OPERA INSTITUTI ARCHAEOLOGICI SLOVENIAE

10

Zbirka / Series **OPERA INSTITUTI ARCHAEOLOGICI SLOVENIAE 10**
Uredniki zbirke / Editors of the series Jana Horvat, Andrej Pleterski, Anton Velušček

RESNIKOV PREKOP

NAJSTAREJŠA KOLIŠČARSKA NASELBINA NA LJUBLJANSKEM BARJU
THE OLDEST PILE-DWELLING SETTLEMENT IN THE LJUBLJANSKO BARJE

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Izdal in založil / Published by Inštitut za arheologijo ZRC SAZU, Založba ZRC / *Institute of Archaeology at the ZRC SAZU in association with ZRC Publishing*

Zanj / Represented by Oto Luthar *in / and* Jana Horvat

Glavni urednik / Editor-in-Chief Vojislav Likar

Tisk / Printed by *???*

Izid knjige sta podprla / Published with the support of
Agencija za raziskovalno dejavnost Republike Slovenije in Občina Ig / *Slovenian Research Agency and Municipality Ig*

Fotografija na ovitku / *Cover photo*
Resnikov prekop, sonda 1 / *Resnikov prekop, trench 1* (Foto / *Photo* Matija Turk)

CIP - Kataložni zapis o publikaciji
Narodna in univerzitetna knjižnica, Ljubljana

903/904(497.4 ???)

Resnikov prekop, najstarejša koliščarska naselbina na Ljubljanskem barju
Resnikov Prekop, the oldest Pile-Dwelling Settlement in the Ljubljansko Barje / Anton Velušček ... [et al.] ; uredil, edited by Anton Velušček ; [prevod Rachel Novšak, Maja Andrič ; risbe gradiva, tlorisov in profilov Tamara Korošec]. - Ljubljana : Inštitut za arheologijo ZRC SAZU = Institut of archaeology, 2006. - (Opera Instituti archaeologici Sloveniae ; 10)

ISBN 961-???
1. Velušček, Anton
128990208

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NAJSTAREJŠA KOLIŠČARSKA NASELBINA NA LJUBLJANSKEM BARJU

THE OLDEST PILE-DWELLING SETTLEMENT IN THE LJUBLJANSKO BARJE

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ZALOŽBA
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LJUBLJANA 2006

VSEBINA

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ALI LAHKO ANALIZA PELODNEGA ZAPISA V KULTURNI PLASTI ARHEOLOŠKEGA NAJDIŠČA POVE, KAKŠNA VEGETACIJA JE RASLA V OKOLICI? PRIMER: RESNIKOV PREKOP

Maja ANDRIČ

Izvleček

Osnovni cilj paleoekološke raziskave, predstavljene v tem članku, je bil ugotoviti, ali s pomočjo pelodne analize prazgodovinske kulturne plasti na Resnikovem prekopu (Ljubljansko barje) lahko povemo, kakšna sta bila vegetacija in paleookolje v neposredni okolici naselbine v 5. tisočletju pr. n. št. Radiokarbonsko datiranje sedimenta je pokazalo, da zaradi sprememb v hidrologiji bazena del pelodnega zapisa, ki se je odlagal v obdobju med ok. 6.000-200 pr. n. št., v holocenski sekvenci manjka. Paleoekološki zapis v preostalem sedimentu, ki je datiran v čas pred ok. 6.000 pr. n. št. in po ok. 200 pr. n. št., pa kaže, da sta bili zgodnje in poznoholocenska pokrajina zelo različni. Zato lahko domnevamo, da je na Ljubljanskem barju v srednjem in/ali poznem holocenu prišlo do večjih sprememb paleookolja. Človekov vpliv na okolje je naraščal in sladkovodno jezero, obdano s pretežno bukovim gozdom, je nadomestila bolj odprta, današnji zelo podobna močvirnata pokrajina na poplavni ravnici.

Ključne besede: Resnikov prekop, Ljubljansko barje, palinologija

Abstract

Palaeoecological research presented in this paper aimed to investigate whether the pollen record in archaeological cultural layer of Resnikov prekop Neolithic settlement (Ljubljansko barje, Slovenia) can give us information about the vegetation and palaeoenvironment in the 5th millennium cal. BC. Radiocarbon dating indicated that, due to changes of hydrology, part of pollen record, dated between ca. 6.000-200 cal. BC was removed from the sedimentary sequence by water activity. Palaeoecological record in the remaining sediment (dated before *ca.* 6.000 cal. BC and after *ca*. 200 cal. BC), however, suggestes that early and late Holocene landscapes were significantly different. That leads us to a conclusion that a major change of Ljubljana marsh landscape occurred in the middle and/or late Holocene. Human impact on the environment increased and thick beech forest surrounding freshwater lake was replaced by open, marshy landscape and vegetation very similar to today's.

Key words: Resnikov prekop, Ljubljansko barje, Slovenia, palynology

1. UVOD

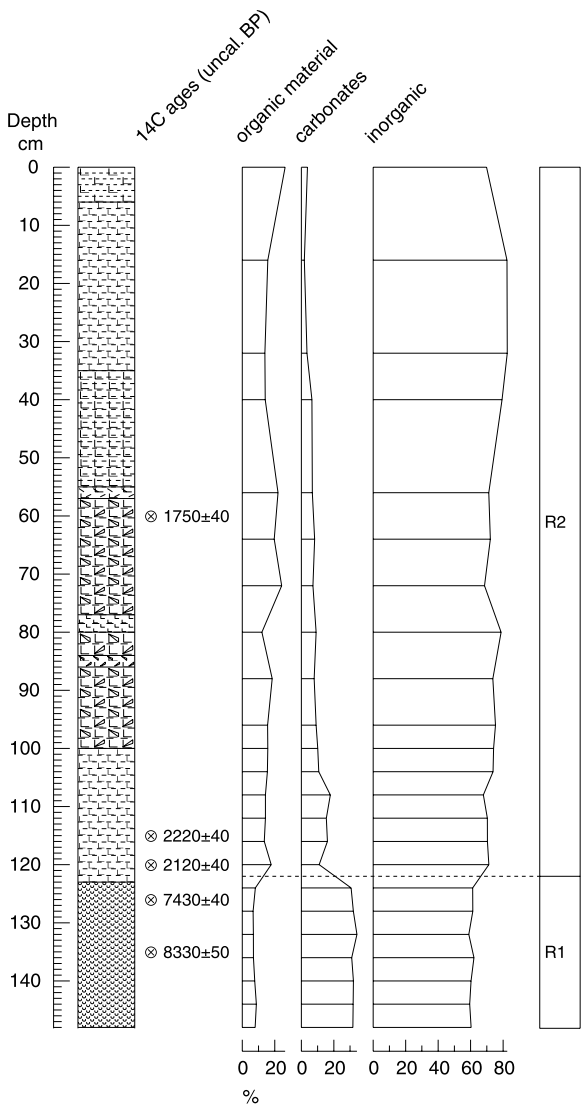
Ljubljansko barje je edino območje v Sloveniji, kjer je pelod zaradi anaerobnih razmer v sedimentu zelo dobro ohranjen in je bila zaradi tega pelodna analiza kulturnih plasti arheoloških najdišč že desetletja obvezni sestavni del arheoloških in paleoekoloških raziskav v regiji. V zadnji 50 letih so palinologi na številnih arheoloških najdiščih proučevali splošen razvoj vegetacije in vpliv posameznih arheoloških naselbin na okolje (npr. Šercelj 1955; 1961; 1975; 1976; 1996; Culiberg, Šercelj 1978; 1980; Šercelj, Culiberg 1980; Gardner 1999; Jeraj 2002; 2004). Na osnovi teh raziskav so tako palinologi kot tudi arheologi zelo pogosto domnevali, da pelodni zapis v arheološki kulturni plasti pove, kakšna vegetacija je rasla v okolici naselja. V nasprotju s takim razmišljanjem pa bi, na primeru paleoekoloških raziskav na Resnikovem prekopu, rada pokazala, da interpretacija pelodnega zapisa ni vedno tako preprosta. Zaradi zapletenih hidroloških razmer na Ljubljanskem barju sta multidisciplinarnost raziskave in radiokarbonsko datiranje sedimenta ključnega pomena za razumevanje tafonomskih procesov in sprememb paleookolja na vsakem arheološkem najdišču posebej.

Arheološka izkopavanja na Resnikovem prekopu v 50. in 60. letih 20. stoletja (Jesse 1954; 1955; Bregant 1964; 1964-1965; Korošec 1964) so pokazala, da kulturno plast na tem najdišču sestavlja meljast sediment, ki vsebuje veliko organskega detritusa (ostanki listja, vej in lesa). V tej zelo tanki kulturni plasti je bila odkrita prazgodovinska keramika (datirana v 5. tisočletje pr. n. št.), živalske kosti in leseni koli. Kulturna plast je ležala neposredno nad karbonatno 'jezersko kredo'. Ker so bile v sedimentu nad 'jezersko kredo' opazne horizontalne plasti organskega detritusa in melja in ker je bila površina kosti zglajena, so izkopavalci domnevali, da se je ta

plast odlagala v tekoči vodi (Korošec 1964; Drobne 1964). Med izkopavanjem niso odkrili obsežnejših plasti šote in zato je bila postavljena domneva, da je naselje stalo na suhih tleh v bližini jezerskega brega (Bregant 1964) ali tekoče vode (Korošec 1964).

Podobno domnevo - da je naselje stalo na jezerskem bregu - je na osnovi pelodne analize postavil tudi A. Šercelj (Šercelj 1981-1982; Culiberg, Šercelj 1991). Med arheološkimi izkopavanji na Resnikovem prekopu leta 1957 je bilo opravljeno palinološko vrtanje do globine 7 m (Šercelj 1961; 1963). Zgornjih 180 cm vrtine (vključno s 'kulturno plastjo' na globini 160-170 cm) palinološko ni bilo raziskanih, ker je bil sediment v tem delu verjetno erodiran in presedimentiran. V odseku vrtine tik pod 'kulturno plastjo' (180-200 cm) pelod ni bil ohranjen, medtem ko je bila pelodna ohranjenost na globini pod 200 cm dobra. Diagram kaže, da se je pelodni zapis v odseku 665-360 cm odlagal v poznem glacialu, medtem ko je zgornji del vrtine (200-360 cm) zgodnjeholocenske starosti (Šercelj 1961, tab. 4; 1963, tab. III). Na osnovi tega pelodnega zapisa je jasno, da sediment, ki se je odlagal takoj po zgodnjem holocenu (borealu), manjka ali pa je zelo tanek (Šercelj 1963). Šercelj je zato sklepal, da je bila sedimentacija v času naselbine na Resnikovem prekopu tako počasna zato, ker je bilo takrat jezero že zelo plitvo ali v celoti izsušeno (Šercelj 1981-1982; Culiberg, Šercelj 1991).

Dosedanje raziskave so torej odprle več zanimivih vprašanj v zvezi s srednjeholocenskimi paleohidrološkimi in paleovegetacijskimi razmerami na Resnikovem prekopu. Glavni cilj v nadaljevanju predstavljene raziskave je ugotoviti, ali nam pelodni zapis na arheološkem najdišču lahko nudi kaj več informacij o nekdanji vegetaciji in človekovem vplivu na okolje, posredno pa tudi o preteklih spremembah hidrologije.



Sl. 1: Resnikov prekop. Loss-on-ignition.
Fig. 1: Resnikov prekop. Loss-on-ignition.

2. METODOLOGIJA

Junija in julija 2002 je ekipa Inštituta za arheologijo ZRC SAZU pod vodstvom A. Velušček na Resnikovem prekopu izkopala tri arheološke sonde (glej Velušček 2006). Vzorce za analizo peloda in fitolitov (glej Golyeva 2006) sem pobrala iz zahodnega profila Sonde 1 (mk. 12) s pomočjo kovinskih škatel, jih zavila v prozorno folijo, aluminijasto folijo in debel polivinil ter shranila pri + 4 °C. V palinološkem laboratoriju so bile opravljene sledeče analize: opis sedimenta, 'loss-on-ignition' in pelodna analiza; radiokarbonsko datiranje sedimenta pa je bilo opravljeno v laboratoriju Beta Analytic na Floridi.

Opis značilnosti sedimenta sledi Troels-Smithu (1955), določanje barve pa Munsellovim tablicam (*tab. 1*). Za določanje količine organskih snovi in karbonatov v sedimentu sem uporabila 'loss-on-ignition' analizo (Bengtsson, Enell 1986). Pri tej analizi sem sediment (vsakič po 1 cm^3) položila v suhe žarilne lončke in jih 6 ur žgala v žarilni peči pri 105 °C, 550 °C in 950 °C. Po vsaki fazi žganja sem žarilne lončke stehtala, da bi ugotovila, kakšna je bila izguba teže zaradi žganja. Količino organskega materiala, karbonatov in anorganskega preostanka sem izračunala kot odstotek suhe teže sedimenta in rezultati so predstavljeni na *sl. 1*.

Vzorci za pelodno analizo (vsakič po 1 cm^3 sedimenta) so bili pripravljeni po standardni laboratorijski metodi (7 % HCl, 10 % NaOH, 40 % HF, acetoliza, barvanje z barvilom safranin, butil-alkohol in dodajanje silikonskega olja, metoda B po Berglund, Ralska-Jasiewiczowa 1986; Bennett, Willis 2002). Za določanje pelodne koncentracije sem vsakemu vzorcu pred pripravo dodala dve tableti z znanim številom spor *Lycopodium* (Stockmarr 1971). Pri pelodni analizi sem uporabljala svetlobni mikroskop Nikon Eclipse E400 pri

povečavi 400 x in sledeče priročnike: Moore, Webb, Collinson 1991; Reille 1992; 1995. V vsakem vzorcu sem preštela najmanj 500 pelodnih zrn kopenskih rastlin in spor praproti, poleg tega pa sem štela tudi mikroskopsko oglje (razdeljeno na dva velikostna razreda, < 40 μm in > 40 μm).

Starost sedimenta je bila določena z AMS radiokarbonskim datiranjem organskega ogljika, ki je bil iz sedimenta izločen z izpiranjem s kislinami (*tab. 2*). Radiokarbonski datumi so bili kalibrirani s pomočjo podatkovne baze INTCAL 98 in položaj vsakega datuma je prikazan na 'loss-on-ignition' in pelodnem diagramu. Palinološki podatki (*sl. 2*) so bili statistično analizirani s pomočjo programa za risanje pelodnih diagramov PSIMPOLL 3.00 (Bennett 1998; http://www.kv.geo.uu.se/inqua; http://www.kv.geo.uu.se/datah), pri čemer je bil diagram s pomočjo 'optimalnega razcepa po obsegu informacije' ('optimal splitting by information content', Bennett 1996; 1998) razdeljen na dva statistično pomembna odseka, ki sta prikazana tudi na 'loss-on-ignition' diagramu. Na vsakem diagramu (*sl. 1; 2*) je prikazana globina, sledi sedimentacijski stolpec (opis sedimenta v *tab. 1*) in oznaka položaja radiokarbonskih datumov (*tab. 2*). Rezultati pelodne analize so prikazani v obliki odstotkovnega pelodnega diagrama, delež vsakega taksona je bil izračunan glede na pelodno vsoto najmanj 500 pelodnih zrn kopenskih rastlin in spor praproti. Taksoni, prisotni z manj kot 0,5 %, so označeni s piko.

3. REZULTATI

Profil z Resnikovega prekopa lahko razdelimo na dva, palinološko in sedimentološko specifična odseka (R-1 in R-2). V spodnjem delu profila (R-1, pod 123 cm) je odstotek karbonatov visok (ok. 30 % suhe teže), medtem ko je delež organskih snovi nizek (< 10 %). V zgornjem, manj karbonatnem delu profila (R-2, 0-123 cm), kjer odstotek organskih snovi naraste (> 10 %), sestavljajo sediment plasti gline, rastlinskega detritusa, melja in peska (*tab. 1; sl. 1*). Rezultati radiokarbonskega datiranja, predstavljeni v *tabeli 2,* kažejo, da sta se odseka R-1 in R-2 odlagala v različnih časovnih obdobjih. Na osnovi radiokarbonskih datumov odsek R-1 lahko datiramo v čas pred ok. 6.000 pr. n. št., medtem ko je odsek R-2 mnogo mlajši in se je odlagal med ok. 200 pr. n. št. in sedanjostjo.

Razlike med obema odsekoma so očitne tudi na pelodnem diagramu (*sl. 2*). V odseku R-1 je pelodna koncentracija visoka (16.000-10.000 pelodnih zrn na 1 cm^3 sedimenta), medtem ko v odseku R-2 pelodna koncentracija močno pade (6.000-2.000 pelodnih zrn na 1 cm^3 sedimenta). V povprečju ok. desetkrat nižja pelodna koncentracija v zgornjem delu profila je domnevno pretežno posledica mnogo hitrejše sedimentacije po 200 pr. n. št., čeprav je na pelodno koncentracijo verjetno vplivala tudi sprememba vegetacije (upad dreves in porast zelišč).

Tab. 1: Opis sedimenta po Troels-Smithu (1955).
Table 1: Description of sediment (after Troels-Smith 1955).

Globina / Depth	Troels-Smithov simbol / symbol	Barva / Colour (Munsell soil chart)
0-6 cm	Sh3 As1 organska ilovica / organic clay	5YR 3/1 very dark grey
6-35 cm	Sh2 As2 organska ilovica / organic clay	7.5 YR 3/1 very dark grey
35-55 cm	Sh2 As1 Ag1 organska meljasta ilovica / organic silty clay	7.5 YR 3/1 very dark grey
55-57 cm	Dl3 Ag1 organska meljasta ilovica / organic silty clay	5 YR 3/1 very dark grey
57-77 cm	Sh1 Dh1 As1 Ag1 organska meljasta ilovica / organic silty clay	5 YR 3/1 very dark grey
77-80 cm	Sh1 Ag3 organska meljasta ilovica / organic silty clay	7.5 YR 4/4 brown
80-84 cm	Sh1 Ag 3 organska meljasta ilovica / organic silty clay	5 YR 3/1 very dark grey
84-86 cm	Dh3 As1 organska meljasta ilovica / organic silty clay	5 YR 3/1 very dark grey
86-100 cm	Sh1 Dh1 As1 Ag1 organska meljasta ilovica / organic silty clay	5 YR 3/1 very dark grey
100-123 cm	Sh2 As2 organska meljasta ilovica / organic silty clay	5 YR 3/1 very dark grey
123-150 cm	Lc4 karbonatna 'jezerska kreda' / calcarous 'lake marl'	10 YR 5/2 greyish brown

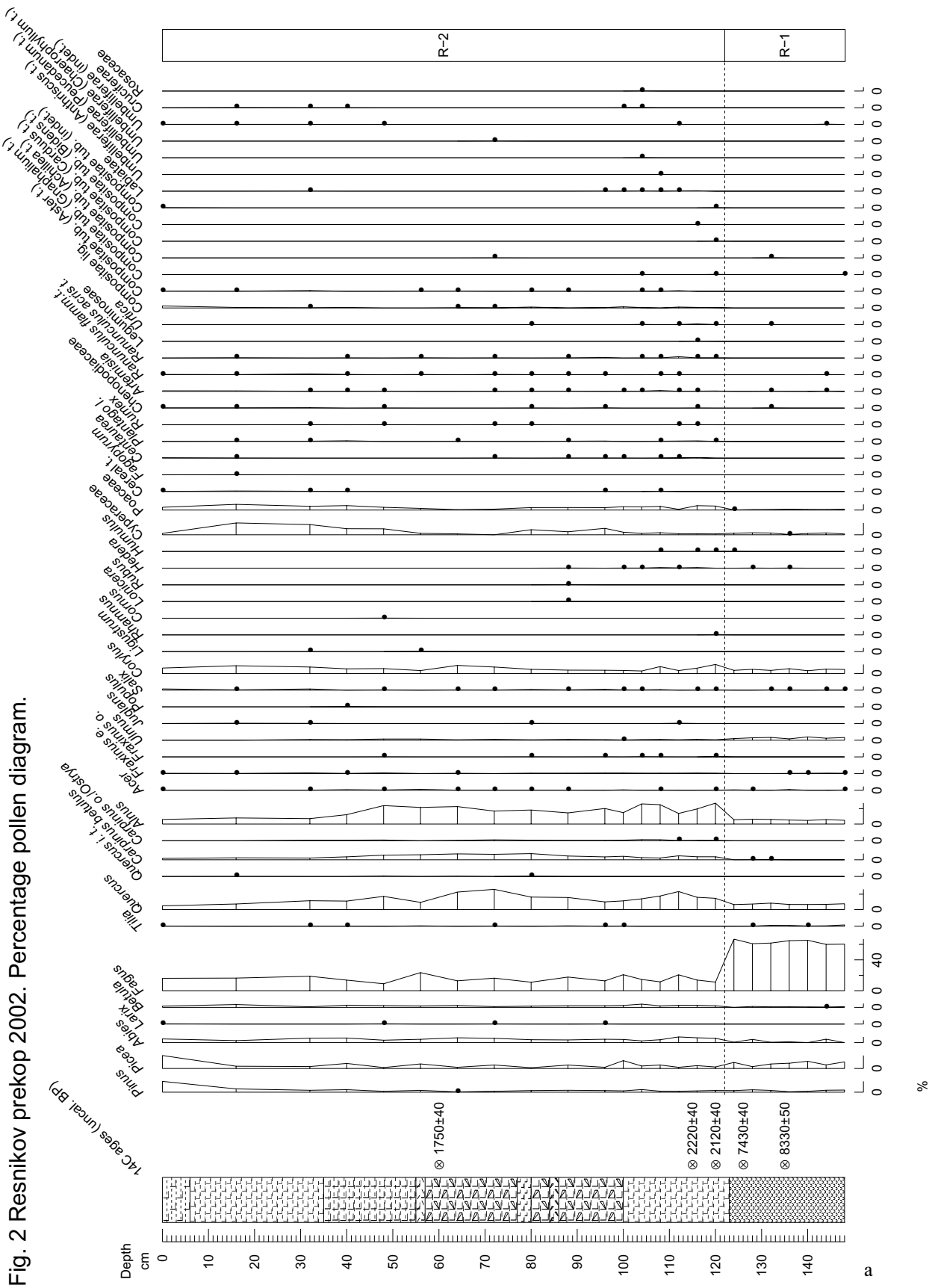
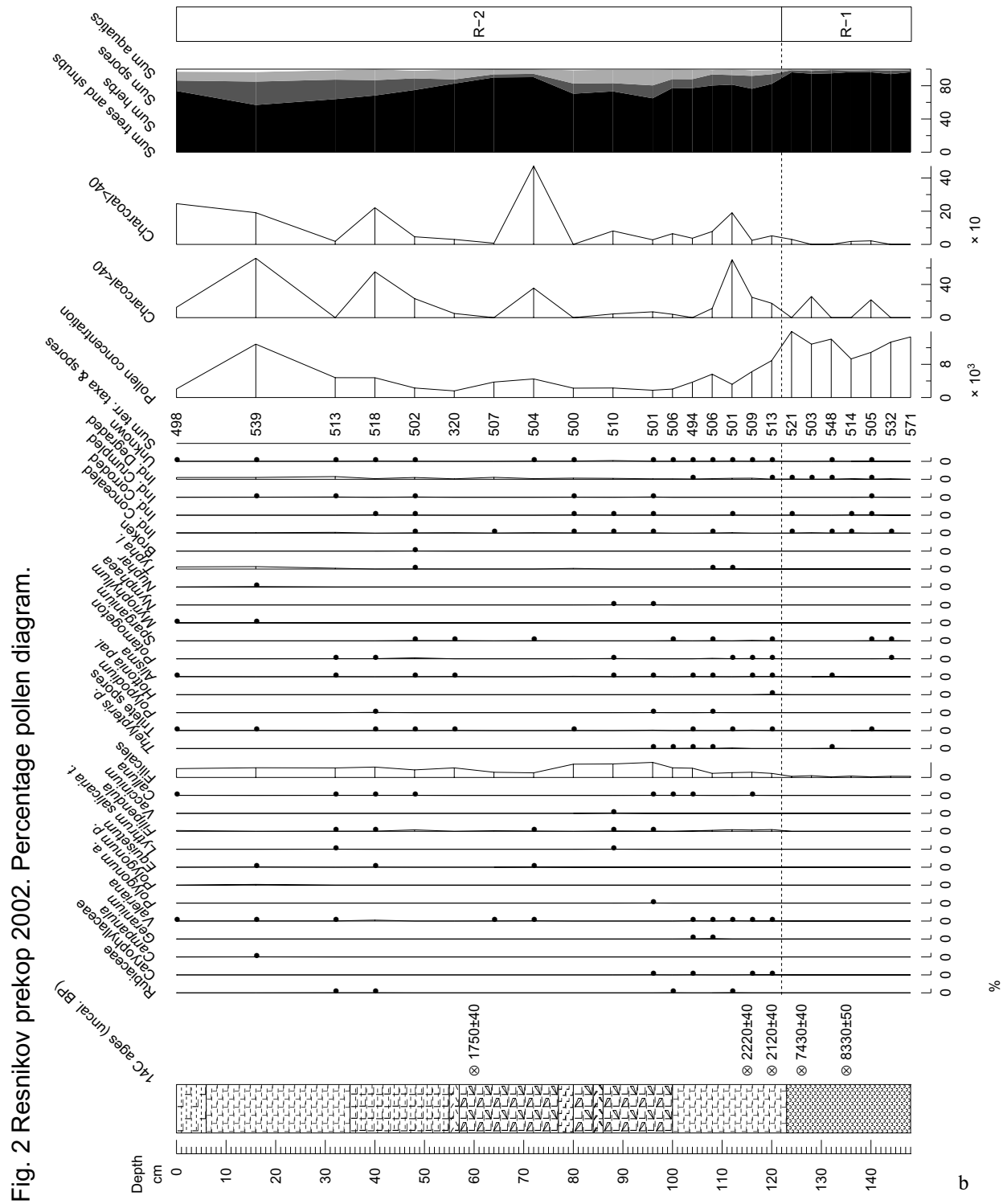


Fig. 2 Resnikov prekop 2002. Percentage pollen diagram.



Sl. 2a,b: Resnikov prekop. Procentni pelodni diagram.
Fig. 2a,b: Resnikov prekop. Percentage pollen diagram.

Osnovna značilnost pelodnega zapisa v spodnjem odseku (R-1) je visoka koncentracija peloda bukve (*Fagus,* ok. 60 %). Ostali drevesni taksoni, prisotni z več kot 5 %, so smreka (*Picea*), hrast (*Quercus*), jelša (*Alnus*), brest (*Ulmus*) in leska (*Corylus*). Odstotek drevesnega peloda presega 90 %, peloda zelišč pa je zelo malo. V zgornjem pelodnem odseku (R-2) delež bukve upade (< 20 %), narastejo pa jelka (*Abies*), hrast, beli gaber

Tab. 2: Resnikov prekop. Radiokarbonski datumi.
Table 2: Resnikov prekop. Radiocarbon dates.

Številka vzorca / Sample number	Globina (cm) / Depth (cm)	Konvencionalna C14 starost / Conventional C14 age	$^{13}C/^{12}C$ delež / $^{13}C/^{12}C$ ratio	Kalibriran rezultat / Intercept of radiocarbon age with calibration curve Cal. BC (cal. BP)	2 sigma kalibriran rezultat / 2 sigma calibrated results
Beta-184791	60	1750 ± 40 BP	-28,0 o/oo	260 cal. AD 1690 cal. BP	220-400 cal. AD (1740-1550 cal. BP)
Beta-184792	115	2220 ± 40 BP	- 29,2 o/oo	360, 290 in / and 230 cal. BC 2310, 2240 in / and 2180 cal. BP	390-180 cal. BC (2340-2130 cal. BP)
Beta-182667	120	2120 ± 40 BP	-29,3 o/oo	165 cal. BC 2115 cal. BP	350-310 cal. BC in / and 210-45 cal. BC (2300-2260 in / and 2160-1995 cal. BP)
Beta-181046	126	7430 ± 40 BP	-26,9 o/oo	6250 cal. BC 8200 cal. BP	6400-6220 cal. BC (8350-8170 cal. BP)
Beta-184793	135	8330 ± 50 BP	-31,7 o/oo	7450, 7390 in / and 7370 cal. BC 9400, 9340 in / and 9320 cal. BP	7530-7290 cal. BC (9480-9240 cal. BP)

(*Carpinus b.*), jelša in leska. V tem pelodnem odseku odstotek peloda dreves upade na 50-80 %, medtem ko zelišča in monoletne spore praproti (*Filicales*) narastejo na ok. 20-45 %.

4. DISKUSIJA

Prvotni cilj multidisciplinarne raziskave na arheološkem najdišču Resnikov prekop je bil analiza vegetacije in človekovega vpliva na okolje ter, posredno, tudi sprememb hidrologije na najdišču. Presenetljivo, da nam, zaradi tafonomskih vzrokov, pelodni zapis v 'kulturni plasti' najdišča ne more povedati, kakšna vegetacija je rasla v okolici naselja v 5. tisočletju pr. n. št. Radiokarbonsko datiranje je namreč pokazalo, da sta se sediment in pelodni zapis v t. i. 'kulturni plasti', ki sta mnogo mlajša od arheološke materialne kulture, začela odlagati šele v drugi polovici prvega tisočletja pred našim štetjem. Paleoekološki zapis na Resnikovem prekopu torej ni popoln, kajti del sedimenta, datiran med ok. 6.000 in 200 pr. n. št., je bil iz profila verjetno odnesen zaradi delovanja tekoče vode. Ker del sedimentološkega zapisa, ki bi bil sočasen s prazgodovinsko naselbino na Resnikovem prekopu, manjka, na osnovi rezultatov te raziskave ni mogoče reči, ali je naselje Resnikov prekop stalo na suhih tleh ob obali jezera (npr. Bregant 1964), v bližini tekoče vode (Korošec 1964) ali na rečni terasi (Budja 1994).

Kljub takim ugotovitvam pa nam rezultati raziskave dajejo nekaj zelo pomembnih informacij o vegetaciji in paleookolju v dveh ločenih časovnih obdobjih - zgodnjem (pred ok. 6.000 pr. n. št.) in poznem (po ok. 200 pr. n. št.) holocenu. Rezultati pelodne in 'loss-on-ignition' analize v kombinaciji s sedimentološko raziskavo (glej Turk 2006) in analizo fitolitov (glej Golyeva 2006) kažejo, da sta bili pokrajina in vegetacija v teh dveh ločenih časovnih obdobjih popolnoma različni.

V zgodnjem holocenu je, kot je ugotovil že Šercelj (1961), v okolici Resnikovega prekopa rasel pretežno bukov gozd. Dobra ohranjenost in visoka koncentracija peloda, karbonatov in diatomej kažejo, da se je 'jezerska kreda' odlagala v sladkovodnem jezeru. Na osnovi sedimentoloških raziskav, zaradi številnih diatomej, zelenih alg (Characeae), ostrakodov in polžev v sedimentu ter odsotnosti rastlinskih makrofosilov je bila postavljena domneva, da se je ta sediment odlagal v sublitoralni zoni sladkovodnega jezera (glej Turk 2006; Golyeva 2006).

Paleoekološki zapis v sedimentu, ki se je odlagal po ok. 200 pr. n. št. je popolnoma drugačen od zgodnje-

holocenskega. Pelodni zapis kaže, da je bila vegetacija ob koncu 1. tisočletja pr. n. št. že zelo podobna današnji vegetaciji na Ljubljanskem barju. Sestava gozda se je, v primerjavi z zgodnjim holocenom, spremenila. Odstotek bukve (*Fagus*) in bresta (*Ulmus*) se je zmanjšal, medtem ko je odstotek drugih taksonov, hrasta (*Quercus*), jelše (*Alnus*) in belega gabra (*Carpinus b.*), narastel. Ta sprememba v sestavi gozda, skupaj s porastom zelišč (vključno z antropogenimi indikatorji, kot je pelod žitaric in pašni indikator ozkolistni trpotec (*Plantago l.*)), nakazuje, da je bil človekov pritisk na okolje na Ljubljanskem barju zelo močan vsaj od pozne prazgodovine dalje. Sedimentološke raziskave in analiza fitolitov kažejo, da so bile tudi hidrološke razmere v omenjenih dveh obdobjih bistveno različne (glej Turk 2006; Golyeva 2006). Aluvialni sediment nad 'jezersko kredo' se je, kot kažejo radiokarbonski datumi, nizka pelodna koncentracija, spikule spužev (Golyeva 2006) in visok odstotek peska in kremenovih zrn (Turk 2006), hitro odlagal v tekoči vodi.

5. ZAKLJUČEK

V zgodnjem holocenu (ok. 6.000 pr. n. št.) je okolico Resnikovega prekopa prekrivalo sladkovodno jezero, okrog katerega je rasel bukov gozd. Razvoj pokrajine in vegetacije v naslednjih nekaj tisočletjih ni znan, ker sedimentološki zapis za čas ok. 6.000-200 pr. n. št. na Resnikovem prekopu manjka. Paleoekološki zapis v sedimentu, ki se je odlagal po 200 pr. n. št. pa je bistveno drugačen od zgodnjeholocenskega. To kaže, da sta se v srednjem in/ali poznem holocenu pokrajina in vegetacija na tem področju verjetno močno spremenili. Okrog Resnikovega prekopa se je izoblikovala poplavna ravnica in zaradi človekovega vpliva na okolje je pokrajina postala zelo odprta in podobna današnji. Kdaj, kako in zakaj je prišlo do teh velikih sprememb vegetacije in hidrologije na Resnikovem prekopu, ostaja še odprto vprašanje, na katero bodo odgovorile multidisciplinarne raziskave, ki trenutno potekajo na drugih delih Ljubljanskega barja. Te raziskave nam bodo pomagale razumeti nekdanje, današnje in bodoče povezave med človekovim vplivom na okolje, klimatskimi spremembami in hidrologijo v tem zapletenem tektonskem bazenu.

ZAHVALA

Arheološki ekipi se zahvaljujem za pomoč pri palinološkem vzorčenju na terenu, A. Veluščku in A. Golyevi pa za zanimivo diskusijo. Raziskavo je financiralo Ministrstvo za šolstvo, znanost in šport RS, raziskovalna projekta Z6-4074-0618 in J6-6348-0618-04.

BENGTSSON, L. in M. ENNELL 1986, Chemical Analysis. - V: B. E. Berglund (ur.), *Handbook of Holocene Palaeoecology and Palaeohydrology,* 423-451, Chichester.

BENNETT, K. D. 1996, Determination of the number of zones in a biostratigraphical sequence. - *New Phytologist* 132, 155-170.

BENNETT, K. D. 1998, Documentation for PSIMPOLL 3.00 and PSCOMB 1.03. - C programs for plotting pollen diagrams and analysing pollen data.

BENNETT, K. D. in K. J. WILLIS 2002, Pollen. - V: J. P. Smol, H. J. Birks in W. M. Last (ur.), *Tracking Environmental Changes Using Lake Sediments* 3. Terrestrial, Algal and Siliceous Indicators, 5-32, Dordrecht.

BERGLUND, B. E. in M. RALSKA-JASIEWICZOWA 1986, Pollen analysis and pollen diagrams. - V: B. E. Berglund (ur.), *Handbook of Holocene Palaeoecology and Palaeohydrology,* 455-484, Chichester.

BREGANT, T. 1964, Poročilo o raziskovanju kolišča in gradbenih ostalin ob Resnikovem prekopu pri Igu. - *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 1, 7-24.

BREGANT, T. 1964-1965, Sondažna raziskovanja v okolici Iga na Ljubljanskem barju. - *Arheološki vestnik* 15-16, 179-209.

BUDJA, M. 1994, Spreminjanje naravne in kulturne krajine v neolitiku in eneolitiku na Ljubljanskem barju I. - *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji* 22, 163-181.

CULIBERG, M. in A. ŠERCELJ 1978, Ksilotomske in palinološke analize rastlinskih ostankov s kolišča na Partih pri Igu - izkopavanja leta 1978. - *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 6, 95-99.

CULIBERG, M. in A. ŠERCELJ 1980, Pelodne, ksilotomske in karpološke analize s kolišča na Partih. - *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 8, 89-94.

CULIBERG, M. in A. ŠERCELJ 1991, Razlike v rezultatih raziskav makroskopskih rastlinskih ostankov s kolišč na Ljubljanskem barju in pelodnih analiz - dokaz človekovega vpliva na gozd. - *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 19, 249-256.

DROBNE, K. 1964, Živalske kosti z Resnikovega prekopa. - *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 1, 61-64.

GARDNER, A. 1999, The ecology of the Neolithic environmental impacts - re-evaluation of existing theory using case studies from Hungary and Slovenia. - *Documenta Praehistorica* 26, 163-183.

GOLYEVA, A. A. 2006, Palaeoecological Reconstructions based on the Biomorphic Analysis. A Case Study: Resnikov Prekop. - V: A. Velušček (ur.), *Resnikov prekop, najstarejša koliščarska naselbina na Ljubljanskem barju*, Opera Instituti archaeologici Sloveniae 10, 115-122.

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

JERAJ, M. 2004, Paleobotanične raziskave na kolišču Hočevarica. Paleobotanical analyses of the Hočevarica pile dwelling. - V: A. Velušček (ur.), *Hočevarica - eneolitsko kolišče na Ljubljanskem barju,* Opera Instituti archaeolgici Sloveniae 8, 56-64.

JESSE, S. 1954, Poročilo o sondiranju v okolici Iga pri Ljubljani. - *Arheološki vestnik* 5/1, 95-111.

JESSE, S. 1955, Novo odkriti kolišči na Ljubljanskem barju. - *Arheološki vestnik* 6/2, 264-267.

KOROŠEC, J. 1964, Kulturne ostaline na kolišču ob Resnikovem prekopu odkrite v letu 1962. - *Poročilo o raziskovanju neolita in eneolita v Sloveniji* 1, 25-46.

MOORE, P. D., J. A. WEBB in M. E. COLLINSON 1991, *Pollen Analysis*. - Oxford.

REILLE, M. 1992, *Pollen et Spores d'Europe et d'Afrique Du Nord*. - Marseille.

REILLE, M. 1995, *Pollen et Spores d'Europe et d'Afrique Du Nord (Supplement).* - Marseille.

STOCKMARR, J. 1971, Tablets with spores used in absolute pollen analysis. - *Pollen et spores* 13, 615-621.

ŠERCELJ, A. 1955, Palinološki profil kolišča pri Kamniku pod Krimom. - *Arheološki vestnik* 6/2, 269-271.

ŠERCELJ, A. 1961, *Naseljevanje gozdne vegetacije v Sloveniji od zadnje poledenitve do danes*. - Ljubljana, doktorska disertacija, Univerza v Ljubljani

ŠERCELJ, A. 1963, Razvoj würmske in holocenske gozdne vegetacije v Sloveniji. - *Razprave 4. razreda SAZU* 7, 363-418.

ŠERCELJ, A. 1975, Analize makroskopskih in mikroskopskih rastlinskih ostankov s kolišča ob Maharskem prekopu, Izkopavanja 1973. in 1974. leta. - *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. - *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 5, 119-122.

ŠERCELJ, A. 1981-1982, Pomen botaničnih raziskav na koliščih Ljubljanskega barja. - *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 9-10, 101-106.

ŠERCELJ, A. 1996, *Začetki in razvoj gozdov v Sloveniji.* - Dela 4. razreda SAZU 35.

ŠERCELJ, A. in M. CULIBERG 1980, Paleobotanične raziskave kolišča na Partih - izkopavanja 1978. - *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji* 8, 83-88.

TROELS-SMITH, J. 1955, *Karakterising af løse jordater / Characterisation of unconslodated sediments.* - Geological Survey of Denmark IV. Series 3/10, 1-73.

TURK, J. 2006, Ugotavljanje paleoekoloških sprememb na Ljubljanskem barju v holocenu na primeru sedimentov z Resnikovega prekopa. - V: A. Velušček (ur.), *Resnikov prekop, najstarejša koliščarska naselbina na Ljubljanskem barju*, Opera Instituti archaeologici Sloveniae 10, 93-98.

VELUŠČEK, A. 2006, Resnikov prekop - sondiranje, arheološke najdbe, kulturna opredelitev in časovna uvrstitev. - V: A. Velušček (ur.), *Resnikov prekop, najstarejša koliščarska naselbina na Ljubljanskem barju*, Opera Instituti archaeologici Sloveniae 10, 19-85.

DOES POLLEN RECORD IN ARCHAEOLOGICAL 'CULTURAL LAYER' TELL US WHAT VEGETATION WAS GROWING AROUND THE SETTLEMENT? CASE STUDY: 'RESNIKOV PREKOP'

Translation

1. INTRODUCTION

Ljubljansko barje (Ljubljana Moor) is the only region in Slovenia where pollen analysis of samples, collected directly on archaeological sites became a standard research procedure. Anaerobic conditions in the sediment and thus excellent pollen preservation are the main reason for such extensive use of palynology. In the last 50 years numerous on-site studies of pollen record were used to reconstruct general vegetation development in the basin and the impact of individual archaeological settlements on the environment (*e.g.* Šercelj 1955; 1961; 1975; 1976; 1996; Culiberg, Šercelj 1978; 1980; Šercelj, Culiberg 1980; Gardner 1999; Jeraj 2002; 2004). In these studies and archaeological discussion based on palaeoecological data it was usually assumed that pollen record in the archaeological 'cultural layer' represents a 'snapshot' of the vegetation, contemporary with the settlement. In contrast to this assumption, palynological research and radiocarbon dating at Resnikov prekop archaeological site will be used to demonstrate that this is not always the case and I would like to argue that, due to complex hydrology of the basin, careful radiocarbon dating of the sediment and multidisciplinary palaeoecological research are essential to understand taphonomy and changes of the landscape on each individual archaeological site.

Previous archaeological research at Resnikov prekop carried out in the 1950s and 1960s (Jesse 1954; 1955; Bregant 1964; 1964-1965; Korošec 1964) revealed that very thin 'cultural layer', composed of silty sediment rich in organic detritus such as leaves, branches and wood, included Neolithic pottery (dated to 5th millennium cal. BC), animal bones and wooden piles. This layer was placed directly on top of calcareous 'lake marl' sediment. Since the sediment above 'lake marl' consisted of distinct layers of organic detritus and silt and since the surface of bone remains found in the 'cultural layer' was smooth, it was suggested that it was deposited by running water (Korošec 1964; Drobne 1964). No extensive layers of peat were discovered during the excavation and it was suggested that Resnikov prekop Neolithic settlement was located on dry ground, either near lake shore (Bregant 1964) or in the vicinity of running water (Korošec 1964).

The same idea - that the settlement was located on lake shore - was suggested also on the basis of pollen analysis (Šercelj 1981-1982; Culiberg, Šercelj 1991). During archaeological excavation on Resnikov prekop in 1957 a 7 m long sedimentary core was collected for pollen analysis (Šercelj 1961; 1963). The upper 180 cm of the core (including 'cultural layer' at 160-170 cm) were not palynologically investigated because material comprising the sediment was probably eroded and redeposited. In the section of the core at 180-200 cm immediately under the 'cultural layer' pollen was not preserved, whereas the preservation of pollen below 200 cm was good. Pollen diagram indicates that sediment between 665 and 360 cm was deposited in the late glacial, whereas upper section of the core (200-360 cm) is of early Holocene (boreal) age (Šercelj 1961, Table 4; 1963, Table III). Pollen data therefore indicate that the sediment, dated immediately after early Holocene (boreal) is either very thin or missing (Šercelj 1963). This led Šercelj to a conclusion that sedimentation rate at Resnikov prekop was very slow because, at the time of archaeological settlement, the Holocene lake was very shallow or already completely dried out (Šercelj 1981-1982; Culiberg, Šercelj 1991).

Previous research therefore opened several very interesting questions about mid-Holocene palaeovegetational and palaeohydrological conditions on Resnikov prekop. This study aims to investigate whether pollen record on Resnikov prekop can give us more detailed information about the vegetation, human impact on the environment and, indirectly, also about past changes of hydrology.

2. METHODOLOGY

In June and July 2002 a team of Institute of Archaeology at the Scientific Research Centre of Slovenian Academy of Sciences and Arts under leadership of

A. Velušček excavated three archaeological trenches at Resnikov prekop site (see Velušček 2006). Samples for pollen and phytolith (see Golyeva 2006) analysis were collected from western profile of *Trench 1* (grid square 12) using metal tin trays. They were wrapped into cling film, aluminium foil and plastic sheeting and stored at + 4 °C. They were brought to palynological laboratory where the following analyses were performed: sediment description, loss-on-ignition and pollen analysis. Sediment samples for radiocarbon dating were sent to Beta Analytic, Florida.

Description of the sediment characteristics followed Troels-Smith (1955) and the colour was described using Munsell soil chart (*Table 1*). The abundance of organic material and carbonates in the sediment was determined using loss-on-ignition analysis (Bengtsson, Enell 1986). During this analysis 1 cm^3 of the sediment was placed in a dry porcelain crucible and heated for 6 hours in a muffle furnace at 105 °C, 550 °C and 950 °C. After each step the crucible with the sediment was weighted on an electronic scale in order to determine the loss of weight due to heating. The amount of organic material, carbonates and remaining inorganic residue was calculated as percentage of sediment dry weight and is plotted on *Figure 1*.

For the pollen analysis 1 cm^3 of the sediment was subsampled from selected levels using a metal volumetric subsampler. Standard laboratory procedure was used (7 % HCl, 10 % NaOH, 40 % HF, acetolysis, staining with safranine, TBA, mounting in silicone oil, method B of Berglund, Ralska-Jasiewiczowa 1986; Bennett, Willis 2002) and two tablets with a known number of *Lycopodium* spores were added prior laboratory preparation in order to determine the pollen concentration (Stockmarr 1971). For pollen identification Nikon Eclipse E400 light microscope at × 400 magnification and the following pollen keys were used: Moore, Webb, Collinson 1991; Reille 1992; 1995. A minimum of 500 pollen grains of terrestrial plants and spores was counted in each sample, together with microscopic charcoal (divided into two size classes, < 40 μm and > 40 μm).

Chronology was determined by radiocarbon dating of organic carbon, extracted from the sediment (*Table 2*). Material pre-treatment included acid washes and direct atomic counting was performed using an accelerator mass spectrometer. The dates were calibrated using INTCAL 98 database and the positions of radiocarbon dates are plotted on pollen and loss-on-ignition diagrams. The pollen data (*Fig. 2*) were analysed and plotted by PSIMPOLL 3.00 program (Bennett 1998; http://www. kv.geo.uu.se/inqua; http://www.kv.geo.uu.se/datah) and pollen diagram was divided into two significant zones using optimal splitting by information content (Bennett 1996; 1998) and these zones are plotted also on loss-on-ignition diagram (*Fig. 1*). Loss-on-ignition (*Fig. 1*) and pollen (*Fig. 2*) diagrams are plotted against depth. Depth scale is followed by sedimentary column (sediment description in *Table 1*) and the position of radiocarbon dates (in years uncal. BP, *Table 2*). The results of pollen analysis are presented as percentage data. In each sample at least 500 pollen grains of terrestrial taxa and spores were counted and taxa present with low values (< 0.5 %) are marked with a solid dot.

3. RESULTS

Investigated profile can be divided into two, palynologically and sedimentologically distinctive sections (R-1 and R-2). In the lower part of the profile (R-1, below 123 cm) the percentage of carbonates is high (*ca.* 30 % of dry weight), and the sediment contains low percentage of organic material (< 10 %). In the upper, less carbonate part of the profile (R-2, 0-123 cm) the percentage of organic material increases (> 10 %) and the sediment is comprised of layers with various amount of clay, plant detritus, silt and sand (*Table 1; Fig. 1*).

The results of radiocarbon dating presented in *Table 2* demonstrate that sections R-1 and R-2 were deposited in different time periods. While section R-1 was deposited before *ca.* 6.000 cal. BC, section R-2 is much younger and is dated between *ca.* 200 cal. BC and present day.

Differences between sections are obvious also on pollen diagram (*Fig. 2*). Pollen concentration in pollen zone R-1 is high (16.000-10.000 pollen grains per 1 cm^3 of sediment), whereas pollen concentration in zone R-2 is much lower (between 6.000 and 2.000 pollen grains per 1 cm^3 of sediment). On average *ca.* 10-times lower pollen concentration in the upper section of the profile is presumably mainly a consequence of much faster sedimentation rate in the period after *ca.* 200 cal. BC.

The main characteristic of pollen zone R-1 is high percentage of beech pollen (*Fagus, ca.* 60 %). Other tree taxa present with more than 5 % are spruce (*Picea*), oak (*Quercus*), alder (*Alnus*), elm (*Ulmus*) and hazel (*Corylus*). The percentage of tree pollen exceeds 90 % and percentage of herb pollen is low. In pollen zone R-2 the percentage of beech pollen is much lower (< 20 %), whereas the percentage of fir (*Abie*s), oak, hornbeam (*Carpinus b.*), alder and hazel increase. In this pollen zone the percentage of tree pollen is much lower than in R-1 (50-80 %), whereas herb pollen and monolete fern spores increase to *ca.* 20-45 %.

4. DISCUSSION

Originally, this study aimed to investigate whether multidisciplinary research approaches can give us more detailed information about the vegetation, human impact on the environment and, indirectly, also about past

changes of hydrology at Resnikov prekop site. Ironically, due to taphonomic processes on archaeological site, pollen record in 'cultural layer' cannot tell us what vegetation grew around archaeological settlement in the 5th millennium cal. BC. Radiocarbon dating namely indicates that the sediment and pollen record in 'cultural layer' are much younger than archaeological material culture. They were not deposited before the second half of the 1st millennium cal. BC. Palaeoecological sedimentary sequence at Resnikov prekop is therefore incomplete because section dated between *ca.* 6.000-200 cal. BC was presumably removed from the sequence by running water. Sediment, contemporary with Resnikov prekop archaeological site is missing and on the basis of this research it is therefore not possible to say whether Resnikov prekop settlement was located on dry ground near lake shore (e.g. Bregant 1964), in the vicinity of running water (Korošec 1964) or on river terrace (Budja 1994).

Nevertheless this research gives us very valuable information about the vegetation and palaeoenvironment in two separate time periods - early (before *ca.* 6.000 cal. BC) and late (after *ca.* 200 cal. BC) Holocene. The results of pollen, loss-on-ignition, sedimentological (see Turk 2006) and biomorphic analysis (see Golyeva 2006) suggest that the landscape and vegetation in these two time periods were significantly different.

As suggested already by Šercelj (1961), in the early Holocene thick beech forest was growing in the area. Good preservation and high concentration of pollen, carbonates and diatoms suggest that the 'lake marl' sediment was deposited in a freshwater lake. On the basis of sedimentological research and because of numerous diatoms, green algae (Characeae), ostracods, snails and absence of plant macroremains it was suggested that sediment was deposited in a sublitoral zone of freshwater lake (see Turk 2006; Golyeva 2006)

Palaeoecological record in the sediment, deposited at *ca.* 200 cal. BC is completely different. Pollen analysis indicates that the vegetation towards the end of 1st millennium cal. BC was already very much similar to the vegetation growing in the region today. Forest composition, in comparison with early Holocene, changed. The amount of beech (*Fagus*) and elm (*Ulmus*) declined, whereas other tree taxa - such as oak (*Quercus*), alder (*Alnus*) and hornbeam (*Carpinus b.*) increased. This change in forest composition, together with an increase of herb taxa (including anthropogenic indicators such as cereal type pollen grains and grazing indicator ribwort plantain (*Plantago l.*) indicate that, at least from late prehistory on, human impact on the environment was significant. Sedimentological and biomorphic analysis also suggest that hydrological conditions at Resnikov prekop in this younger time period were completely different from the early Holocene (see Turk 2006; Golyeva 2006). Sediment overlying lake marl is alluvial and radiocarbon dates and low pollen concentration, sponge spicules (see Golyeva 2006) and high percentage of sand and quartz grains (see Turk 2006) suggest that the sediment above lake marl was rapidly deposited by running water.

5. CONCLUSIONS

At *ca.* 6.000 cal. BC the area around Resnikov prekop was covered by freshwater lake, surrounded by thick beech forest. Landscape development in the following millennia is not known since sedimentological record for time period between 6.000 and 200 cal. BC is missing. However, paleoecological record in the sediment deposited after 200 cal. BC is very dissimilar to early Holocene record. This suggests that in the middle and/or late Holocene landscape and vegetation around Resnikov prekop changed significantly. The area became a floodplain and, due to human impact on the environment, landscape became more open and very similar to that of today. When, how and why these major changes of vegetation and hydrology at Resnikov prekop took place still remains an open question, which will be addressed by ongoing multidisciplinary palaeoecological research on other study sites in the area. Only then it will be possible to understand past, present and future relationships between human impact on the vegetation, climatic changes and changes of hydrology in this complex tectonic basin.

ACKNOWLEDGEMENTS

I would like to thank archaeological team for help with palynological sampling and A. Velušček and A. Golyeva for discussion of results. This research was funded by Slovenian Ministry of Education, Science and Sports, project no. Z6-4074-0618-03 and J6-6348-0648-04.

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