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Fragments of Ice Age environments. Proceedings in Honour of Ivan Turk's Jubilee

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Fragments of Ice Age environments

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Uredil / Edited by
Borut Toškan

ZALOŽBA ZRC

LJUBLJANA 2011

Ivanu!

VSEBINA

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POZNOGLACIALNA VEGETACIJA V OKOLICI BLEJSKEGA JEZERA IN GRIBELJ (BELA KRAJINA): PRIMERJAVA V ZADNJEM STADIALU POLEDENELE IN NEPOLEDENELE POKRAJINE

Maja ANDRIČ

Izvleček

Na začetku poznoglacialnega interstadiala (14.300 cal. BP) je v okolici Blejskega jezera in Gribelj uspevala precej enotna vegetacija, redek gozd bora in breze (*Pinus, Betula*), povečanje peloda mezofilnih listavcev (*Quercus, Tilia, Ulmus*) ter breze (*Betula*) in smreke (*Picea*) okrog 13.800 cal. BP pa nakazuje klimatsko otoplitev in večanje razlik med regijama. Medtem ko sta bili v toplejši jugovzhodni Sloveniji lipa (*Tilia*) in breza (*Betula*) pogostejši, je pelodni influks teh dveh taksonov na pelodnem diagramu Blejskega jezera, ki leži v hladnejši in ob vrhuncu zadnje poledenitve z ledom prekriti severozahodni Sloveniji, veliko nižji. V obeh regijah upad peloda dreves in porast zelišč (Poaceae, Chenopodiaceae in *Artemisia*), ki sta sledila otoplitvi, nakazuje hladnejšo in bolj suho klimo mlajšega driasa.

Ključne besede: palinologija, pozni glacial, lipa (*Tilia*), Slovenija, Blejsko jezero, Griblje

UVOD

Slovenija leži v bližini ledenodobnih območij iglastih in listnatih drevesnih vrst (e. g. Cheddadi *et al.* 2006; Culiberg 1991; Magri *et al.* 2006; Petit *et al.* 2003; Willis *et al.* 2000; Willis, van Andel 2004), zato je bila v poznem glacialu prekrita z zelo pestro vegetacijo. Na začetku poznega glaciala je na območju Slovenije uspevala stepa z redkimi drevesi (e.g. *Pinus, Betula*), kasneje pa so se s klimatsko otoplitvijo tu razširili tudi mezofilni listavci (e.g. *Quercus, Tilia, Corylus, Ulmus*) (Culiberg 1991; Culiberg, Šercelj 1998; Šercelj 1970). Palinološke raziskave kažejo, da je bila poznoglacialna vegetacija Slovenije razmeroma enotna, z manjšimi

LATEGLACIAL VEGETATION AT LAKE BLED AND GRIBLJE MARSH (SLOVENIA): A COMPARISON OF (IN LAST GLACIAL MAXIMUM) GLACIATED AND NON-GLACIATED LANDSCAPES

Abstract

The results of pollen analysis suggest that at the beginning of the Lateglacial interstadial (14300 cal. BP) an open woodland (*Pinus, Betula*) was growing at both study sites, but an increase of mesophilous deciduous trees (*Quercus, Tilia, Ulmus*), *Betula* and *Picea* at ca. 13800 cal. BP indicated further climatic warming, and the differences between study sites became apparent. Whereas in warmer southestern Slovenia (Griblje) *Tilia* and *Betula* were more abundant, pollen influx for these two taxa was much lower at Lake Bled, which was located in colder northwestern Slovenia in glaciated landscape and mountains. At both study sites a decline of tree taxa and an increase of herbs (Poaceae, Chenopodiaceae and *Artemisia*) suggest colder and drier conditions in the Younger Dryas.

Keywords: palynology, Lateglacial, lime (*Tilia*), Slovenia, Lake Bled, Griblje

INTRODUCTION

Slovenia is located in the vicinity of glacial refugia for coniferous and deciduous tree taxa (e.g. Cheddadi *et al.* 2006; Culiberg 1991; Magri *et al.* 2006; Petit *et al.* 2003; Willis *et al.* 2000; Willis, van Andel 2004), so Lateglacial vegetation in the area was very diverse. At the beginning of the Lateglacial, a steppe with few trees (e.g. *Pinus, Betula*) was growing in Slovenia, but with climatic warming mesophilous deciduous trees (e.g. *Quercus, Tilia, Corylus, Ulmus*) expanded (Culiberg 1991; Culiberg, Šercelj 1998; Šercelj 1970). Palynological research also suggests that, although Lateglacial vegetation seems quite uniform, minor differences in vegetation composition observed at razlikami v sestavi vegetacije na najdiščih v osrednji in severozahodni Sloveniji, ki so bile verjetno posledica različne mikroklime in lokalne topografije (Culiberg 1991). V tem prispevku predstavljena raziskava primerja med seboj pelodni zapis dveh paleoekoloških najdišč, ki ležita v danes klimatsko zelo različnih območjih Slovenije. Prvo najdišče, Blejsko jezero, leži v alpski fitogeografski regiji severozahodne Slovenije, ki je bila ob vrhuncu zadnje poledenitve prekrita z ledom, medtem ko drugo najdišče, močvirje v okolici Gribelj (Bela krajina), ni bilo prekrito z ledom. Rezultati pelodne analize vrtine z Blejskega jezera so bili že objavljeni kot del multidisciplinarne študije poznoglacialne klime, vegetacije in hidrologije (Andrič *et al.* 2009), preliminarni rezultati podrobne palinološke raziskave pri Gribljah pa so v tem prispevku predstavljeni prvič. V članku bom primerjala samo zgornji del obeh vrtin (8–232 cm za Blejsko jezero in 0–270 cm za Griblje), datiran v obdobje po pribl. 14.300 cal. BP. Starejši, spodnji del vrtine z Blejskega jezera (232–521 cm), kjer je pelodna koncentracija nizka, ohranjenost peloda pa slaba, radiokarbonsko ni bil datiran, medtem ko spodnji del vrtine v Gribljah (270–600 cm) še ni bil analiziran. Rezultati te raziskave imajo tudi arheološke implikacije: pomagali nam bodo razumeti, kako so poznoglacialna klimatska nihanja vplivala na sestavo vegetacije in življenje paleolitskih, lovsko-nabiralniških prebivalcev Slovenije.

OPIS PALEOEKOLOŠKIH NAJDIŠČ

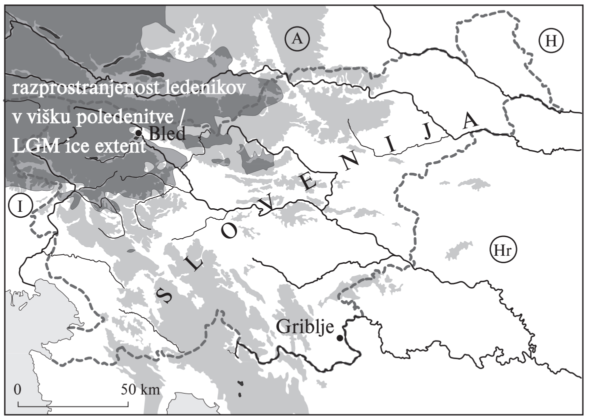
Blejsko jezero (površina 1,45 km^2, največja globina 30 m) leži v severozahodni Sloveniji (46°22'N; 14°06' E) na nadmorski višini 475 m na apnenčasti in dolomitni geološki podlagi (*sl. 1*). Jezero je ledeniškega nastanka in obkroženo s pleistocenskimi morenami; čelne morene, ki so verjetno nastale v zadnjem stadialu, ležijo vzhodno od jezera (Grimšičar 1955; Radinja *et al.* 1987). Današnja klima v regiji je zmerna, s submediteranskim padavinskim režimom (1300–2800 mm letno, padavinski maksimum jeseni). Povprečna temperatura najhladnejšega meseca je med –3 °C in 0 °C, povprečje najtoplejšega meseca pa med 15 °C in 20 °C (Ogrin 1996). Bukovi (*Fagus sylvatica*) gozdovi uspevajo zahodno in severno od jezera, s posamičnimi sestoji belega gabra (*Carpinus betulus*) in vrbe na vzhodu (*Salix* sp.) ter travniki in polji v bližini jezera.

Sl. 1: Geografska lokacija paleoekoloških najdišč z vrisano razprostranjenostjo ledenikov okoli 20.000 cal. BP (po Pohar 1994).
Fig. 1: Geographical position of study sites with Last Glacial Maximum ice extent (after Pohar 1994).

sites mostly located in central and northwestern Slovenia might be a consequence of various microclimate and local topography conditions (Culiberg 1991). This study aims to investigate these differences by comparing pollen records (percentage and pollen influx data) of two study sites located in areas with contrasting climatic conditions. The first site, Lake Bled, is located in the Alpine area of northwestern Slovenia, which in the last glacial maximum was covered by a glacier, whereas the second site, Griblje marsh, located in more continental southeastern Slovenia, was not glaciated (*Fig. 1*). The results of pollen analysis at Lake Bled have already been published as a part of multi-proxy research concerning Lateglacial climate, vegetation, and hydrology (Andrič *et al.* 2009), whereas the preliminary results of high-resolution pollen analysis at Griblje (GRIB 1 site) are presented here for the first time. In this paper only the upper sections of the cores (8-232 cm at Bled and 0-270 cm at Griblje), dated after ca. 14300 cal. BP, are compared. The lower part of the Lake Bled core (232-521 cm) was not radiocarbon-dated and has low pollen concentration and poor pollen preservation (Andrič *et al.* 2009), whereas the pollen record in the lower section of the Griblje core (270-600 cm) has not yet been analysed. The results of this study have also archaeological implications for understanding how rapid Lateglacial climatic fluctuations influenced vegetation composition and affected the Palaeolithic, hunter-gatherer populations of Slovenia.

STUDY AREA

Lake Bled (area 1.45 km^2, max. depth 30 m) is located in northwestern Slovenia (46°22'N; 14°06' E) at 475 m a.s.l. on limestone and dolomite bedrock (*Fig. 1*). The lake developed in a depression shaped by a glacier. It is surrounded by moraines, with Last Glacial Maximum terminal moraines located east of the lake (Grimšičar 1955; Radinja *et al.* 1987). The climate today in the area is temperate, with a submediterranean precipitation regime (1300-2800 mm annual precipitation, with maximum in autumn). The average temperatures of the coldest month



Močvirje v bližini vasi Griblje (GRIB 1) leži v jugovzhodni Sloveniji (Bela krajina) (*sl. 1*). Današnja klima v Beli krajini je zmerna, kontinentalno-subpanonska, s submediteranskim padavinskim režimom (1200–1300 mm padavin letno) in vročimi poletji. Povprečna temperatura najhladnejšega meseca se giblje med –3 °C in 0 °C, najtoplejšega pa med 15 °C in 20 °C (Bernot 1984; Ogrin 1996; Plut 1985). Palinološka vrtina je bila zvrtana v osrednjem delu manjšega, z rogozom (*Typha latifolia*) preraščenega močvirja (s premerom pribl. 20 m), na 160 m nadmorske višine, pribl. 1 km zahodno od vasi Griblje (45° 34' 03" N; 15° 16' 55" E). Močvirje obdajajo polja in travniki, z manjšimi krpami gozda z brezo (*Betula pendula*), rdečim borom (*Pinus sylvestris*) in hrastom (*Quercus petraea*), ter številna manjša močvirja (pribl. 0,5–1 km severno in severovzhodno), nekatera prerasla s šaši (Cyperaceae) ali jelšo (*Alnus glutinosa*), vrbo (*Salix* sp.) in brezo (*Betula pendula*).

METODE

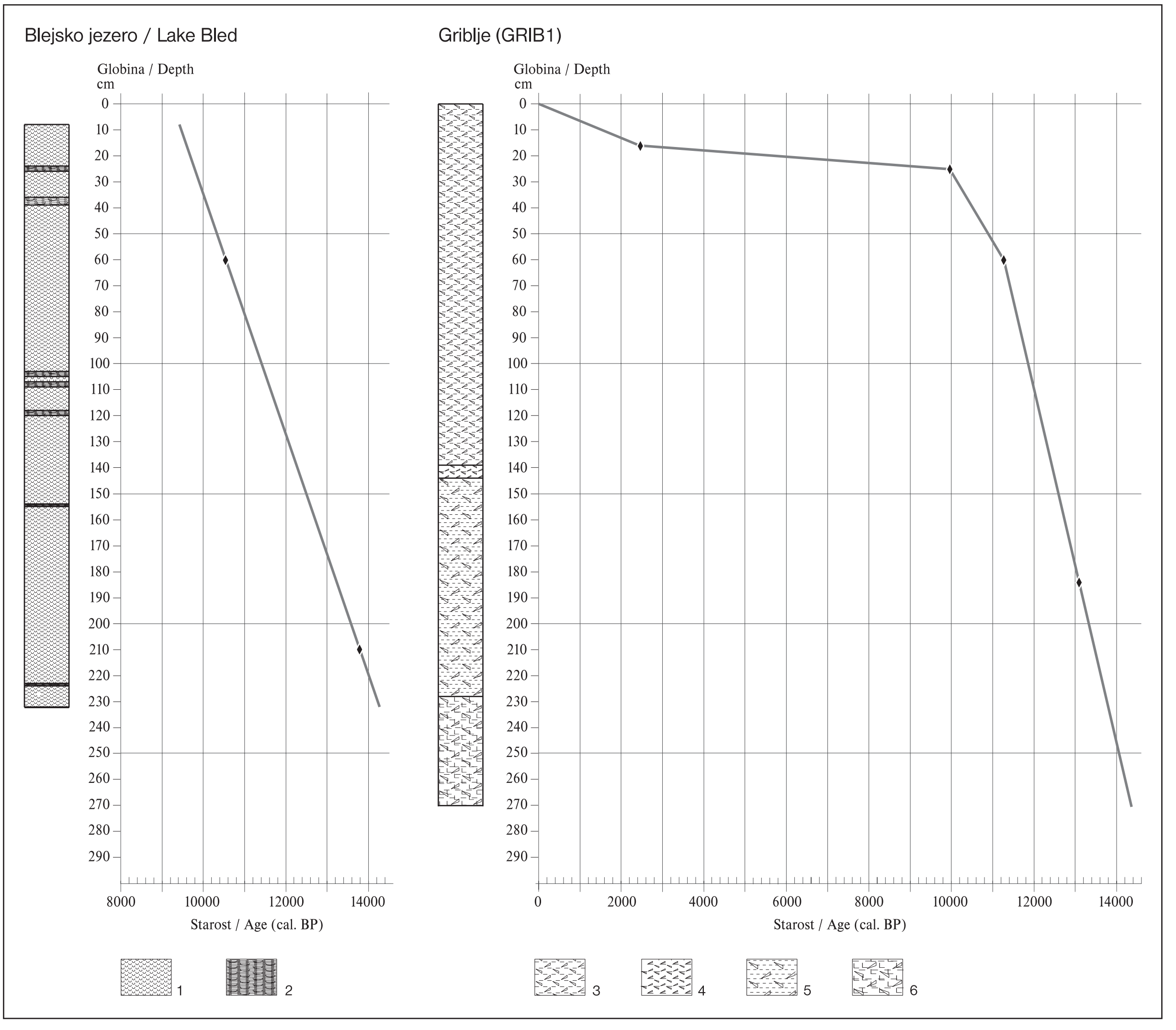
Vrtina iz Blejskega jezera je bila zvrtana z vrtalno opremo Livingstone (modifikacija po Merktu in Streifu, 1970, s premerom cevi 4,8 cm) s platforme, postavljene v jugozahodnem delu jezera (Andrič *et al.* 2009). Za vrtanje močvirja pri Gribljah (GRIB 1) smo uporabili vrtalno opremo Livingstone (modifikacija 'Stitz') s premerom 8,4 cm, vezano na električno kladivo in prenosni generator. Na obeh lokacijah smo 1 m dolge segmente vrtine zavili v folijo na terenu in shranili v hladilnici pri +4 °C. Starost paleoekološkega zapisa v vrtinah je bila določena s pomočjo AMS-radiokarbonskega datiranja (*tab. 2*) makrofosilov kopenskih rastlin (Blejsko jezero) in organskega sedimenta (Griblje). Konvencionalni datumi C14 so bili kalibrirani z računalniškim programom CALIB rev 5.0.1 (CALIB 5.0 Website; Stuvier, Reimer 1993), ob uporabi podatkovne baze IntCal 04 (Reimer *et al.* 2004). Za določanje starosti sedimenta je bilo uporabljeno modeliranje s pomočjo linearne interpolacije skozi srednje cal. BP vrednosti (*sl. 2*). Opis litologije (*tab. 1*) je bil opravljen po Troels-Smithu (1955). Vzorci za pelodno analizo (vsakič 1 cm^3 sedimenta) so bili pripravljeni po standardnem laboratorijskem postopku (Bennett, Willis 2002). Pred laboratorijsko pripravo so bile sedimentu dodane tablete spor *Lycopodium* za določanje pelodne koncentracije (Stockmarr 1971). Koncentracija mikroskopskega oglja je bila določena po Clarkovi točkovni ('point count') metodi (Clark 1982). Pelodna zrna so bila identificirana s pomočjo svetlobnega mikroskopa Nikon Eclipse E400 pri 400-kratni povečavi, pri čemer je bila minimalna vsota preštetih pelodnih zrn kopenskih rastlin in spor (praproti in mahov) 500 na vzorec. Rezultati pelodne analize (*sl. 3, 4 in 5*) so bili matematično obdelani in zrisani s pomočjo programa PSIMPOLL 3.00 (http://chrono.qub.ac.uk/psimpoll/psimpoll.html).

are between -3 °C and 0 °C, while the average for the warmest month is between 15 °C and 20 °C (Ogrin 1996). Beech (*Fagus sylvatica*) forests grow west and north of the lake, patchy woodlands of hornbeam (*Carpinus betulus*) and willow (*Salix* sp.) to the east. Meadows and fields are also located in the vicinity of the lake.

Griblje (GRIB 1) marsh is located in the Bela krajina region of southeastern Slovenia (*Fig. 1*). The climate today in the area is moderate continental-subpannonian with a sub-mediterranean precipitation regime (1200-1300 mm annual precipitation) with hot summers. The average temperatures of the coldest month are between -3 °C and 0 °C, while the warmest month average is between 15 °C and 20 °C (Bernot 1984; Ogrin 1996; Plut 1985). The sedimentary core GRIB 1 was collected in marsh area, which developed in a small depression (diameter ca. 20 m) at 160 m a.s.l., ca. 1 km west of the Griblje village (45° 34' 03"; 15° 16' 55"). Reed-mace (*Typha latifolia*) grows at the coring location, which is surrounded by meadows and fields, with patchy woodlands of birch (*Betula pendula*), pine (*Pinus sylvestris*), and oak (*Quercus petraea*). Several small marshy areas, some overgrown with sedges (Cypearceae) or alder (*Alnus glutinosa*), willow (*Salix* sp.) and birch (*Betula pendula*) are located around the Griblje village, ca. 0.5-1 km to the north and northeast of the coring location.

METHODS

Lake Bled was cored from a platform in the southwestern part of the lake with a Livingstone piston corer modification after Merkt and Streif (1970), with tube diameter of 4.8 cm (Andrič *et al.* 2009), while the Griblje (GRIB 1) site was cored with a 'Stitz' Livingstone modification with tube diameter 8.4 cm, attached to an electric hammer and portable generator. At both sites, core sections 1 m long were extruded from the piston corer in the field, wrapped in thick plastic, and stored in a dark coldstore at + 4 °C. The age was determined by AMS radiocarbon dating (*Tab. 2*) of terrestrial plant macrofossils (Lake Bled) and organic sediment (Griblje). Conventional ages were calibrated by CALIB rev 5.0.1 (CALIB 5.0 Website; Stuvier, Reimer 1993) on IntCal 04 calibration dataset (Reimer *et al.* 2004). Linear interpolation through median cal. BP values was used for age-depth modeling (*Fig. 2*). Sediment composition (*Tab. 1*) was described according to Troels-Smith (1955). For the pollen analysis 1 cm^3 samples of sediment were prepared with standard laboratory procedures (Bennett, Willis 2002); *Lycopodium* tablets were added to determine the pollen concentration (Stockmarr 1971), and microscopic charcoal concentration in both cores was established with Clark's (1982) point count method. The pollen was identi-



Sl. 2: Modeliranje starosti (linearna interpolacija) za Blejsko jezero in Griblje (GRIB 1). Litoligija: 1 – karbonatni melj (jezerska kreda); 2 – plasti mahov, 3, 5 – organski sediment s preperelim rastlinskim materialom; 4 – organski sediment, zelo bogat s preperelim rastlinskim materialom; 6 – organski sediment z meljem in preperelim rastlinskim materialom.
Fig. 2: Age-depth modelling (linear interpolation) for Lake Bled and Griblje (GRIB 1). Lithology: 1 - calcareous silt (lake marl); 2 - moss layers; 3, 5 - organic sediment with plant detritus; 4 - organic sediment very rich in plant detritus; 6 - organic sediment with silt and plant detritus.

REZULTATI

OPIS SEDIMENTA IN RADIOKARBONSKO DATIRANJE

Sediment vrtin se zaradi različnih naravnih značilnosti bazenov med seboj močno razlikuje. Vrtina iz Blejskega jezera vsebuje veliko sivkastega meljastega sedimenta (jezerske krede) s posameznimi plastmi mahov (iz družin *Scorpidium, Pseudocalliergon* in *Calliergon*) na naslednjih globinah: 24–29 cm, 107–155 cm in 223–315 cm (Andrič *et al.* 2009). Vrtina iz Gribelj vsebuje veliko organskih snovi (z ostanki preperelega rastlinskega materiala na 139–144 cm), pod 228 cm pa nekoliko manj organskih snovi kot v zgornjem delu

fied with a Nikon Eclipse E400 light microscope at 400x magnification. At least 500 terrestrial pollen grains and spores were counted per sample. Pollen data (*Figs. 3-5*) were analysed and plotted with the PSIMPOLL 3.00 program (http://chrono.qub.ac.uk/psimpoll/psimpoll.html).

RESULTS

SEDIMENT DESCRIPTION AND RADIOCARBON DATING

Due to contrasting natural characteristics of the basins studied, the sedimentary composition of paly-

Tab. 1: Opis sedimenta po Troels-Smith (1955).
Tab. 1: Troels-Smith (1955) description of the sediment.

Globina / Depth	Troels Smith oznaka / Troels Smith symbol	Opis sedimenta (Munsellova barvna lestvica) / Sediment description (Colour Munsell soil chart)
Blejsko jezero (C) / Lake Bled (C)		
0-232 cm	Lc4	Karbonaten siv melj (jezerska kreda) / Calcarous grey silt (lake marl)
S plastmi mahov na sledečih globinah / With moss layers at 24-26, 36-39, 103-105, 107-109, 118-120, 154-155 and 223-224 cm	Lc1 Tb3	Karbonaten siv melj (jezerska kreda) z mahovi / Calcarous grey silt (lake marl) with moss macrofossils
Griblje (GRIB 1)		
0-139 cm	Dh2 Sh2	Črn sediment z organskimi snovmi in preperelim rastlinskim materialom / Organic black sediment with plant detritus
139-144 cm	Dh3 Sh1	Črn sediment, zelo bogat z organskimi snovmi in preperelim rastlinskim materialom / Organic black sediment, very rich in plant detritus
144-228 cm	Dh1 Sh3	Temno rjav organski sediment s preperelim rastlinskim materialom / Organic very dark brown sediment, with plant detritus
228-270 cm	Dh1 Sh1 As2	Meljast temno sivorjav organski sediment / Organic very dark greyish brown sediment with silt

(*tab. 1*). Čeprav je razlika v sestavi sedimenta med obema paleoekološkima najdiščema velika, je hitrost sedimentacije primerljiva: pribl. 0,046 cm na leto v Blejskem jezeru in med 0,027 in 0,068 cm na leto v poznoglacialnem delu vrtine iz Gribelj. Medtem ko v vrtini iz Blejskega jezera (ki je datirana v zgodnji holocen in pozni glacial med pribl. 9400–14.300 cal. BP) manjka večina holocenskega sedimenta, je ta v vrtini iz Gribelj v celoti ohranjen, vendar izjemno plitev (75 cm). Počasna sedimentacija v zgornjem delu vrtine iz Gribelj (pribl. 0,001–0,006 cm na leto) je verjetno posledica bolj suhih hidroloških razmer v srednjem in poznem holocenu zaraščajočega se jezera.

PELODNA ANALIZA

Rezultati pelodne analize za izbrane taksone so prikazani na dveh kratkih odstotkovnih pelodnih diagramih (*sl. 3 in 4*). V prvotni objavi je bil pelodni diagram vrtine iz Blejskega jezera razdeljen na pet statistično pomembnih pelodnih con s pomočjo metode optimalnega razcepa po obsegu informacije ('optimal splitting by information content') (Bennett 1996). Glavna značilnost zgornjega dela pelodne cone B-3 (*sl. 3*, 232–200 cm) je visok odstotek peloda bora (*Pinus*, pribl. 75–95 %) in veliko nižji delež peloda zelišč kot v prejšnjih dveh conah (B-1, B-2 in spodnjem delu B-3, ki niso prikazane na *sl. 3*). Na začetku pelodne cone B-4 (200–115 cm) odstotek bora začne upadati, medtem ko

nological cores is very dissimilar. The Lake Bled core is rich in greyish calcareous silt (lake marl) with distinct moss layers (belonging to genera *Scorpidium, Pseudocalliergon* and *Calliergon*) at 24-29 cm, 107-155 cm and 223-315 cm (Andrič *et al.* 2009). The Griblje core, on the other hand, is rich in organic material (with lots of plant detritus at 139-144 cm), whereas below 228 cm the amount of organic material is less and the sediment contains more clay (*Tab. 1*). Despite these differences the sedimentation rates at both sites are comparable, with ca. 0.046 cm yr^{-1} at Lake Bled and between 0.027 cm yr^{-1} and 0.068 cm yr^{-1} in the Lateglacial part of the Griblje core. Wereas at Lake Bled (dated to the early Holocene and Lateglacial, ca. 9400-14300 cal. BP) most of the Holocene sediment is missing, at Griblje a complete but extremely short (ca. 75 cm) Holocene sequence was deposited. This slow mid- and late-Holocene sedimentation rate at Griblje (ca. 0.001-0.006 cm yr^{-1}) is most probably a consequence of drier hydrological conditions in the final, successional phase of the infilling lake.

POLLEN ANALYSIS

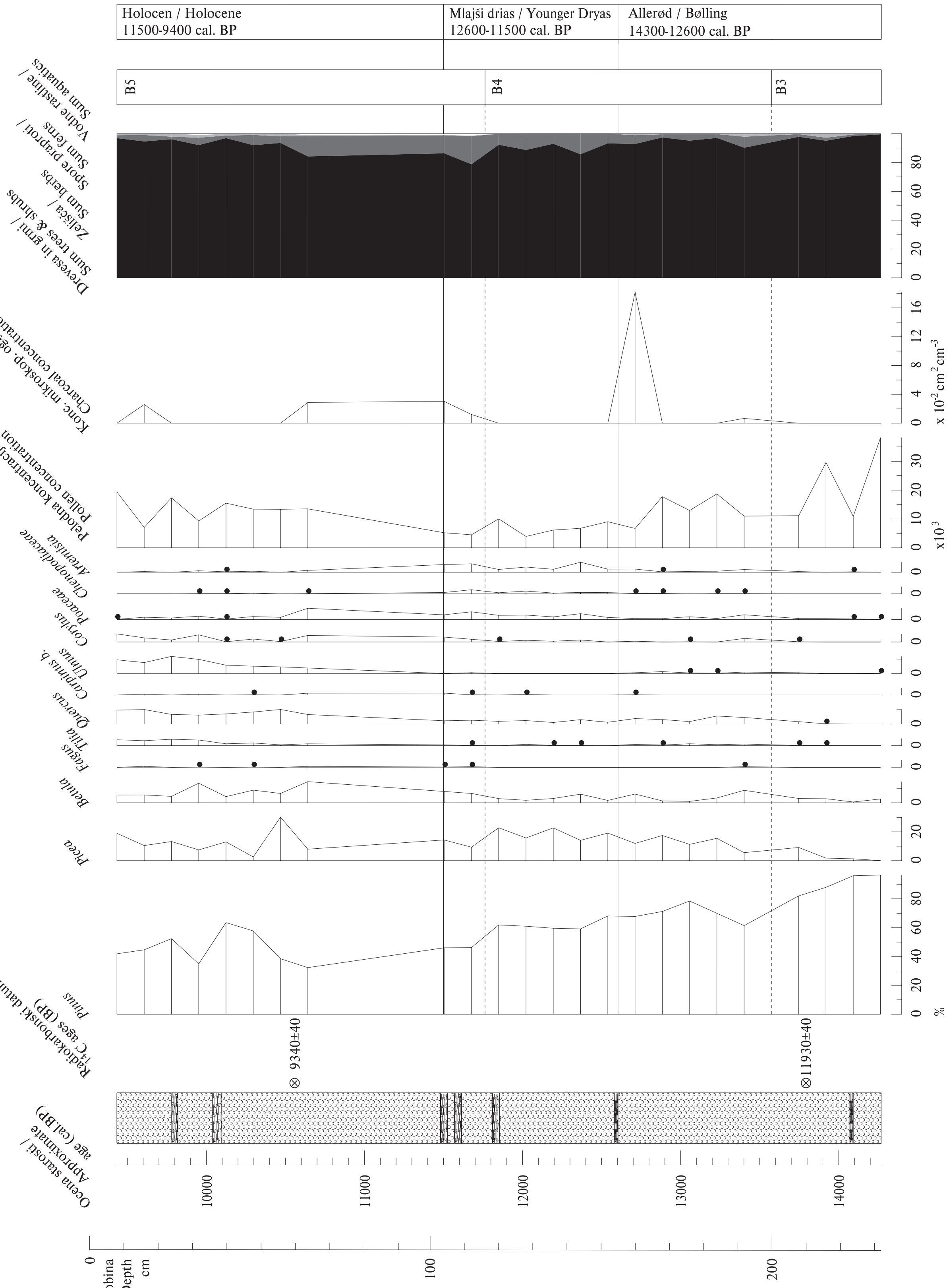
The results of pollen analysis are presented in two short percentage pollen diagrams of selected taxa (*Figs. 3-4*). In the original publication (Andrič *et al.* 2009) the Lake Bled pollen diagram was divided into five statistically significant pollen zones by the method of optimal splitting by information content (Bennett

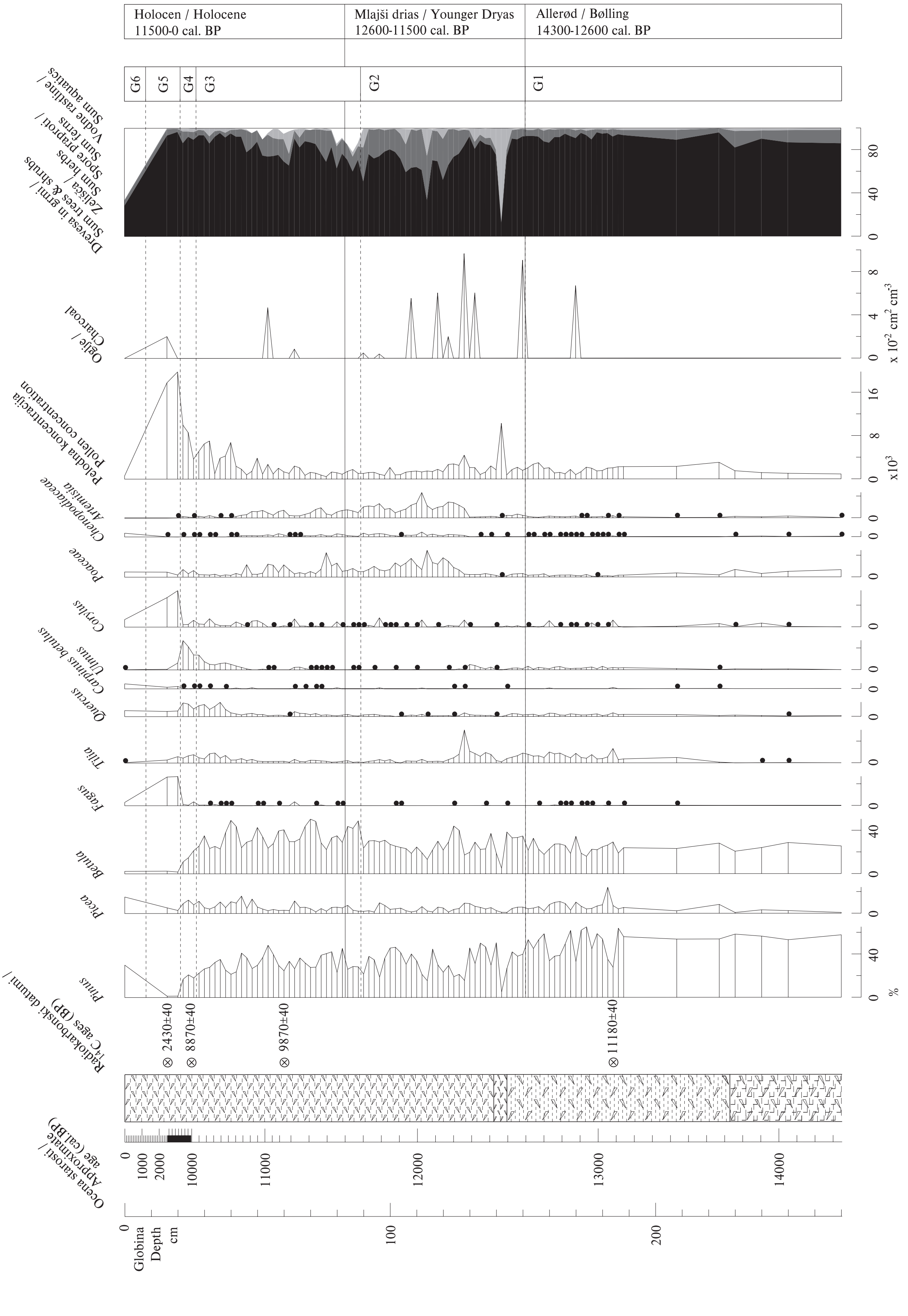
→

Sl. 3: Blejsko jezero. Odstotkovni pelodni diagram za izbrane taksone: *Pinus* (bor), *Picea* (smreka), *Betula* (breza), *Fagus* (bukev), *Tilia* (lipa), *Quercus* (hrast), *Carpinus betulus* (beli gaber), *Ulmus* (brest), *Corylus* (leska), Poaceae (trave), Chenopodiaceae (metlikovke), *Artemisia* (pelin).
Fig. 3: Lake Bled. Percentage pollen diagram of selected taxa: *Pinus* (pine), *Picea* (spruce), *Betula* (birch), *Fagus* (beech), *Tilia* (lime), *Quercus* (oak), *Carpinus betulus* (hornbeam), *Ulmus* (elm), *Corylus* (hazel), Poaceae (grasses), Chenopodiaceae (goosefoot), *Artemisia* (wormwood).

Tab. 2: Radiokarbonski datumi za Blejsko jezero in Griblje (GRIB 1). Radikarbonska datuma za Blejsko jezero z globine 40 cm (Beta-189953 in Poz-3123, organski sediment) nista bila uporabljena pri modeliranju starosti vrtine zaradi domnevnega vpliva starejšega ogljika, ki izvira iz geološke podlage bazena ('reservoir' efekta).
Tab. 2: Radiocarbon dates for Lake Bled and Griblje (GRIB 1). Lake Bled radiocarbon dates at 40 cm (Beta-189953 and Poz-3123, organic sediment) were not used for age-depth modelling due to errors presumably caused by reservoir effect.

Številka vzorca / Sample number	**Globina (cm) / Depth (cm)**	**Datirani material (laboratorijski postopek) / Material dated (pretreatment)**	**Konvencionalni radiokarbonski datum / Conventional C14 age**	**13C/12C delež / 13C/12C ratio**	**2 sigma kalibracija (cal. BP, Intcal 04) / 2 sigma calibration (cal. BP, Intcal 04)**	**Median (BP) / Median (BP)**
Bled C						
Beta-222472	60 cm	iglice macesna (*Larix*), del storža in krilca semen iglavcev (spiranje kislina/baza/kislina) / *Larix* leaves, part of cone scale and wings of coniferous seeds (acid/alkali/acid)	9340 ± 40 BP	-26.9 ‰	10679-10426	10555
Beta-217805	210 cm	vejica in iglice macesna (*Larix*) (spiranje kislina/baza/kislina) / *Larix* twig and needles (acid/alkali/acid)	11930 ± 40 BP	-28.2 ‰	13908-13699	13790
Beta-189953	40 cm	organski sediment (spiranje s kislino) / organic sediment (acid washes)	13860 ± 100 BP	-33.8 ‰		
Poz-3123	40 cm	organski sediment (spiranje s kislino) / organic sediment (acid washes)	15430 ± 80 BP	/		
Griblje (GRIB 1)						
Beta-182668	16 cm	organski sediment (spiranje s kislino) / organic sediment (acid washes)	2430 ± 40 BP	-28.8 ‰	2351-2702	2475
Beta-189851	25 cm	organski sediment (spiranje s kislino) / organic sediment (acid washes)	8870 ± 60 BP	-27.9 ‰	9737-10184	9993
Beta-183924	60 cm	organski sediment (spiranje s kislino) / organic sediment (acid washes)	9870 ± 40 BP	-27.4 ‰	11206-11386	11262
Beta-182669	184 cm	organski sediment (spiranje s kislino) / organic sediment (acid washes)	11180 ± 60 BP	-28.7 ‰	12946-13202	13083


Holocen / Holocene
11500-9400 cal. BP
Mlajši drias / Younger Dryas
12600-11500 cal. BP
Allerød / Bølling
14300-12600 cal. BP
B5
B4
B3
Vodne rastline / Sum aquatics
Spore praproti / Sum ferns
Zelišča / Sum herbs
Drevesa in grmi / Sum trees & shrubs
Konc. mikroskop. oglja / Charcoal concentration
Pelodna koncentracija / Pollen concentration
Artemisia
Chenopodiaceae
Poaceae
Corylus
Ulmus
Carpinus b.
Quercus
Tilia
Fagus
Betula
Picea
Pinus
Radiokarbonski datumi / ^{14}C ages (BP)
⊗ 9340±40
⊗11930±40
Ocena starosti / Approximate age (cal BP)
10000
11000
12000
13000
14000
Globina
Depth
cm
0
100
200
x 10^{-2} cm^{2}cm^{-3}
x10^3
%



Holocen / Holocene
11500-0 cal. BP
Mlajši drias / Younger Dryas
12600-11500 cal. BP
Allerød / Bølling
14300-12600 cal. BP
G6
G5
G4
G3
G2
G1
Drevesa in grmi / Sum trees & shrubs
Zelišča / Sum herbs
Spore praproti / Sum ferns
Vodne rastline / Sum aquatics
Oglje / Charcoal
x 10^{-2} cm^{2} cm^{-3}
Pelodna koncentracija
Pollen concentration
x10^{3}
Artemisia
Chenopodiaceae
Poaceae
Corylus
Ulmus
Carpinus betulus
Quercus
Tilia
Fagus
Betula
Picea
Pinus
%
Radiokarbonski datumi / ^{14}C ages (BP)
2430±40
8870±40
9870±40
11180±40
Ocena starosti / Approximate age (cal. BP)
Globina
Depth
cm

←
Sl. 4: Griblje (GRIB 1). Odstotkovni pelodni diagram za izbrane taksone: *Pinus* (bor), *Picea* (smreka), *Betula* (breza), *Fagus* (bukev), *Tilia* (lipa), *Quercus* (hrast), *Carpinus betulus* (beli gaber), *Ulmus* (brest), *Corylus* (leska), Poaceae (trave), Chenopodiaceae (metlikovke), *Artemisia* (pelin).
Fig. 4: Griblje (GRIB 1). Percentage pollen diagram of selected taxa: *Pinus* (pine), *Picea* (spruce), *Betula* (birch), *Fagus* (beech), *Tilia* (lime), *Quercus* (oak), *Carpinus betulus* (hornbeam), *Ulmus* (elm), *Corylus* (hazel), Poaceae (grasses), Chenopodiaceae (goosefoot), *Artemisia* (wormwood).

delež drugih drevesnih taksonov (*Picea, Larix, Tilia, Ulmus, Quercus* in *Corylus*) narašča. V zgornji polovici zone B-4 (160–115 cm) delež dreves za kratek čas upade, vendar spet naraste na začetku zone B-5 (115–8 cm).

Pelodni diagram vrtine iz Gribelj (*sl. 4*) je razdeljen na šest pelodnih con s pomočjo metode binarnega razcepa po vsoti kvadratov ('binary splitting by sum of squares') v PSIMPOLLU. Glavna značilnost spodnje pelodne cone (G-1, 270–150 cm) je razmeroma visok odstotek peloda bora (*Pinus,* pribl. 30–60 %) in breze (*Betula,* pribl. 20–30 %), delež peloda ostalih listavcev (e.g. *Tilia, Quercus, Ulmus*) pa proti vrhu cone narašča. Glavna značilnost pelodne cone G-2 (150–90 cm) je nižji odstotek peloda dreves (e.g. *Tilia, Quercus* in *Ulmus* upadejo na pribl. 130 cm) in porast deleža peloda zelišč (e.g. Poaceae, Chenopodiaceae in *Artemisia*). V coni G-3 (150–21 cm) delež peloda dreves spet začne naraščati, medtem ko so spremembe v conah G-4, G-5 in G-6 povezane s spremembami holocenske vegetacije.

Primerjava vrednosti za pelodni influks na obeh najdiščih (*sl. 5*) kaže najvišje vrednosti za bor (*Pinus*, pribl. 200–1600 pelodnih zrn na 1 cm^2 na leto) za obdobje med pribl. 14.300 in 12.600 cal. BP. V Gribljah je plodni influks breze (*Betula,* pribl. 200–600 pelodnih zrn na 1 cm^2 na leto) in lipe (*Tilia,* 50–200 pelodnih zrn na 1 cm^2 na leto med 13.450 in 12.600 cal. BP) veliko večji kot v Blejskem jezeru (oba taksona < 50 pelodnih zrn na 1 cm^2 na leto). Po 12.600 cal. BP pelodni influks bora na obeh najdiščih upade. Upad deleža ostalih drevesnih vrst (e.g. *Tilia, Quercus, Ulmus*) in porast deleža zelišč (e.g. Poaceae, *Artemisia*) okrog 12.300 cal. BP sta izrazitejša v Gribljah. Porast pelodnega influksa drevesnih vrst na obeh najdiščih okrog 10.600 cal. BP je povezan s holocensko klimatsko otoplitvijo.

RAZPRAVA

POZNOGLACIALNI INTERSTADIAL (BØLLING IN ALLERØD, PRIBL.14.300−12.600 CAL. BP)

Okrog 14.300 cal. BP je v okolici obeh najdišč verjetno uspeval redek mešani gozd. Na podlagi fosilnega pelodnega zapisa je zelo težko rekonstruirati nekdanjo pokrajino; še zlasti težko je potegniti ločnico med odprtim borealnim gozdom in tundro ali stepo (Pelánková *et al.* 2008; Seppä, Hicks 2006). Rezultati

1996). The main characteristic of the upper pollen zone B-3 (*Fig. 3*, 232-200 cm) is the high percentage of *Pinus* pollen (ca. 75-95 %) and much lower percentage of herb pollen than in the previous two zones (B-1, B-2 and lower B-3, not presented in *Fig. 3*). At the beginning of pollen zone B-4 (200-115 cm) the percentage of *Pinus* starts to decline, whereas other tree taxa (*Picea, Larix, Tilia, Ulmus, Quercus* and *Corylus*) increase. There is a short decline of tree taxa in the upper half of the zone (160-115 cm), but at the beginning of zone B-5 (115-8 cm) tree taxa increase again.

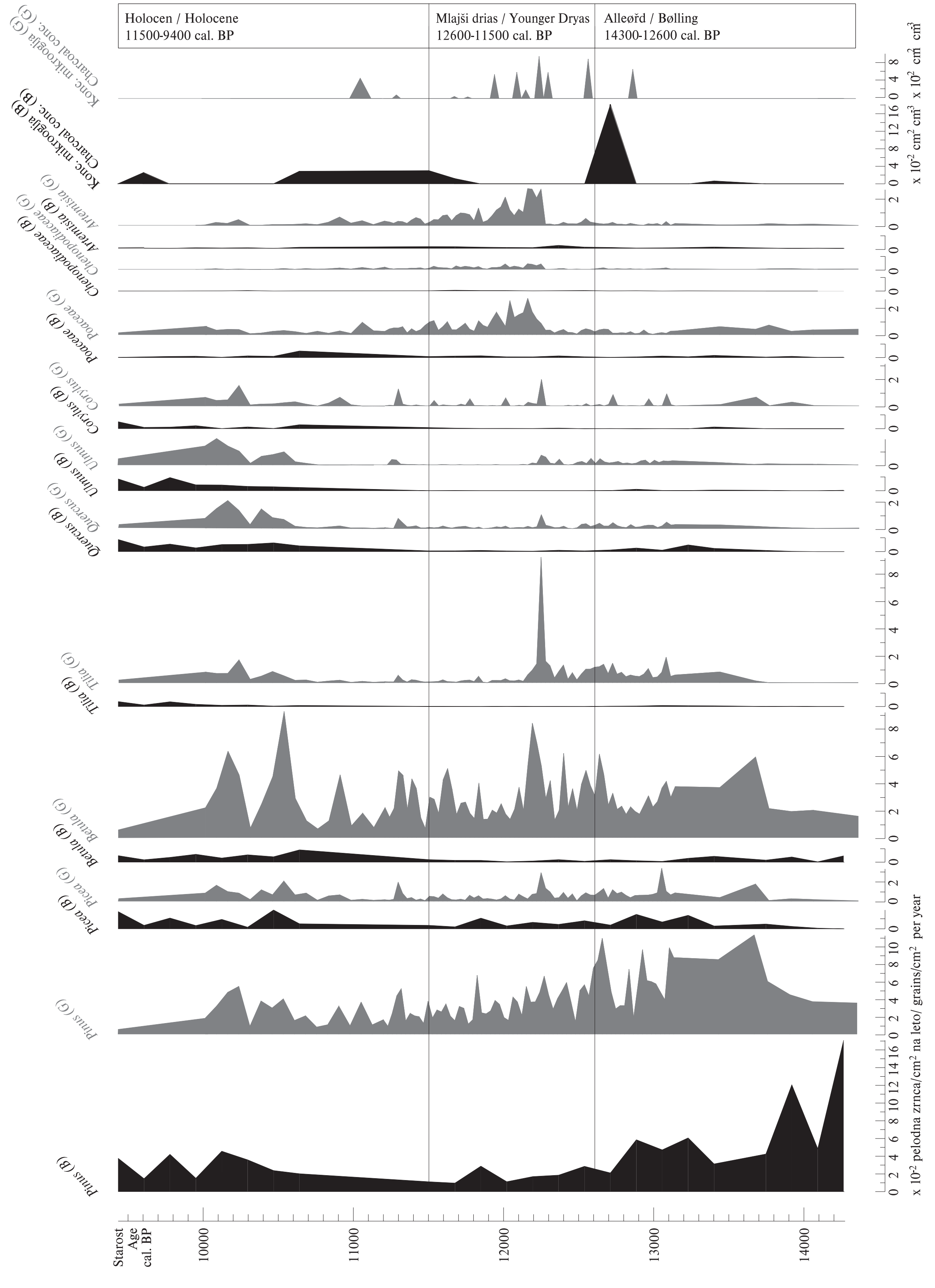
The Griblje pollen diagram (*Fig. 4*) is divided into six pollen zones with the 'binary splitting by sum of squares' option in PSIMPOLL. The main characteristic of the lowest pollen zone (G-1, 270-150 cm) is the rather high percentage of *Pinus* (ca. 30-60 %) and *Betula* (ca. 20-30 %) with pollen of other deciduous tree taxa (e.g. *Tilia, Quercus, Ulmus*) increasing towards the top of the zone. The main characteristic of pollen zone G-2 (150-90 cm) is the lower percentage of tree pollen (e.g. *Tilia, Quercus* and *Ulmus* decline at ca. 130 cm) and an increase of herbs (e.g. Poaceae, Chenopodiaceae and *Artemisia*). In zone G-3 (150-21 cm) trees start to increase again, whereas changes in zones G-4, G-5, and G-6 are associated with changes of vegetation composition in the Holocene.

The comparison of pollen influx values for the two sites (*Fig. 5*) shows highest pollen influx values for *Pinus* (ca. 200-1600 grains cm^{-2} per year) ca. 14300-12600 cal. BP. At Griblje, *Betula* (ca. 200-600 grains cm^{-2} yr^{-1}) and *Tilia* (50-200 grains $cm^{-2}yr^{-1}$ between 13450 and 12600 cal. BP) pollen influx is much higher than at Lake Bled (both taxa < 50 grains $cm^{-2}yr^{-1}$). After 12600 cal. BP *Pinus* pollen influx at both study sites decreases. The decline of other tree taxa (e.g. *Tilia, Quercus, Ulmus*) and an increase of herbs (e.g. Poaceae, *Artemisia*) at ca. 12300 cal. BP are more pronounced at Griblje. Finally, an increase of tree pollen influx at 10600 cal. BP is associated with the Holocene climatic warming.

DISCUSSION

LATEGLACIAL INTERSTADIAL (BØLLING AND ALLERØD, CA. 14300-12600 CAL. BP)

At ca. 14300 cal. BP open woodland of deciduous and needle-leaved taxa was probably growing at both



Sl. 5: Primerjava pelodnega influksa za Blejsko jezero (B, črno) in Griblje (G, sivo).
Fig. 5: Comparison of pollen influx at Lake Bled (B, black) and Griblje (G, grey) study sites.

analize rastlinskih makrofosilov iz Blejskega jezera (Andrič *et al.* 2009) kažejo na lokalno prisotnost breze (*Betula*) in macesna (*Larix*), presenetljivo pa v vrtini ni bilo rastlinskih makrofosilov bora (*Pinus*), čeprav visoke vrednosti peloda v nekaterih vzorcih presegajo vrednosti, značilne za lokalno prisotnost bora (= 500 pelodnih zrn na 1 cm^2 na leto) glede na raziskave modernega pelodnega influksa (Seppä, Hicks 2006; van der Knaap *et al.* 2001). V Gribljah, kjer analiza rastlinskih makrofosilov ni bila opravljena, pelodni zapis kaže podobno sliko kot v primeru Blejskega jezera. Edina razlika med najdiščema so nižje odstotkovne in influksne vrednosti za bor v Gribljah med 14.300 in 13.800 cal. BP (ki pa bi lahko bile posledica premajhnega števila radiokarbonskih datumov v spodnjem delu cone G-1) in precej večje vrednosti za brezo v Gribljah (*sl. 5*).

Porast vrednosti za hrast (*Quercus*), lipo (*Tilia*), brezo (*Betula*), brest (*Ulmus*) in smreko (*Picea*) okrog 13.800 cal. BP na obeh najdiščih (*sl. 3 in 4*) je verjetno povezan z nadaljnjo otoplitvijo klime. Breza in lipa sta bili mnogo bolj številčno zastopani v Gribljah. Lipa tvori malo peloda in je na pelodnih diagramih običajno slabo zastopana (Faegri, Iversen 1989). Tudi v primeru, ko so vrednosti lipe na pelodnem diagramu zelo nizke (< 2 %, pribl. 2 pelodni zrni na 1 cm^2 na leto; Giesecke 2005), je ta drevesna vrsta vseeno lahko prisotna lokalno. Visoke odstotkovne (5–25 %) in influksne (50–900 pelodnih zrn na 1 cm^2 na leto) vrednosti za lipo v Gribljah (*sl. 5*) torej kažejo, da je v okolici Gribelj verjetno uspevalo kar veliko lokalne lipe. Vrednosti za lipo na pelodnem diagramu iz Blejskega jezera (0,5–1 %, 1 pelodno zrno na 1 cm^2 na leto) so v nasprotju z Gribljami precej nižje, kar je verjetno posledica hladnejše klime v severozahodni Sloveniji, čeprav ne bi smeli zanemariti tudi vpliva različnih naravnih značilnosti bazenov. Veliko manjše močvirje v Gribljah je namreč tudi veliko bolj občutljivo za beleženje lokalnih sprememb vegetacije (*sensu* Jacobson, Bradshaw 1981) in lažje zazna vpliv manjše populacije lokalne lipe.

Vrednosti za lipo v Gribljah so višje tudi od vrednosti na nekaterih drugih paleoekoloških najdiščih zahodno od Slovenije, na primer na najdišču Palughetto (70 x 90 m, 1040 m n.m., *Tilia* ≤ 10 %, Vescovi *et al.* 2007), ki leži na večji nadmorski višini in ima hladnejšo klimo. Tudi na vzhodu, na Madžarskem in v Romuniji, so poznoglacialne vrednosti za lipo, ki je bila verjetno prisotna na nekaterih izoliranih lokacijah in se je močneje razširila šele na prehodu poznega glaciala v holocen, nizke (e.g. pribl. ≤ 2 % na najdišču Sarrett; Feurdean *et al.* 2007; Willis *et al.* 2000). Borovi gozdovi so prevladovali na območjih z nizko nadmorsko višino na madžarski ravnici v celotnem poznem glacialu, najverjetneje zaradi sušne klime (Feurdean *et al.* 2007).

Zakaj so pelodne vrednosti za lipo v Gribljah višje kot na sosednjih območjih? Klima v jugovzhodni Sloveniji je bila verjetno toplejša kot na območju

study sites, although the reconstruction of past landscapes from fossil pollen assemblages is very difficult, especially for distinguishing between open boreal forest and grassland or tundra (Pelánková *et al.* 2008; Seppä, Hicks 2006). The results of plant-macrofossil analysis at Lake Bled (Andrič *et al.* 2009) suggest local presence of *Betula* and *Larix*. Surprisingly, no *Pinus* macrofossils were discovered, although *Pinus* pollen-accumulation rates (PAR) in some samples exceed the threshold values (= 500 pollen grains $cm^{-2}yr^{-1}$) for local presence according to modern PAR studies (Seppä, Hicks 2006; van der Knaap *et al.* 2001). At Griblje, where no plant-macrofossil analysis was carried out, pollen-percentage and influx values suggest a vegetation composition similar to that in the Lake Bled area. The only difference between the study sites is lower *Pinus* percentage and influx values at Griblje between 14300 and 13800 cal. BP (which might be affected by lack of radiocarbon dating in the lower part of Griblje zone G1), whereas *Betula* values at Griblje are much higher than at Lake Bled (*Fig. 5*).

At ca. 13800 cal. BP an increase of *Quercus, Tilia, Betula, Ulmus* and *Picea*, which could be associated with further climatic warming, was detected at both study sites (*Figs. 3-4*). *Betula* and *Tilia* were much more abundant at Griblje. *Tilia* is a poor pollen producer and thus under-represented in pollen diagrams (Faegri, Iversen 1989). It could be present locally even when percentage and PAR values are very low (< 2 %, ca. 2 grains cm^{-2} per year; Giesecke 2005). High *Tilia* percentage (5-25 %) and PAR (50-900 grains cm^{-2} per year) values at Griblje (*Fig. 5*) therefore suggest that a significant local population of *Tilia* was growing around the study site. In contrast to Griblje, *Tilia* values at Lake Bled are much lower (0.5-1 %, 1 grain cm^{-2} per year). It seems that this is a consequence of a presumably colder climate in northwestern Slovenia, although the impact of basin size should not be ignored, whereby the much smaller Griblje basin would more likely 'pick up' pollen of the small, local *Tilia* population (*sensu* Jacobson, Bradshaw 1981).

If we compare Griblje with other study sites, located farther west, *Tilia* values at Palughetto basin (70 x 90 m, 1040 m a.s.l.) are lower (≤ 10 %) than at Griblje (Vescovi *et al.* 2007), presumably because of the colder climate at higher altitude. Also on the east, in Hungary and Romania, where Lateglacial *Tilia* values are very low (e.g. ca. ≤ 2 % at Sarrett), *Tilia* was most probably present in a few isolated places throughout the Lateglacial and rapidly expanded at the Lateglacial - Holocene transition (Feurdean *et al.* 2007; Willis *et al.* 2000). It was suggested that *Pinus*-dominated woodlands on the Hungarian plain throughout the Lateglacial are a consequence of drier climatic conditions at lower elevations (Feurdean *et al.* 2007).

What was the main reason for the high *Tilia* values at Griblje in comparison with neighbouring regions?

Alp (ki so bile na vrhuncu glaciala poledenele) in verjetno tudi manj ekstremno suha kot na vzhodu, kjer paleoklimatske ocene za območje severozahodne Romunije predvidevajo kontinentalno, veliko bolj suho poznoglacialno klimo s precej hladnejšimi zimami in le rahlo hladnejšimi poletji kot danes (Feurdean *et al.* 2008). Pelod lipe potrebuje za kalitev visoke temperature (Pigott, Huntley 1981), vendar pa se lahko lipa razmnožuje tudi vegetativno (Pigott 1991), preživi nizke temperature (Pigott 1991) in je odpornejša na poletno sušo kot leska (*Corylus*), jelša (*Alnus*) ali brest (*Ulmus*) (Diekmann 1996). V tem času je klima verjetno postala tudi bolj sušna, kar nakazujejo nizki nivoji jezer na območju južno od Alp (e.g. Magny *et al.* 2006; Vannière *et al.* 2004; Vescovi *et al.* 2007). Ostanki insektov (chironomida) in plasti mahov v Blejskem jezeru nakazujejo hidrološko plitvejše razmere (Andrič *et al.* 2009), medtem ko je v Gribljah opazna sprememba litologije (manjša vsebnost ilovice in povečanje količine organskih snovi) okrog 13.750 cal. BP, kar bi lahko povezali s hidrološko spremembo in stabilizacijo pokrajine zaradi gostejše vegetacije. Poznoglacialni interstadial se je končal s fazo, za katero so značilni pogosti gozdni požari (pribl. 13.900–13.600 cal. BP) in rahel porast deleža peloda zelišč.

MLAJŠI DRIAS (PRIBL. 12.600–11.500 CAL. BP)

Za začetek mlajšega driasa je značilna povečana koncentracija mikroskopskega oglja in peloda zelišč, čemur je sledila sprememba v sestavi sedimenta (plast mahov v vrtini iz Blejskega jezera (*sl. 3*) in plast s povečano vsebnostjo organskih snovi in povišano pelodno koncentracijo v Gribljah). Tudi delež *Assulina muscorum* in spor mahov *Sphagnum* (ni prikazano na *sl. 4*) naraste. Vse to kaže na hladnejšo in bolj suho klimo. Odstotek *Quercusa, Ulmusa* in *Tilie* v Blejskem jezeru (kjer je začetek mlajšega driasa natančno določen s spremembo v sestavi kisikovih stabilnih izotopov, Andrič *et al.* 2009) upade na začetku mlajšega driasa (pribl. 12.600 cal. BP), v Gribljah pa šele nekaj stoletij kasneje (pribl. 12.250 cal. BP). Vendar pa sta pri ocenjevanju starosti vrtine iz Gribelj, kjer hitrost sedimentacije ni linearna (litološka sprememba in porast koncentracije peloda na 142 cm), potrebna previdnost in dodatno radiokarbonsko datiranje. Vegetacija v okolici Gribelj je bila verjetno manj občutljiva na poslabšanje klime v mlajšem driasu in je morda reagirala kasneje, vendar pa je bila bolj občutljiva na sušne razmere. Porast deleža zelišč (Poaceae, Chenopodiaceae, *Artemisia*) in mikroskopskega oglja je bil izrazitejši v jugovzhodni Sloveniji, ki je bolj odprta proti Panonski nižini in ima danes bolj kontinentalno klimo kot Blejsko jezero. Termofilne drevesne vrste so se spet razširile s klimatsko otoplitvijo in domnevno vlažnejšimi razmerami na začetku holocena.

Climatic conditions in southeastern Slovenia were probably warmer than in the vicinity of the glaciated Alpine region, but probably also less extremely dry than farther east, where palaeoclimatic estimations for northwestern Romania suggest a more continental Lateglacial climate with much colder winters and only slightly colder summers and a drier climate (Feurdean *et al.* 2008). *Tilia* requires high summer temperatures for the growth of the pollen tube (Pigott, Huntley 1981), but it has a good capacity for vegetative reproduction (Pigott 1991), is tolerant of very low temperatures (Pigott 1991) and is more resistant to summer drought than *Corylus, Alnus* or *Ulmus* (Diekmann 1996). It is possible that the climate also became drier, as suggested by lower lake levels in the area south of the Alps (e.g. Magny *et al.* 2006; Vannière *et al.* 2004; Vescovi *et al.* 2007). At Lake Bled the chironomid record and moss layers indicate a lower lake level (Andrič *et al.* 2009), whereas at Griblje the change in lithology (lower clay and higher organic material content) at ca. 13750 cal. BP could be also associated with hydrological change and landscape stabilisation due to the denser vegetation cover. The Lateglacial interstadial ended with a phase of more frequent forest fires (ca. 13900-13600 cal. BP) and a slight increase in herb taxa.

YOUNGER DRYAS (CA. 12600-11500 CAL. BP)

The onset of Younger Dryas (YD) is associated with an increased concentration of microscopic charcoal and herb pollen, followed by a change of sediment composition (moss layer at Lake Bled (*Fig. 3*), a layer with increased plant detritus and pollen concentration at Griblje). Also *Assulina muscorum* and *Sphagunum* spores increase (not presented in *Fig. 4*), suggesting a colder and drier climate. Whereas *Quercus, Ulmus* and *Tilia* at Lake Bled, where the onset and end of YD is sharply defined by the changes in oxygen isotopes (Andrič *et al.*, 2009), start to decline at the beginning of the YD (ca. 12600 cal. BP), at Griblje they appear to decline only a few centuries later (ca. 12250 cal. BP). However, caution is needed when interpreting the age of the Griblje core, since the sedimentation rate might not be linear (lithological change and an increase in pollen concentration at 142 cm). Additional radiocarbon dating is needed. The vegetation around Griblje, therefore, seems to be less susceptible to YD climatic cooling and possibly reacted later, but it seems that it was more affected by the dryness. An increase of herbs (Poaceae, Chenopodiaceae, *Artemisia*) and microscopic charcoal is more pronounced in southeastern Slovenia, which is more open towards the Pannonian plain and today has a more continental climate than Lake Bled. With the Holocene climatic warming and presumably also wetter conditions, thermophilous tree taxa spread again.

POZNOGLACIALNO OKOLJE IN PLEISTOCENSKI LOVCI IN NABIRALCI

Poznoglacialna klimatska nihanja in razširitev listnatega gozda so vplivali tudi na favno. Ostanki sesalske makrofavne na arheoloških najdiščih v Sloveniji kažejo, da je delež vrst, značilnih za tundro (e.g. severni jelen), ki so bile najštevilčnejše v zadnjem stadialu (pribl. 20.000 cal. BP), upadel, medtem ko je delež vrst, značilnih za gozdne habitate (e.g. jelen, los, divja svinja) narasel (Pohar 1994; 1997). V Poljšiški cerkvi (najdišče je datirano na prehod mlajšega driasa v preboreal), ki leži v bližini Blejskega jezera, so v nasprotju z drugimi arheološkimi najdišči ostanki gamsa in kozoroga številni. Favna alpskega okolja, tundre in stepe je pogostejša kot gozdne vrste, verjetno zaradi bližine gora in ledenikov (Pohar 1991; 1997). V Judovski hiši v Beli krajini sta jelen in divja svinja pogosta, kar nakazuje gozdnato pokrajino in toplejšo klimo, čeprav so bili najdeni tudi ostanki alpskega svizca, ki verjetno sodijo v hladnejša obdobja poznega glaciala. Najdišče ni bilo radiokarbonsko datirano, na podlagi tipologije kamenega orodja, ostankov favne in litologije je domnevno poznoglacialne starosti (Pohar 1985; 1997). Rezultati analize favne se tako ujemajo s palinološkimi podatki, ki nakazujejo bolj gozdnato pokrajino v okolici Gribelj kot v okolici Blejskega jezera v poznoglacialnem interstadialu.

Poleg zgoraj opisanih medregionalnih razlik v sestavi vegetacije je ena od glavnih značilnosti poznoglacialnega okolja tudi to, da so bile spremembe vegetacije razmeroma hitre. V Gribljah, na primer, je pretežno borovo-brezov gozd okrog 13.600 cal. BP nadomestila lipa. Ni jasno, kako so te hitre (= v pribl. 100 letih) spremembe v sestavi gozda vplivale na favno in ali so morale lokalne lovsko-nabiralniške skupnosti spremeniti svoje ekonomske strategije. Potem ko je bila lipa okrog 12.250 cal. BP najbolj razširjena, se je pokrajina spet spremenila; postala je bolj odprta, domnevno zaradi hladnejše in bolj suhe klime mlajšega driasa. Upad lipe je povezan s povečano koncentracijo mikroskopskega oglja (*sl. 4*), kar nakazuje, da so lipov gozd uničili naravni požari zaradi suhe klime (kar je verjetneje) ali pa so ga namerno požgali lokalni lovci in nabiralci. Požiganje pokrajine je pomembna strategija za povečanje količine rastlinskih in živalskih virov hrane (e.g. Clarke 1979; Mellars 1976; Simmons 1996; Šercelj 1970; Zvelebil 1994) in v Beli krajini je bila ta praksa pogosta tudi še kasneje, ves holocen (Andrič 2007). Da pa bi bolje razumeli poznoglacialne spremembe okolja, v prihodnosti potrebujemo podrobnejše multidisciplinarne paleoekološke in arheološke raziskave. Intenzivne arheološke raziskave nekdanje ekonomije s podrobno datiranimi poznoglacialnimi fazami so bistvene za razumevanje odzivov ljudi in ekosistemov na poznoglacialna klimatska nihanja.

LATEGLACIAL ENVIRONMENT OF PLEISTOCENE HUNTERS AND GATHERERS

Lateglacial climatic fluctuations and the spread of deciduous woodland are reflected also by the faunal composition. The remains of mammal macrofauna discovered in archaeological sites suggest that tundra representatives (e.g. reindeer), which were most numerous in the Last Glacial maximum (at ca. 20000 cal. BP) were declining, whereas populations of species, characteristic of forest habitats (e.g. red deer, moose, wild boar) were increasing (Pohar 1994; 1997). At Poljšiška cerkev (dated to Younger Dryas-Preboreal transition), located in the vicinity of Lake Bled, in contrast to other sites, chamoix and ibex remains are numerous. The fauna of alpine, tundra and steppe habitats are more abundant than forest taxa, probably due to proximity to mountains and glaciers (Pohar 1991; 1997). At Judovska hiša in Bela krajina (estimated to be of 'Lateglacial' age on the basis of stone tool typology, fauna and lithology), on the other hand, red deer and wild boar suggest a wooded, warmer habitat, although remains of alpine marmot, which probably lived here in colder phases of the Lateglacial (site was not radiocarbon dated), were also discovered (Pohar 1985; 1997). These results are in accordance with palynological data suggesting a more wooded landscape at Griblje in the Lateglacial interstadial.

In addition to these interregional differences, palynological results also suggest rapid changes of vegetation composition. At Griblje, for example, at ca. 13600 cal. BP predominantly *Pinus-Betula* woodland was replaced by *Tilia* forest. It is not clear how this change in forest composition and more wooded landscape affected Lateglacial animals and local human populations and whether they had to change their hunting and gathering strategies. After the *Tilia* peak at ca. 12250 cal. BP the landscape changed again, for it became more open, presumably due to the colder and drier Younger Dryas climate. The *Tilia* decline is associated with an increase in microscopic charcoal (*Fig. 4*), suggesting that *Tilia* forest was destroyed either by natural fire due to a drier climate (which is more likely) or by intentional landscape burning by local hunter-gatherers. Landscape burning was used as a significant strategy to increase plant and animal food resources in the landscape (e.g. Clarke 1979; Mellars 1976; Simmons 1996; Šercelj 1970; Zvelebil 1994) and in Bela krajina landscape burning was an important forest-clearance strategy also later, throughout the Holocene (Andrič 2007). However, in the future more detailed, multi-proxy palaeoecological and archaeological research is needed to understand better the reasons for Lateglacial environmental changes. Intensive archaeological research with more precisely dated Lateglacial phases and focused on the past economy is essential for tackling the question of how people and ecosystems responded to Lateglacial climatic fluctuations.

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14. Andrej Pleterski (with Timotej Knific, Borut Toškan, Janez Dirjec, Benjamin Štular and Mateja Belak), Zgodnjesrednjeveška naselbina na blejski Pristavi. Najdbe / Frühmittelalterliche Siedlung Pristava in Bled. Funde, 2008. (EUR 51.00)

15. Benjamin Štular, Mali grad. Visokosrednjeveški grad v Kamniku / Mali grad. High Medieval Castle in Kamnik, 2008. (EUR 51.00)

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17. Jana Horvat, Alma Bavdek, OKRA. Vrata med Sredozemljem in Srednjo Evropo / OCRA. The gateway between the Mediterranean and Central Europe (2009). (EUR 51.00)

18. Janez Dular, Marjana Tomanič Jevremov (with contributions by Borut Toškan and Janez Dirjec) ORMOŽ. Utrjeno naselje iz pozne bronaste in starejše železne dobe / ORMOŽ. Befestigte Siedlung aus der späten Bronze- und der älteren Eisenzeit (2010). (EUR 57.00)

19. Andrej Pleterski (with contributions by Igor Bahor, Vid Pleterski, Mark Žagar and Veronika Pflaum) Zgodnjesrednjeveška naselbina na blejski Pristavi. Tafonomija, predmeti in čas. / Frühmittelalterliche Siedlung Pristava in Bled. Taphonomie, Fundgegenstände und zeitliche Einordnung (2010). (EUR 39.00)

20. Jana Horvat and Andreja Dolenc Vičič (with the contribution of Marjana Tomanič Jevremov, Marija Lubšina Tušek), Arheološka najdišča Ptuja. Rabelčja vas / Archaeological Sites of Ptuj. Rabelčja vas (2010). (EUR 45.00)

Ivan Turk (ur. / ed.)

Moustérienska "koščena piščal" in druge najdbe iz Divjih bab I v Sloveniji
Mousterian "bone flute" and other finds from Divje babe I - cave site in Slovenia

V zborniku je celovito predstavljeno in obdelano trenutno najbolj aktualno srednjepaleolitsko najdišče v Sloveniji. Jamsko najdišče Divje babe I je postalo znano zaradi arheološke najdbe, za katero dosedanje raziskave kažejo, da bi lahko bila najstarejša piščal, izdelana iz kosti jamskega medveda. Osrednji del zbornika je posvečen prav tipološki, tehnološki, akustični in muzikološki obdelavi znamenite najdbe. V posameznih poglavjih je predstavljena še stratigrafija, kronologija, favna in flora najdišča ter paleolitske najdbe, vendar le do vključno plasti, v kateri je bila najdena koščena piščal. V knjigi so prvič strnjene in povzete ugotovitve dosedanjih arheoloških izkopavanj, ki pa seveda še niso zaključena. Poleg urednika, ki je tudi avtor in soavtor večine poglavij, sodelujejo v zborniku s prispevki še G. Bastiani, M. Culiberg, J. Dirjec, B. Kavur, B. Kryštufek, T.-L. Ku, D. Kunej, D. E. Nelson, M. Omrzel-Terlep in A. Šercelj.

1997, (Opera Instituti Archaeologici Sloveniae 2), 223 str., 29 barvnih in 75 cb slik, 20 x 29,5 cm, trda vezava, ISBN 961-6182-29-3

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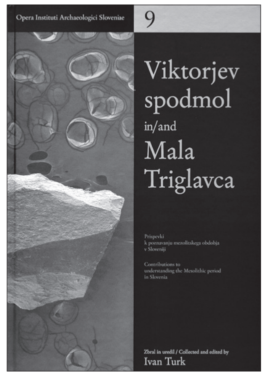
The most topical Middle Paleolithic site in Slovenia is presented in full and discussed in detail in this series. The Divje Babe I cave site became famous for the archaeological discovery of what current investigations indicate could be the oldest flute, made of the bone of a cave bear, yet discovered. The principal part of the compilation is dedicated to a typological, technological, acoustic and musicological discussion of the remarkable find. Individual chapters present the stratigraphy, chronology, fauna and flora from the site, in addition to the Paleolithic material finds (however, only up to the layer including the bone flute).
The book incorporates the first abridged and summarized determinations from the current archaeological excavations, which are not yet concluded. In addition to the editor, who is also the author and coauthor of the majority of chapters, the following individuals also provided contributions to the series: G. Bastiani, M. Culiberg, J. Dirjec, B. Kavur, B. Kryštufek, T.-L. Ku, D. Kunej, D. E. Nelson, M. Omrzel-Terlep and A. Šercelj.

1997, (Opera Instituti Archaeologici Sloveniae 2), 223 pp., 29 coloured photos, 75 b/w photos, 20 exposure tables + 7 tables, 20 x 29.5 cm, hardcover, ISBN 961-6182-29-3.



Ivan Turk (ur. / ed.)

Viktorjev spodmol in / and Mala Triglavca

Prispevki k poznavanju mezolitskega obdobja v Sloveniji
Contributions to understanding the Mesolithic period in Slovenia

V zborniku, prvem s področja mezolitika v Sloveniji, sta obravnavani dve izjemno bogati najdišči na Krasu v zahodni Sloveniji: Viktorjev spodmol in Mala Triglavca. Viktorjev spodmol je novo odkrito najdišče, kjer so se raziskave komaj začele, v Mali Triglavci pa potekajo že dalj časa. Oodrobno je obdelan predvsem Viktorjev spodmol. Pomembna je primerjava rezultatov različnih terenskih in poterenskih metod, uporabljenih v Mali Triglavci in predvsem v Viktorjevem spodmolu.
V posameznih poglavjih so obdelana mikrolitska orodja, ki pripadajo sovterjensko-kastelnovjenskemu (sauveterrien-castelovien) kompleksu, njihova tipologija in odnosi z drugimi najdišči tega kompleksa s posebnim poudarkom na kronologiji in kronoloških povezavah mezolitskih najdišč v severni Italiji, vključno s Tržaškim krasom, in zahodni Sloveniji (I. Turk in M. Turk). V drugih poglavjih so sistematsko prikazani redki rastlinski ostanki (M. Culiberg), izjemno bogate favne mehkužcev (R. Slapnik, V. Mikuž), ektotermnih vretenčarjev (M. Paunović) in malih sesalcev (B. Toškan, B. Kryštufek) ter ostanki velikih sesalcev (B. Toškan). Samo v Viktorjevem spodmolu je bilo na površini dveh kvadratnih metrov v mezolitski plasti najdenih 58.000 ostankov slepca in 6.076 ostankov, ki pripadajo 103 živalskim vrstam. Na isti površini je bilo 72 tipološko opredeljivih mikrolitov, 104 makrolitska orodja in 12.708 kamnoseških odpadkov.

2004, (Opera Instituti Archaeologici Sloveniae 9), 247 str. + 20 tabel, 64 črno-belih risb, fotografij in zemljevidov, 20 x 29,5 cm, trda vezava, ISBN 961-6500-54-6.

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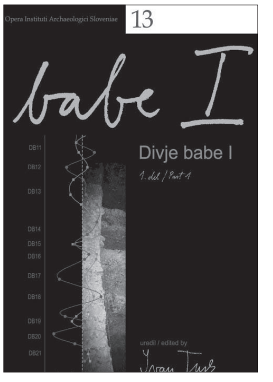
The monograph, the first regarding the Mesolithic in Slovenia, presents a discussion of two exceptionally rich sites in the Karst in western Slovenia: Viktorjev spodmol and Mala Triglavca. Viktorjev spodmol is a newly discovered site, where only test excavations have been done, while research has been underway at Mala Triglavca for already a while. The compilation primarily presents a detailed review of Viktorjev spodmol. The comparison of results from various field and post-field methods, which were applied at both Mala Triglavca and especially at Viktorijev spodmol, is particularly important.
Individual chapters address the topic of microlithic tools attributed to the Sauveterrien-Castelovien complex, their typology and relations with other sites from this complex, and with a special emphasis on the chronology and chronological correlations between Mesolithic sites in northern Italy, including the Trieste karst, and western Slovenia (I. Turk in M. Turk). The remaining chapters systematically present rare vegetal remains (M. Culiberg), the exceptionally rich collections of mollusc fauna (R. Slapnik, V. Mikuž), ectothermic vertebrates (M. Paunović) and small mammals (B. Toškan, B. Kryštufek) as well as the remains of large mammals (B. Toškan). At Viktorijev spodmol about 58,000 remains of slowworm and 6,076 remains attributed to 103 other animal species were discovered upon a surface of two square metres in the Mesolithic layer. The same surface revealed 72 typologically classifiable microliths, 104 macrolithic tools and 12,708 debris.

2004, (Opera Instituti Archaeologici Sloveniae 9), 247 pp. + 20 plates, 64 b/w photos, drawings and maps, 20 x 29.5 cm, hardcover, ISBN 961-6500-54-6..

Ivan Turk (ur. / ed.)



DIVJE BABE I. Paleolitsko najdišče mlajšega pleistocena v Sloveniji. I. del
DIVJE BABE I. Upper Pleistocene Palaeolithic site in Slovenia. Part I

V prvem delu monografije Divje babe I so podani, analizirani in interpretirani podatki s področja naravoslovja. V prvi vrsti gre za stratigrafsko-sedimentološke-kronološke podatke ter za ostanke flore in favne. Med slednjimi je podrobno obdelano oglje iz številnih ognjišč ter mali in veliki sesalci s poudarkom na jamskem medvedu. Posebej je treba izpostaviti niz absolutnih ESR-datacij in klimatogram najdišča, ki kaže potek temperature in vlage po plasteh v kronoconi zgodnjega in srednjega würma oz. kisikove izotopske stopnje OIS 5 in OIS 3. Zlasti podrobno so obdelani ostanki flore in favne iz izotopske stopnje OIS 3, ki omogočajo nov vpogled v paleookoljske in klimatske razmere tega slabo poznanega kronološkega odseka v Sloveniji in sosednjih pokrajinah. Arheološke najdbe, ki vključujejo musterjenske koščene artefakte, bodo predstavljene v drugem, načrtovanem delu monografije.

2007, (Opera Instituti Archaeologici Sloveniae 13), 480 str., 10 barvnih fotografij, 178 črno-belih risb, fotografij in zemljevidov, 89 tabel in 38 prilog; 20 x 29,5 cm, trda vezava, ISBN 978-961-254-019-7.

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In the first part of the Divje babe I monograph, data from the fields of the natural sciences are presented, analysed and interpreted. This is primarily stratigraphic, sedimentological and chronological data and data about the remains of flora and fauna. The latter includes detailed analysis of charcoal from a number of hearths and the remains of small and large mammals, with an emphasis on cave bear. The series of absolute ESR datings and the climatogram of the site should be highlighted in particular, which shows the course of temperature and humidity by layers in the chronozone of the Early and Middle Würm or oxygen isotope stages OIS 5 and OIS 3. The remains of flora and fauna from OIS 3 in particular are analysed, which enables new insight into palaeo-environmental and climatic conditions of this poorly known chronological segment in Slovenia and neighbouring regions. Archaeological finds, including Mousterian bone artefacts, will be presented in the planned second part of the monograph.

2007, (Opera Instituti Archaeologici Sloveniae 13), 480pp, 10 colour photoogaphs, 178 b-w drawings, photoogaphs and maps, 89 tabels and 38 annexes; 20 x 29.5 cm, hardcover, ISBN 978-961-254-019-7.