica, archaeological and dendrochronological investigations). – *Arheološki vestnik* 51, 83–107.
VELUŠČEK et al. 2004 = VELUŠČEK, A., K. ČUFAR, M. CULIBERG, B. TOŠKAN, J. DIRJEC, V. MALEZ, F. JANŽEKOVIČ, M. GOVEDIČ 2004, Črešnja pri Bistri, novoodkrito kolišče na Ljubljanskem barju (Črešnja pri Bistri, a newly discovered pile-dwelling settlement in the Ljubljansko barje). – *Arheološki vestnik* 55, 39–54.
VELUŠČEK et al. 2018 = VELUŠČEK, A., B. PODPEČAN, T. TOLAR, B. TOŠKAN, J. TURK, M. MERELA, K. ČUFAR 2018, Črnelnik in Devce, novoodkriti najdišči iz bakrene dobe na Ljubljanskem barju / Črnelnik and Devce, Newly discovered Copper Age sites at Ljubljansko barje. – *Arheološki vestnik* 69, 9–68.
VUGA, D. 1977, Ig (Studenec). – *Varstvo spomenikov* 21, 165–166.
ZIBULSKI, P. 2004, Zweige und Knospen. – In / V: S. Jacomet, U. Leuzinger, J. Schibler (ur. / eds.), *Die neolithische Seeufersiedlung Arbon Bleiche* 3. *Wirtschaft und Umwelt,* Archäologie im Thurgau 12, 313–326.
ZOHARY, D., M. HOPF 2000[3], *Domestication of plants in the Old World.* – Oxford.

Comparison of different sampling and treatment methods in order to reconstruct plant economies at the Eneolithic pile-dwellings of Strojanova voda and Maharski prekop at Ljubljansko barje

Translation

INTRODUCTION

Already in 1875, Karl Deschmann, who excavated the first pile-dwellings in Slovenia, discovered that wet and clayey soil of Ljubljansko barje is rich in (archaeo)biological remains. In addition to pottery, he discovered animal bones and vertical piles, which he decided to study more closely. In 1875 he already published the first archaeobotanical data. Two types of wooden piles were recognized, i.e. older poplar piles with a circular cross-section and younger split oak piles. In addition to wood, he mentions also the remains of seeds such as hazelnuts, cornelian cherries and water chestnuts (Deschmann 1875; 1876; 1878). Later, in 1907 and 1908, Walter Schmid undertook research at a newly discovered pile-dwelling at Notranje Gorice. In addition to numerous archaeological finds, he determined also oak, poplar and alder piles (Schmid 1910). An important milestone for the application of natural sciences in Slovene archaeology is 1953, when the archaeologist Josip Korošec began his research at Ljubljansko barje. He invited researchers from other disciplines to engage in the investigation of pile-dwellings at Blatna Brezovica and Založnica (Korošec 1953; 1954; 1955). Biologist (palynologist) Alojz Šercelj analysed palynological profile (Šercelj 1955) and carried out xylotomic analyses with the specifications of types of wood used (Šercelj 1955), while geologist and palaeontologist Ivan Rakovec studied bone remains (e.g. Rakovec 1955; 1958). In 1970, a new era of extensive archaeological excavations began at Ljubljansko barje under the leadership of Tatjana Bregant. During this period, the first important information on the internal organization of a prehistoric pile-dwelling was obtained. The pile-dwelling referred to as Maharski prekop was studied in 1970 (Bregant 1974a), 1972–1974 (Bregant 1974b; 1975; 1976) and 1976–1977, on a total area of 1208 m^2 (Bregant 1996). In addition to the large excavation area, this research is of great importance also because extensive natural science research was carried out along with archaeological investigations (cf. Drobne 1974a; 1974b; 1975; Osterc 1975; Stritar 1975; Šercelj 1974; 1975; 1976; Culiberg, Šercelj 1978; 1980; Šercelj, Culiberg 1978; 1980). Archaeobotanical research of Ljubljansko barje pile-dwellings received renewed impetus in 1995 when the Institute of Archaeology (Inštitut za arheologijo – IzA ZRC SAZU, Ljubljana) in cooperation with the dendrochronological laboratory of the Department of Wood Science and Technology at the Biotechnical Faculty University of Ljubljana (Oddelek za lesarstvo Biotehniške fakultete Univerze v Ljubljani), made an important step forward. At that time, the first-ever dendrochronological investigations of archaeological sites in Slovenia started. At well-preserved waterlogged sites of Založnica (Čufar, Levanič, Velušček 1997; Velušček, Čufar 2003), Hočevarica, Spodnje mostišče 1 and 2 (Čufar, Levanič, Velušček 1998), Stare gmajne and Črešnja pri Bistri (Velušček et al. 2004) wood was sampled from drainage ditches. To acquire more archaeological wood for dendrochronological investigations, the already excavated areas of Parte (Čufar, Levanič, Velušček 1997; Velušček, Čufar, Levanič 2000), Blatna Brezovica and Maharski prekop were re-excavated (see Velušček, Čufar 2002; Čufar et al. 2009; 2010; 2015; Čufar, Velušček, Kromer 2013; Velušček 2013). By following the European model, sediments from the entire cultural layer were wet-sieved (cf. Velušček [ed.] 2004; 2006; 2009) and all archaeological material was systematically collected, i.e. pottery fragments as well as biological (plant and animal) macroremains. After more than 10 years of successful archaeobotanical research at Ljubljansko barje pile-dwellings (e.g. Velušček [ed.] 2004; 2006; 2009), the methodology of sampling and treatment of waterlogged samples was further elaborated to the extent that today's results of natural sciences (e.g. palynology, archaeobotany, archaeozoology) can be compared with the results of foreign similar studies (e.g. Toškan, Dirjec 2004; 2006; Andrič et al. 2008; 2009; 2010; Tolar et al. 2010; 2011; Toškan 2012; 2013; Tolar, Jacomet, Velušček 2016).

This article presents the results of the latest investigations of plant macroremains from two Eneolithic pile-dwellings located at the south-eastern part of Ljubljansko barje (i.e. Strojanova voda and Maharski prekop sites). The main aim of the presented research is to establish whether the investigations provide different possible interpretations of the economy (nutrition habits) and vegetation history in the vicinity of the researched settlements, as well as of the duration of the settling in the researched area, depending on the methodology used (i.e. sampling methods and sample treatment methods in the laboratory). In addition, the research clearly shows that not only proper examining of waterlogged organic samples (Tolar et al. 2010), but also proper field sampling methods (i.e. at greater depths) significantly contribute to the archaeological interpretation of the researched area, especially regarding the duration of the settlement period.

PREVIOUS RESEARCH OF STROJANOVA VODA AND MAHARSKI PREKOP SITES

Strojanova voda

The settlement, located along the drainage ditch of the same name at the south-eastern part of Ljubljansko barje, was discovered in 1875 by K. Deschmann (Deschmann 1876). Later, in 1953, it was also found by sample trenching carried out by researchers of the Section for Archaeology (Sekcija za arheologijo, SAZU, Ljubljana) (Jesse 1954). Later, finds at Strojanova voda were discovered also by Davorin Vuga (1977), Anton Velušček (1997) and Andrej Knific (Velušček, Čufar 2008). By 2008, more than 70 pottery fragments were obtained (Velušček, Čufar 2008, 45, Fig. 6). Finds from Strojanova voda indicate a similarity with the finds from Hočevarica and Gornje mostišče pile-dwellings, meaning that they can be dated to the *horizon of pottery with furrowed incisions*, and hence to the period of the second quarter of the 4th millennium BC (Velušček 2004; Velušček, Čufar 2008; Čufar et al. 2015).

In 2012, during deepening and cleaning of the Strojanova voda ditch, archaeological surveillance was carried out. Documentation and sampling were conducted under the leadership of A. Velušček from the Institute of Archaeology (IzA ZRC SAZU). The main purpose was sampling of vertical piles for dendrochronological investigation, and at the same time all archaeological finds (e.g. pottery fragments, fragments of quern and animal bones) that came out during deepening were collected. Dendrochronological research enabled absolute dating of construction activities at Strojanova voda, with the youngest tree ring dated to 3586 BC[1] (Čufar et al. 2015).

Maharski prekop

In the immediate vicinity (approximately 200 m to the south-west) of Strojanova voda, a slightly younger Maharski prekop pile-dwelling is located. It was discovered in 1953 by the Section for Archaeology (Sekcija za arheologijo, SAZU, Ljubljana) (Jesse 1954). However, more extensive archaeological research of Maharski prekop was carried out, with occasional interruptions, between 1970 and 1977 (Bregant 1996; Velušček 2001). Later, the

[1] This is the indicative year of the last tree felled, the remains of which were included in the research and could also be synchronized (Čufar, pers. communication).

same location was researched by Hermann Parzinger (1984), A. Velušček (Velušček 2001; 2013; Velušček, Čufar 2008), Dimitrij Mlekuž (Mlekuž, Budja, Ogrinc 2006; Mlekuž et al. 2012) and others. Velušček (2009a, 28) assigned the Maharski prekop pottery to a special group of pottery called *Stare gmajne cultural group*, dated to the second half of the 4th millennium BC. During the excavations by T. Bregant, also some paleobotanical analyses were carried out, mostly xylotomic analyses, i.e. identification of wood species (Šercelj 1974; 1975; Šercelj, Culiberg 1978). In addition to vertical piles, Šercelj also mentions decorative items such as bone and stone berries, a wooden handle, blade, paddle, basket-like knitted item and boards. He identified two different dimensions of piles, i.e. foundation piles with a larger diameter that were mostly made of oak and piles with a smaller diameter, mostly made of alder, which served as a breakwater or protective fence next to the settlement. He found out that in the central part of the pile-dwelling, where increased load capacity was needed, more resistant wood species were used (oak, ash, rowan), while in the outer parts of the pile-dwelling, where such a high load capacity was not required, less resistant species predominated (alder, hazel, willow, maple, hawthorn) (Bregant[2] 1974b, 67; 1975, 107; Šercelj, Culiberg 1978). Although cereal macroremains were not discovered, agricultural activities are proved by fragments of quern and cereal pollen in the cultural layer. As far as gathering economy is concerned, the remains of wild strawberries (*Fragaria*), raspberries (*Rubus*), black nightshade (*Solanum*), and hazel (*Corylus*) were discovered. Pollen analysis of the cultural layer showed vegetation typical of open landscape, pastures and swamp margins (or lakeshore). Šercelj notes that species that are well-represented in the pollen records are not equally well-represented among plant macroremains (such as: wood, seeds, fruits) from the cultural layer. He explains this with the deliberate choice, selection and bringing of wild-grown plants into the settlement, even though these species are not frequent in the nearest vicinity of the pile-dwellings. In addition, a modest representation of beech (*Fagus sylvatica*) among the remains of vertical foundation piles, which was already quite widespread in nature, proves this phenomenon (all after Šercelj 1975). At that time, radiometric dating of plant macroremains was also performed to determine the absolute age of the pile-dwelling. Median values range from 3872 to 2991 cal BC (Bregant 1975). A pedological analysis of soil from the cultural layer was also performed, which showed, inter alia, that the cultural layer was between 40 and 60 cm thick (increased presence of phosphorus in the soil, which is supposed to reflect the concentrated presence of bone remains and faeces; according to Šercelj 1975).

In 2005, a team of researchers from the Institute of Archaeology (IzA ZRC SAZU) performed re-excavation to acquire wood samples from vertical piles for dendrochronological investigations. Four trenches were re-excavated that covered a large extent of the area that had been excavated by T. Bregant (Velušček, Čufar 2008). Results of dendrochronological investigation show that the settlement existed for less than a century and that it was settled in the period after Hočevarica (and therefore after Strojanova voda) and prior to the settlement of adjacent (ca. 170 m to the west) Spodnje mostišče pile-dwelling (Velušček, Čufar 2002; 2008; Čufar et al. 2015, Fig. 3). According to the latest findings, the last (i.e. the youngest)[3] tree ring of the dendrochronologically investigated piles at the Maharski prekop pile-dwelling is dated to 3489 BC (Čufar et al. 2010; 2015; Čufar, Velušček, Kromer 2013). At approximately same period, the area of Maharski prekop was investigated also by a group of researchers from the Department of Archaeology of the Faculty of Arts of the University of Ljubljana (Oddelek za arheologijo, Filozofska fakulteta Univerze v Ljubljani) under the leadership of Mihael Budja. Field research was directed into LIDAR recording, drilling of boreholes and radiocarbon dating, with the intention of explaining the development of the Holocene landscape and human activity. Mlekuž and his colleagues (Mlekuž, Budja, Ogrinc 2006; Mlekuž et al. 2012) note, like already T. Bregant (1975) before them, that the area of Maharski prekop was affected by complex events, strongly dependent on the flood activity of the Iščica river. They also assume that the area was settled several times, even in the period before the dendrochronologically determined settlement phase by Čufar and colleagues in 2010 (Mlekuž, Budja, Ogrinc 2006; see also Andrič 2009; Velušček 2009b; 2013), although no pottery has been discovered in this area so far

[2] T. Bregant summarizes after: Šercelj (1974; 1975).

[3] The youngest tree ring corresponds to the year of the felling of the last tree, the remains of which were included in the research. It should be noted that the research does not cover all felled trees used for the construction or renovation of the pile-dwelling, and those covered, are not all synchronized, i.e. taken into account.

that would date the settlement to around 4400–4000 BC (Bregant 1974a; 1974b; 1975; Velušček, Čufar 2008; Velušček 2009b; 2013). However, the pottery dates the settlement to the period after 3500 BC, which corresponds to the dendrochronological results (Čufar et al. 2010; 2015).

MATERIAL AND METHODS

Strojanova voda

Within the framework of archaeological surveillance in 2012, two stratigraphic columns of sediment samples for archaeobotanical investigation were also collected from the profile of the cleaned and deepened trench (Profile 1 and Profile 2). The profiles were located approximately 50 m apart in the southeastern direction and measured 130 cm in height. Profile 1 was completely waterlogged, organic and well preserved, whereas the upper part of the Profile 2, which was degraded and started to decay, was most likely burnt and therefore contained less preserved organic remains. Both profiles were archaeobotanically analysed (report is available at the Archive of IzA ZRC SAZU). Since Profile 2 showed signs of considerable degradation, especially in the presumed archaeological cultural layer, only Profile 1 was included in the presented research. One of the two main subjects of this article is archaeobotanical analysis of a 130 cm long sedimentary column collected from Profile 1 at a depth of 288.09–289.39 m a.s.l. (*Fig. 1*). The stratigraphic column was sampled using three-edged boxes of 7×7×50 cm (*Fig. 1b*).

The 130 cm long sedimentary column collected from Profile 1 was precisely described and examined in the laboratory. Based on the morphological characteristics, it was divided into 12 sequences (*Fig. 1c*), numbered sequentially from the highest (the latest, Seq. 1) to the deepest (the earliest, Seq. 12). Boundaries between them were subjectively determined on the basis of sedimentary structure and colour. Sequences 6–3/1SV was visually determined as a cultural layer (in total 35 cm high, *Fig. 1c*).

Standard methods for treatment and preparation of waterlogged sediment samples from wetland archaeological sites were used (e.g. Kenward, Hall, Jones 1980; Hosch, Zibulski 2003). The volume of sediment samples before and after wet-sieving was measured for each sequence separately. Thus, in the end, the results were converted into concentrations of plant macroremains per litre of sediment sample. Samples (in total 8.25 litres of sediment) were gently wet-sieved through two sieves with standard sieve mesh sizes: 2 and 0.355 mm. The fractions, caught on the sieves, were stored in a cool liquid and examined under a Leica stereomicroscope at 6.3× up to 50× magnification. Fragments and whole fruits, seeds, grains, cereal chaff, apple and acorn pericarps, needles and spores from the *Characaceae* algae family were sorted out, counted and identified. The quantity (absolute number) of identified plant macroremains was calculated to a concentration per 1 litre of sediment. Identification was based on standard literature, i.e. identification keys for plant macroremains (e.g. Berggren 1969; 1981; Anderberg 1994; Cappers, Bekker, Jans 2006; Jacomet 2006a) and reference collection of seeds, fruits, wood and charcoal at the IzA ZRC SAZU. Identification of plant species followed Zohary, Hopf (2000) for cultivated plants, and Binz, Heitz (1990) for gathered and wild plants, supplemented by *Mala flora Slovenije* (Martinčič et al. 1990).

Maharski prekop

In 2005, in addition to sampling of wood for dendrochronological investigation (cf. Velušček, Čufar 2008, 47), two small 1 m^2 and 150 cm deep archaeological trenches were excavated in the north-western part of the presumed location of Maharski prekop pile-dwelling area. At a depth of 288.95–289.30 m a.s.l. the sediment from the cultural layer was sampled for archaeobiological (including botanical) analyses (*Fig. 2*).

From the western profile of the excavated archaeological Trench 2/b, a 160 cm long sedimentary column for palynological and sedimentological research was also collected[4] (*Fig. 2*).

Surface sampled sediment samples for archaeobiological research were taken stratigraphically from the presumed cultural layer from both excavated trenches. They were collected systematically layer by layer, from the latest D1 to the earliest D6 depth (*Fig. 2*). Since the palynological profile column was collected and analysed from Trench 2/b (see Fn. 4), this article deals only with archaeobotanical analysis of remains from the archaeologically documented cultural layer (D6–D1; *Fig. 2*) of the Trench 2/b.

Unlike archaeobotanical research at Strojanova voda, different methodologies were used at Maharski prekop (i.e. field sampling and laboratory treatment

[4] M. Andrič, *Stare gmajne settlement and the vegetation of Ljubljansko barje in the 4th mill. BC* (in preparation).

methods (i.e. sieving, preserving in wet condition), and consequently identification and counting.

At Maharski prekop, in total approx. 360 litres of sediment from a 35 cm long sequence of cultural layer was collected and wet-sieved from Trench 2/b. Approx. 60 litres of sediment from each depth were wet-sieved over two sieves with 3 and 1 mm mesh sizes. After wet-sieving, organic fractions caught on the sieves were air-dried for the reason of faciliting examination (sorting) and storage.[5] All identified plant macroremains (seeds, fruits, grains, pericarp fragments, chaff), which were caught on the large sieve (3 mm) and which underwent air-drying were sorted out and counted. Remains caught on the small sieve (1 mm) – only those that underwent air-drying, i.e. carbonized or with a hard, lignified seed shell – were sub-sampled due to their abundance. The results (quantity or absolute number of identified macroremains) are presented in absolute numbers of seeds/fruits/chaff and not in concentrations per litre of sediment. Calculation of concentrations was not possible because the volumes of samples (both, sediment samples and the organic fractions caught on sieves, thus examined sub-samples) were not measured. The approximate volume of sediment samples (i.e. about 360 litres or approximately 60 litres from each of the six depths) was estimated only after excavations, based on the number and size of the buckets used when excavating (i.e. surface sampling of the cultural layer) and wet sieving.

RESULTS

Strojanova voda

The vast majority of plant macroremains from Strojanova voda (Profile 1) are preserved in uncarbonized waterlogged state. The 61 different plant taxa and a relatively high concentration of macroremains were identified (according to Hosch, Zibulski 2003; Jacomet, Brombacher 2005), varying between Sequences (12–1/1SV; see *Fig. 1*). The highest concentration of plant remains was determined in Sequences 7–4/1SV (i.e. at a depth of 288.73–289.04 m a.s.l.) (*Figs. 3; 4; 7*), which does not fully match with the initial visual determination of the archaeological cultural layer (i.e. Sequences 6–3/1SV; see above and *Fig. 1c*). On average, 6.448 plant macroremains were identified per 1 litre of sediment, which indicates good preservation and archaeobotanically rich sediment (e.g. Hosch, Jacomet 2004; Tolar et al. 2011).

Cultivated plants and weeds

Among cereals, the remains of emmer wheat and naked barley predominate; while the concentration of einkorn wheat remains is significantly lower (*Fig. 3a*). The remains of cereals mainly include well-preserved uncarbonized waterlogged chaff, such as rachis fragments and glumes (for explanation see Tolar 2016, 51). Carbonized cereal grains are scarce.

Among oilseeds, the highest concentrations of preserved macroremains include poppy and turnip (for the use and possible cultivation of this plant, see Tolar 2016, 170). Flax was also determined (*Fig. 3a*).

The presence of macroremains of six cultivated plants (*Fig. 3b*) as well as eleven weed/ruderal plant taxa (*Fig. 3c*) – the more important: *Chenopodium album* (white goosefoot), *Agrostemma githago* (corn cockle), *Veronica hederifolia* (ivy-leaved speedwell), *Silene* sp. (campion), *Stellaria media* (chickweed), *Urtica dioica* (common nettle), *Fallopia convolvulus* (wild buckwheat), *Polygonum aviculare* (common knotgrass), *Stachys* sp. (hedgenettle) – show the greatest human impact in Sequences 7–4/1SV, representing 31 cm of sediment column. The remains of these anthropogenic indicators are, although at lower concentrations, present from the Sequence 11/1SV (with a small increase in sequence 10) to Sequence 3/1SV (*Fig. 3*), which is in total in 94 cm of sediment column (see *Fig. 1*).

Gathered plants

The 20 presumably gathered plant taxa were identified. The highest concentrations of remains identified include danewort, wild strawberries, blackberries, bladder cherries, apples/pears and cornelian cherries/red dogwoods. In addition, numerous shell fragments of seeds/fruits belonging to taxa with calorific fruits, such as acorn, hazelnut and water chestnut were identified, but the remains of juicy fruits predominate (*Fig. 4*). All the remains of presumably gathered plants are preserved in uncarbonized waterlogged state.

Vertical distribution of gathered plant remains in the stratigraphic column from Strojanova voda shows most intensive human activity, similar to that shown by cultivated plants and weeds/ruderals,

[5] For a critical assessment of the methods used in 2005, see Tolar et al. 2010.

in Sequences 7–4/1SV. Remains of gathered plant taxa, although at lower concentrations, are present in all sequences from the deepest Sequence 12/1SV (see *Fig. 4a*).

Among the most interesting discoveries are numerous fragments of red dogwood fruits/seeds (*Cornus sanguinea*), which is an inedible plant (*Fig. 5a*), but was obviously used, which is proven by the numerous crushed kernels of otherwise very crush-resistant seeds/fruits (*Figs. 5b,c*). Possible uses of crushed red dogwood seeds/fruits at Strojanova voda include the production of juice, oil or even colour. More information about the results of the experiment will be published in a special article.[6] The results shown in *Fig. 4* only include red dogwood seeds/fruits in a non-fragmented state, i.e. whole seeds/fruits. Approximate concentrations of crushed (i.e. fragmented) remains of red dogwood are presented in *Fig. 5d*.

Radiocarbon dating of cultivated and gathered plant macroremains

A few fragmented red dogwood seeds (*Cornus sanguinea*) and cereal chaff (*Hordeum vulgare, Triticum mono/dicoccum*) from Sequences 10, 7 and 4/1SV were radiocarbon dated. The results are presented in *Fig. 6*.

Red dogwood remains from both Sequences (7 and 4/1SV) were dated to the same age, i.e. 4005 and 4008 cal BC (median values; *Fig. 6*), although samples were colected at different depths; i.e. at a depth difference of approx. 31 cm (see *Fig. 1c*). The estimated age of cereal macroremains from different depths does not show such uniformity, nor does it imply a vertical age succession. Considering all six calibration curves (*Fig. 6b*), at least two periods are clearly visible: 4225–3948 cal BC (2-sigma range for three dates: Poz-81369 [Seq. 10/1SV], -57455 [Seq. 7/1SV], -81360 [Seq. 4/1SV]) and 3971–3667 cal BC (2-sigma range for two dates: Poz-55525 [Seq. 10/1SV], -55524 [Seq. 4/1SV]).

Environmental conditions at the time of the Strojanova voda settlement

In addition to the remains of cultivated and gathered plants and weeds or ruderals, which are all strongly linked to human activity, remains of other wild plant species were discovered too, a total of 24 taxa. Since they are presumably not edible or not usable, they were probably not cultivated or gathered neither deliberately brought into the settlement. Therefore, they are considered to indicate wild vegetation, which grew in the immediate vicinity of the pile-dwelling. Remains of lakeshore (or wetland) (11 taxa) and water plants (8 taxa) are predominant among them, while remains of meadow taxa are scarce (4–5 taxa) (*Fig. 7*). All the remains of "wild" plant taxa are preserved in waterlogged, uncarbonized state.

The most frequent lakeshore or wetland taxa are, inter alia: *Alisma plantago aquatica* (common water-plantain), Cyperaceae (sedges), *Epilobium hirsutum* (great willowherb), *Mentha aquatica* (water mint). The highest concentrations of their remains (especially common water-plantain) are recorded in Sequences 7–5 (4)/1SV, which coincide with the distribution of the anthropogenic plant macroremains (cf. *Figs. 3; 4*).

Not taking into account remains of water chestnut (*Trapa natans*), which was probably one of the gathered plant species, the most frequent remains among water plant taxa include: Characeae (aquatic green algae from the genus *Chara*), *Oenanthe aquatica* (water dropwort), *Ranunculus aquatilis* (water crowfoot), *Potamogeton* sp. (pondweed). In contrast to the lakeshore/wetland plant taxa, concentration of preserved macroremains of water taxa is relatively constant throughout the entire stratigraphic column, a slight decrease is observed only in the lower and upper parts of the column (*Fig. 7b*). Concentrations of the remains of lakeshore/wetland taxa in Sequences 8–3/1SV are much higher than concentrations of the remains of water plant taxa, especially due to remains of common water-plantain, which is a common plant thriving in sunny or semi-shaded open sites and humid soil or in shallow waters. According to archaeobotanical results, especially anthropogenic remains, the Sequences 7–4/1SV are considered to show the period of the most intensive human activity at the site (cf. *Figs. 3; 4*). Remains of wild plants thus show that the settlement was located in the immediate vicinity of water, in humid and most likely flood areas.

Grassland plants are represented by only 4 to 5 taxa and the concentrations of their macroremains are by far the lowest (*Fig. 7*). This result confirms the fact that there were no meadows characteristics of the present-day landscape of Ljubljansko barje

[6] T. Tolar, *Selective use of* Cornus sanguinea *L. (red dogwood) berries in Late Neolithic* (in preparation).

in the surrounding areas of the Eneolithic pile-settlements (Tolar et al. 2011).

Maharski prekop

Due to the already presented inappropriate treatment methodology used for waterlogged samples from wetland sites in 2005, only lignified and carbonized plant macroremains have been preserved at Maharski prekop. Since there is no data on the volume of organic fractions, that were caught on sieves and analysed, it is not possible to calculate the concentrations of individual types of seeds/fruits that could be compared between the sites. However, compared to archaeobotanical research of Strojanova voda, much more sediment from the cultural layer was sampled and examined at Maharski prekop (Trench 2/b), since systematic surface sampling was performed and the entire presumed cultural layer was wet-sieved and researched. In total, 72 plant taxa were identified and on average 8.727 plant macroremains were collected and identified from each depth (*Fig. 8*).

The number of preserved plant macroremains is obviously increasing by depth, especially in the depths D5 and D6 (*Fig. 8*). Archaeobotanically the richest layer (D6) is located in the lowest, i.e. the deepest excavated layer of the determined cultural layer. Therefore, the question arises whether there could still be some preserved remains left below the layer mentioned, that were, unfortunately, not sampled.

Cultivated plants and weeds

At least four taxa of cultivated plants were identified, among which barley remains prevail. The absolute number of remains of other taxa, i.e. einkorn, emmer and peas, is significantly lower (*Fig. 9*). Among the cereal remains, mostly carbonized grains and rachis fragments of barley were preserved, which is most probably why barley remains are numerically predominant at this location. Remains of glume bases and rachis of both wheat species (*Triticum* sp.) were found or identified in small numbers and only in the carbonized state, which again raises doubts about the actual representativeness of the results and their comparability with the results from the nearby sites of Strojanova voda (cf. *Fig. 3*) and/or e.g. Stare gmajne (Tolar et al., 2011), where also uncarbonized remains of cereal chaff were identified and counted. Seeds/fruits of turnip were also identified, which could be the fifth taxon of cultivated plants (see Tolar 2016, 170).

Remains of other oil-rich seeds/fruits, e.g. poppy and flax (Jacomet 2009; Kohler-Schneider, Cannepele 2009; Pieroni 1999; Tolar et al. 2011) that were commonly found at other contemporaneous settlements, were not preserved at Maharski prekop, most likely due to inappropriate sample treatment methods used. However, more pea seeds (*Fig. 9*) were discovered at Maharski prekop compared to other settlements, since pea seeds are rarely preserved in waterlogged environment or are preserved in small numbers, due to unknown tafonomic reasons, and are always preserved in a carbonized state (Jacomet 2006b; 2009; Tolar et al. 2011). Most likely, there was a slightly higher number of carbonized pea seeds found at Maharski prekop than are usually discovered at pile-dwelling areas in Slovenia and elsewhere in Europe (e.g. Tolar et al. 2011; Kreuz, Marinova 2017) due to a large quantity (about 360 litres) of wet-sieved and investigated sediment samples from the cultural layer.

Anthropogenic taxa (cultivated and weeds or ruderals) remains are found in all six depths of Maharski prekop (Trench 2/b), which were archaeologically defined as a single cultural layer. They are probably also preserved in deeper layers (i.e. below the sampled layers up to a depth of 288.95 m a.s.l.), which were unfortunately not sampled.

Figs. 8 and *9* show a decline of macroremains of cultivated plants and weeds/ruderals from the earliest D6 to the latest D1 layer or depth. Archaeobotanical results suggest that sediment from depths D6 and D5 (absolute altitude of 288.95–289.06 m a.s.l.) is archaeobotanically the richest, meaning that it was deposited during the period of the greatest human activities in the region.

Gathered plants

The 16 presumably gathered plant taxa were identified (*Figs. 8; 10*). The most numerous were remains (seeds/fruits) of raspberry/blackberry, bladder cherry, wild grapevine, black nightshade, acorn, cornel, hazelnut and danewort (*Fig. 10*).

Since gathered crops mostly included forest fruits and nuts, whose seeds are protected by a resistant and lignified inner wall of the pericarp (endocarp; see Tolar 2016, 56), macroremains of gathered plants, unlike the remains of cultivated plants from Maharski prekop, were mostly well preserved also in a non-carbonized and dried state and therefore representative and comparable with other sites.

Lignified, dry-resistant macroremains (seeds/fruits) of gathered plants show a completely different vertical distribution of macroremains (D6–D1) to the one shown by the remains of cultivated and ruderal taxa. At all depths, approximately the same number of gathered plant macroremains was found, for some taxa, even slightly more remains were found in the upper, latest layers (D2–D1) than in the deeper, earliest layers (D6) (*Fig. 10*), which is exactly the opposite as is the case of the remains of cultivated plants and weeds/ruderals (*Fig. 9*). The reason for this phenomenon can be explained by the methodology used in 2005 and, consequently, tafonomy of plant macroremains at Maharski prekop (see further explanation in *Discussion*).

Environmental conditions at the time of Maharski prekop pile-dwelling

In addition to cultivated and gathered plants, as well as weeds/ruderals, also other plant taxa were identified (see *Fig. 8:* rows 5–7), which do not have a nutritional or other value for humans and are therefore considered as wild or natural vegetation that grew in the immediate vicinity of the settlement. 27 presumably inedible plant taxa were grouped into 3 larger ecological groups, similar to the ones at Strojanova voda (see *Fig. 7*): lakeshore or wetland plants, water plants and grassland plants (*Fig. 11*).

Fig. 11 clearly shows that the absolute number of water and lakeshore/wetland taxa significantly exceeds the number of grassland taxa. The number of identified taxa from each ecological group of plants shows a similar result: 7 taxa (i.e. 26%) belong to grassland plants, 9 (33%) to water plants, and 11 to lakeshore or wetland plants (11%).

It is difficult to interpret vertical distribution of plant macroremains (from D6 to D1; *Fig. 11*) because non-standard treatment methods were used at Maharski prekop. Namely, taxa with more resistant seeds/fruits were mostly preserved and identified. Among water plant taxa, for example, only three species were mostly preserved: water dropwort (*Oenanthe aquatica*), small pondweed (*Potamogeton pusillus*) and common mare's tail (*Hippuris vulgaris*), which are all commonly found in standing and slow-flowing waters, including water ditches, whereas common mare's tail is also found in shallow waters, swamps and muddy flooded soils. Among wetland taxa, two types of seeds/fruits predominate: lakeshore bulrush (*Schoenoplectus lacustris*) and creeping buttercup (*Ranunculus repens*). While the first one thrives also along the banks of standing and slow-flowing waters, the second one is more commonly found in wet grasslands and along ditches. For conclusion, similar to Strojanova voda, Maharski prekop settlement was located near water, probably lakeshore and/or wetland which were occasionally flooded.

DISCUSSION

Interpretation and comparison of archaeobotanical results from two Eneolithic pile-dwellings located at the south-eastern part of Ljubljansko barje is difficult because different methods of work were used. Nevertheless, there are some interesting conclusions to be drawn. The pile-dwelling areas were researched several times and the latest research (i.e. in 2005 at Maharski prekop and in 2012 at Strojanova voda) also included systematic archaeobotanical analyses. Both sites were dendrochronologically and typologically dated. Strojanova voda was supposedly inhabited up to around 3586 cal BC (Čufar et al. 2015) and Maharski prekop up to around 3489 cal BC (Čufar et al. 2010; 2015). Their immediate surroundings were supposed to have been populated several times, as even more pile-dwellings from the 5th and 4th millennium BC were discovered in the area (e.g. Resnikov prekop, Gornje mostišče and Spodnje mostišče; cf. Čufar, Levanič, Velušček 1998; Čufar, Korenčič 2006; Velušček, Čufar 2008; Čufar et al. 2010; Čufar, Velušček, Kromer 2013), and also from the 3rd millennium BC (e.g. Parte-Iščica; cf. Velušček, Čufar, Levanič 2000; Velušček, Čufar 2002; Čufar, Velušček, Kromer 2013).

Table (*Fig. 12*) shows the main, mostly distinctive parameters of the compared researched sites. The main and most important differences are methodological, i.e. sampling methods and preparation of archaeobotanical samples. The absolute altitude of the sampling area is, interestingly, practically identical at both sites. However, special care should be taken with this parameter, since we know that the surface of today's Ljubljansko barje (i.e. marshes) has changed several times due to tectonic, water and human activities (cf. Melik 1946). T. Bregant (1974b, 67; 1975) also writes about altitude changes and the influence of water and water levels in the researched area. A great difference between the researched sites is that a 130 cm long sediment column was sampled at Strojanova voda and only

35 cm long cultural layer was sampled at Maharski prekop site. Row 10 in *Fig. 12* clearly shows at which depth the archaeobotanically richest layers were discovered at Strojanova voda (i.e. 288.73–289.04 m a.s.l). Presumably the richest layers at Maharski prekop, which is located only approx. 200 m from Strojanova voda site, interestingly end at almost the same depth (i.e. 289.06 m a.s.l.), but since sampling was obviously not deep enough, they do not include all (even earlier) archaeobotanical records below these layers and therefore do not include the beginning of the deposition of nutritious plant macroremains. Marjeta Jeraj and Maja Andrič came to a similar conclusion. At the Hočevarica site, for example, in the trench from 1998, remains of cultivated plants were preserved in a whole **60 cm** thick layer which was sampled (Jeraj 2004a, 58; Jeraj, Velušček, Jacomet 2009, Fig. 7). In a nearby palynological core cereal pollen was detected in a **150 cm** sediment sequence caught in a 500 cm long borehole (Jeraj 2002, Fig. 2; Jeraj 2004b, Fig. 4.8). Similarly, cereal pollen at Maharski prekop (Trench 2/b in 2005) was preserved in a **120 cm** thick layer caught in a 150 cm long profile column.[7] In addition to these two investigations, the third one now gives the same result. Preserved macroremains of cultivated plants were found in high concentrations in a **68 cm** long sequence of a 130 cm long stratigraphic column sampled at Strojanova voda and, although in lower concentrations, these remains were found even in a **118 cm** long sequence (i.e. between Sequences 12 to 2/1SV, see *Fig. 3*). These researches clearly show that, deeper sampling, as predicted by archaeological exploring, could recognize or detect possible impact of even earlier settlements at the same location and/or in the vicinity of the researched area. It can be concluded that not all the earliest archaeobotanically rich layers were sampled at Maharski prekop.

Another important difference between the researched sites is also the quantity of material sampled and analysed. At Strojanova voda, in total only 8.25 litres of sediment were sampled, while as much as approx. 360 litres of sediment were researched at Maharski prekop. Therefore, comparison of absolute numbers of seeds/fruits found is not appropriate, since such different volumes of sediment were researched (*Fig. 12:* rows 8 and 9). As far as Strojanova voda is concerned, we have information about the concentration of seeds/fruits per litre of sediment (*Figs. 3; 4; 7*), whereas absolute numbers of identified plant macroremains from Maharski prekop (*Figs. 8–10*) do not tell us much. The only possible comparison of archaeobotanical results from the two sites where such significantly divergent methodological approaches were used is the number and variety of identified plant taxa (*Fig. 12:* rows 12 and 13). We can compare taxa between the two sites (*Figs. 13; 14*) and, within individual sites, between Sequences (Strojanova voda) or depths (Maharski prekop) of the stratigraphic column (see *Results*).

The upper part of the table in *Fig. 13* shows the presence of remains of cultivated plant taxa and the lower part the remains of gathered plant taxa at both locations. Although a smaller amount of sediment was investigated at Strojanova voda, the majority of nutritionally important plant taxa were discovered. Samples from Maharski prekop, although significantly larger, did not include taxa with less resistant or fragile seeds/fruits (such as flax, poppy, mistletoe) and vegetative parts of plants that are assumed to have been brought into the settlement for winter bedding or feed, as well as for insulation purposes (e.g. fir, spruce, bracken, and mistletoe needles or leaves; cf. Zibulski 2004; Tolar et al. 2011). Since only lignified and carbonized plant macroremains were preserved, also vertical distribution (graphs) of macroremains of cultivated (*Fig. 9b*) and gathered plants (*Fig. 10b*) at Maharski prekop differ significantly. However, since much more sediment from the cultural layer was wet-sieved at Maharski prekop, eleven more taxa were discovered (see also *Fig. 14*), especially those that are less frequently detected (and probably also less commonly used) and which are carbonized or have a more resilient and lignified seed/fruit shell (e.g. peas, dog rose, black elder and some nutritionally insignificant taxa; see *Fig. 14*). Peas, for example, were not detected at Strojanova voda most likely due to tafonomic reasons (cf. Jacomet 2006b; Tolar 2016, 170) and smaller quantities of examined sediment (cf. Tolar et al. 2011, 218).

Since incomparable units were used (i.e. absolute numbers) and since the remains are not representative (i.e. prevalence of carbonized seeds/fruits and cereal chaff or lignified seeds/fruits) it is difficult to interpret the importance of certain plant taxa discovered at individual depths (D6–D1) at Maharski prekop (e.g. *Figs. 9–11*). It is therefore also impossible to assert with certainty the archaeobotanically richest depth at Maharski prekop. Regarding remains of presumably gathered plants, roughly the same number of lignified and mostly uncarbonized (excluding seeds/fruits of blackberries/raspberries

[7] M. Andrič (in preparation), see fn. 4.

that strongly deviate; cf. *Fig. 10*) seeds/fruits were found at all the six depths. Conversely, carbonized remains of cultivated plants (cf. *Fig. 9*) and non-carbonized, lignified remains of non-nutritious wild plant taxa show a different picture (cf. *Fig. 11*). Cultivated plants show that the lowest two depths D5 and D6 are the richest, which opens the question whether surface sampling at Maharski prekop was deep enough, at least as far as archaeobotanical finds are concerned. A similar situation can be seen in the case of uncarbonized and lignified remains of wild (natural) plant species (cf. *Fig. 11*). The abundance of remains of water and wetland plant taxa in depths D5 and D6 can be explained by the fact that more seeds/fruits were deposited in the area of the settlement and where houses were built, because plants got tangled around piles, and, in addition, had favourable ecological conditions (e.g. more phosphorus, nitrogen etc.) for growth. An increased number of remains of certain water and wetland plants can also be a consequence of human activities, for example, bringing reed and water chestnut into the settlement due to their usefulness.

If we look at the absolute altitude of the sampling areas at both sites (cf. *Fig. 12*), and, as already mentioned, with a reservation due to natural and anthropogenic factors that could affect the credibility of this data, it is very interesting to note (by accident or not?) that in both adjacent locations the remains of cultivated plants (which are the evidence of human activity) were preserved and deposited somewhere up to an altitude of 289.04 to 289.06 m a.s.l. While the evidence of the beginning of this kind of human impact at Strojanova voda can be found at approx. 94 cm greater depth, we can be certain that at Maharski prekop, considering the above-average richness of archaeobotanical remains in the deepest excavated Layer D6, the beginning of human impact should have been detected at levels deeper than the sampled 35 cm (cf. also Jeraj 2002; 2004b and Andrič[8]). Already Šercelj (1975) and Bregant (1975, 107) assumed, based on increased phosphorus content in the soil, that the cultural layer at Maharski prekop is between 40 and 60 cm thick, although on the basis of the presence of pottery it was supposed to be on average between 30 and 45 cm thick (Bregant 1975, 107). Therefore, the actual depth of the cultural layer (at least from the archaeobotanical point of view) at Maharski prekop site should be the subject of future research. It should be emphasized that due to improper handling of waterlogged organic samples in 2005, most of the uncarbonized cereal chaff and oil-rich flax and poppy remains were destroyed and therefore not identified, which implies that there should have been even more remains of cultivated crops preserved at Maharski prekop.

More reliable, although not as numerous, are the results from Strojanova voda (*Figs. 3; 4; 7*) which show with confidence the presence of cultivated and gathered plants in 94 cm (i.e. Seq. 11–3/1SV) of the stratigraphic column. Archaeobotanically the richest layer was a 31 cm long sedimentary sequence between 7–4/1SV (289.04–288.73 m a.s.l.). Remains of all major identified cultivated and gathered plant taxa were preserved in that layer in the highest concentrations. Compared to the spectrum and the proportion of plant macroremains from Stare gmajne (Tolar et al. 2011, 212) dated to approx. 3300 and 3100 cal BC (Čufar et al. 2009; 2010; 2015; Čufar, Velušček, Kromer 2013), where a proper archaeobotanical method was used, Strojanova voda gives a very similar result or set of archaeobotanical remains, especially as regards cultivated plants. Minor differences can be observed in gathered plant taxa, such as, for example, a greater importance of red dogwood and danewort at Strojanova voda. Vertical distribution of the apparently crushed red dogwood fruits (thousands of fragments per 1 litre of sediment; *Fig. 5*) coincides with the distribution of remains of other anthropogenic plant taxa (cultivated, gathered plants and weeds/ruderals; *Fig. 3*), which further confirms the very likely dedicated use of presumably inedible red dogwood during the settlement period. At Strojanova voda site, several remains of quern-stone were discovered (A. Velušček, pers. communication), which additionally confirms the activity of crushing seeds/grains.

Vertical distributions of plant taxa of cultivated plants, weeds/ruderals (*Fig. 3*) as well as gathered plants (*Fig. 4*) might indicate increased human activity (possibly up to three times) in a 68 cm sedimentary column at Strojanova voda (e.g. in Sequences 10, 7–6/1SV and 4–3/1SV). Such a vertical distribution of macroremains (*Figs. 3–5*) opened the question of a possible multi-phased settling of Strojanova voda site or, more likely, its vicinity. Theoretically, the oldest (earliest) remains from the Sequence 10/1SV, although lower concentrations were detected, could have been indirectly brought to the settlement (with wind, water, or were deposited during human activities outside the settlement) from some other, earlier pile-dwelling located in

[8] M. Andrič (in preparation), see Fn. 4.

the surrounding area.[9] The remains from Sequences 7–6/1SV could be attributed to Strojanova voda itself due to highest concentrations established. In a higher layer, a short interruption in the deposit of macroremains was detected, followed by a minor and the latest increase in the concentration of remains in Sequences 4–3/1SV, which could be the result of re-settlement of Strojanova voda or some later, possibly yet undiscovered pile-dwelling in the vicinity. Similar conclusions on the possible multi-phased settlement at Strojanova voda could also be drawn on the basis of dendrochronological results which show that some trees used for piles were fallen around 3700 cal BC. So they are earlier than most of the dendrochronological samples included in the research, which construction phase is believed to have been completed around 3600 cal BC (Čufar et al. 2015, Fig. 3).

Attempting to solve the question of multi-phased settlement, we decided to perform radiocarbon dating of 6 samples of macroremains of cultivated and gathered plants (*Fig. 6*) collected at different depths within archaeobotanically the richest 68 cm layer of the sediment column from Strojanova voda (i.e. from Sequences 10–4/1SV). Remains of red dogwood from Sequences 7 and 4/1SV were dated to approximately the same year, i.e. 4005 and 4008 cal BC (median), which can be explained by the fact that the sequences (in total 31 cm thick) were deposited at the same time meaning that the remains of red dogwood were deposited by the same settlers. This datation is also supported, with a high degree of precision, by the datation of cereal remains from Sequence 10/1SV (4008 cal BC, median), while the age of barley remains does not support this result with such a high precision. Dated barley remains from Sequences 10 and 4/1SV indicate a single yet slightly (about 100 years) later period than the one shown by the remains of red dogwood and cereals from the same sequences (i.e. 10 and 4/1SV; see *Fig. 6*). Median of both barley samples (from 10 and 4/1SV) are dated in around 3865 cal BC. Among the six dates, the earliest date stands out the most, i.e. the date of barley remains from Sequence 7/1SV (Poz-81363), the median value of which is 4196 cal BC. 2-sigma range of this date (4328–4054 cal BC) is partially overlapping with 2-sigma range of the median of 4008 cal BC (4225–3948 cal BC) obtained from the samples of crushed red dogwood remains (Poz-81360; *Fig. 6*). Therefore, we should not exclude the possibility of simultaneous origin, although the remains more likely originate from different periods.

Interestingly, the dates mentioned above do not show a vertical time distribution, meaning, for example, that barley remains from Sequence 7/1SV (Poz-81363) are dated as the earliest whereas the same remains from Sequence 10/1SV (Poz-55525) are dated as the latest. There are at least two explanations for this phenomenon:

1. Since the majority of dates obtained are very close in time and 2-sigma ranges sometimes overlap (*Fig. 6*), we could simply conclude that this is a single, simultaneous cultural layer of sediment, in which, due to human activity, water and natural factors, plant macroremains were sinking and formed at least a 68 cm deep layer of deposits.

2. The more likely explanation: it is well known that sedimentology and hydrology of the south-eastern part of Ljubljansko barje are extremely complicated and still not defined in some areas. Former water currents and the occurrence/disappearance of the lake, which is also partly visible on LIDAR record (e.g. Mlekuž et al. 2012), show that this area was hydrologically very active in the past (already Bregant 1975, and later also Turk 2006; Andrič 2006; 2009; Budja, Mlekuž 2008; Velušček 2009b), so it is also possible that the dated remains of cultivated and gathered plants might have been brought to the area where stratigraphic column was collected, for example, with water, wind, or in some other way, from one of the numerous neighbouring pile-dwellings in the vicinity (see Velušček, Čufar 2008; Velušček 2013).

Since dating was performed on 6 samples, all uncarbonized remains of cultivated and gathered terrestrial plant taxa, we assume that the dates are reliable. However, this is contradicted by the recent chronological definition of the site on the basis of the dendrochronology and pottery typology (Čufar et al. 2015). The latter was, however, determined on the basis of pottery, discovered accidentally, i.e. non-stratigraphically. Čufar et al. (2015) suggest at least 280 years later settlement of the main construction phase as predicted by the median values of our dates (i.e. two of the latest of the six dated plant macroremains). Although the values of absolute dates in dendrochronology and the median C14 values are not entirely comparable, we nevertheless attempted to interpret this statement. A precise topographical overview of the locations of dendrochronologically dated piles from Strojanova

[9] T. Bregant (1974b, 67) also speaks about possible contamination from the neighbouring pile-dwellings in the framework of research at the Maharski prekop site.

voda and the location of the archaeobotanically researched Profile 1, could suggest that most of the dendrochronologically dated piles actually originate from a younger (later) settlement phase, as shown by radiocarbon dates of the cultivated and gathered plant macroremains from Profile 1. The stratigraphic column, referred to as Profile 1, was collected at a slightly different location (more to the east) than the two major groups of piles that were dendrochronologically dated (pers. communication A. Velušček; K. Čufar; Archive of IzA ZRC SAZU). There are many undated piles even slightly more to the east of the Profile 1 and also in the central and western parts (Archive of IzA ZRC SAZU). All these unpublished data may support the hypothesis that this area could have been settled before 3586 cal BC,[10] which is also confirmed by the aforementioned two samples of piles made of trees that were fallen at around 3700 cal BC (Čufar et al. 2015, Fig. 3). It should be borne in mind that only about 10–20% of piles found at pile-dwellings are usually suitable for dendrochronological dating and that only piles that were preserved and discovered during excavations are included in the research (pers. communication K. Čufar; Čufar et al. 2015). In conclusion, many interdisciplinary investigations are still needed to define the settlement events along Strojanova voda site, with the assumption that wood from various construction phases has been preserved to date.

As far as plant macroremains of wild species are concerned, both investigations, i.e. of Strojanova voda and Maharski prekop, confirm that the settlements were located in a lakeshore or wetland area which was most likely occasionally flooded. The vertical abundance of uncarbonized macroremains of wild vegetation (mainly water and wetland taxa) at both sites roughly coincides with the vertical abundance of macroremains of cultivated and gathered taxa (cf. *Figs. 7* and *11*), which can be explained by favourable ecological conditions for the growth and reproduction of these plants in the immediate vicinity of the settlement. At the same time, vertical distribution of these remains gives us information about environmental changes, i.e. from more humid and watery to more wetland, lakeshore conditions and vice versa. Changes in hydrological conditions in the history of Ljubljansko barje were repeatedly proven also from the sedimentological point of view (e.g. Andrič 2009; Turk, Horvat 2009). In the 4th millennium BC, e.g. hydrological changes occurred all around the Alps (e.g. several phases of elevated lake water level and floods, probably in connection with climate change, 3650–3370 BC; e.g. Haas et al. 1998; Magny 2004; Magny et al. 2006; Velušček et al. 2018). In order to determine the possible effects of these changes on the environmental conditions and, consequently, the settlement image of Ljubljansko barje, more such and similar interdisciplinary research will be required.

CONCLUSION

The south-eastern part of Ljubljansko barje was settled several times. We tried to investigate and archaeobotanically compare two Eneolithic pile dwellings, Strojanova voda and Maharski prekop, which are located approx. 200 meters apart. Different methods of work used contributed to important, mostly methodological conclusions.

Stratigraphically sampled site of Strojanova voda gave us insights into the events in this area over a longer time-period. At the time of settling, at least a 68 cm long sedimentary column was deposited at the location of sampling. On the basis of cultivated and gathered plant macroremains it was radiocarbon dated to the period between 4225 and 3667 cal BC (2-sigma ranges of six dated samples). We managed to confirm the nutritional habits of pile-dwellers from the Eneolithic Stare gmajne site (Tolar et al. 2011). The cultivation of einkorn, emmer, barley, poppy, flax, and possibly also turnip was confirmed. In terms of quantity, crushed fragments of red dogwood seeds/fruits prevailed among the remains of presumably gathered plants at Strojanova voda, and the purpose of this plant is still being investigated.

Archaeobotanical analyses of the adjacent Maharski prekop, where a different sampling method was used (i.e. surface sampling), showed that most likely not the whole cultural layer was sampled (at least as far as the presence of plant remains is concerned), which should be taken into account in future sample trenching. The species variety of macroremains is similar to the one found at Strojanova voda site, with two important differences in the spectrum of cultivated plants: at Strojanova voda flax and poppy were discovered, whereas peas were identified at Maharski prekop. These differences are attributed to methodological and, consequently, to tafonomic factors. It can be concluded that the spectrum of cultivated and gathered plants at both sites is fairly typical for Eneolithic lakeshore communities in both

[10] The aforementioned dendrochronologically the latest tree ring at Strojanova voda is dated to 3586 BC (Čufar et al. 2015)

Slovenia and elsewhere around the Alps (e.g. Tolar et al. 2011). Similar to other Slovene pile-dwellings that have been researched so far, also this time we did not find any remaining tetraploid naked wheat (*Triticum durum/turgidum*), which supports the hypothesis that this type of wheat was most likely introduced from Central Europe, and not, as is the case with most cultivated plant species, from the south-eastern Europe through the Balkans (Maier 1996; Jacomet 2007; Tolar et al. 2011; Tolar, Jacomet, Velušček 2016; Kreuz, Marinova 2017).

The stratigraphic, i.e. profile sampling method for archaeobotanical research, which was used for the first time in the framework of this research in Slovenia, proved to be successful. Research of a 130 cm long sedimentary column from Strojanova voda, in contrast to 35 cm surface-sampled sediment from the cultural layer at Maharski prekop, showed the presence of remains of cultivated, gathered and weed/ruderal plants in at least 94 cm (individual finds were detected also in a 118 cm long column, see *Figs. 3; 4*) long column of sediment, which is consistent with palynological research of two other previously researched Eneolithic pile-dwellings at Ljubljansko barje (see Jeraj 2004b; Andrič[11]). We established that for archaeobotanical investigations, sedimentary samples from the deepest possible depth should be collected, which can give information about events at the site and its immediate surroundings over a long time-period.

Taking into account the dendrochronological dating of the Strojanova voda pile-dwelling, which is also supported by the typological analysis of pottery, and all six radiocarbon dates of macroremains of cultivated and gathered plants taken from a 68 cm thick archeobotanically rich ("cultural") layer, we can conclude that the area near Strojanova voda was settled several times and that it was settled even before the period, which is determined by the current dendrochronological and typological research (Čufar et al. 2015; A. Velušček, K. Čufar, pers. communication).

In the field (see Bregant 1975; Velušček 2009b), as well as on the LIDAR record (Mlekuž et al. 2012, Fig. 1), the exceptionally diversified past hydrological activities are clearly visible, which makes it difficult to make final interpretations of the events in this part of Ljubljansko barje. As it was already observed by T. Bregant, we assume that most likely waters before, during and/or after the settlement period(s) of the investigated area affected the distribution of the artefacts. Radiocarbon dating of cultural plant macroremains from Strojanova voda suggests possible displacement of the remains (*Fig. 6*). For example, T. Bregant (1974b, 67) suggests the possibility of pottery fragments being floated from Resnikov prekop pile-dwelling or from some other yet undiscovered pile-dwelling of approx. the same age, at Maharski prekop. The same was later also proved by interdisciplinary research of Resnikov prekop (Velušček [ed.] 2006). T. Bregant (1975, 107) also mentions the possibility that the area of Maharski prekop was populated several times, successively or even simultaneously. This could also be confirmed by archaeobotanical research of Strojanova voda.

The current archaeobotanical results contribute only a fraction to the mosaic of secrets recorded in the soil of Ljubljansko barje. In order to obtain concrete conclusions in this regard, in particular with regard to chronology of all pile-dwellings, their number, subsequent or simultaneous existence, additional sample trenching and interdisciplinary research in this part of Ljubljansko barje will be needed.

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[11] M. Andrič (in preparation), see fn. 4.

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