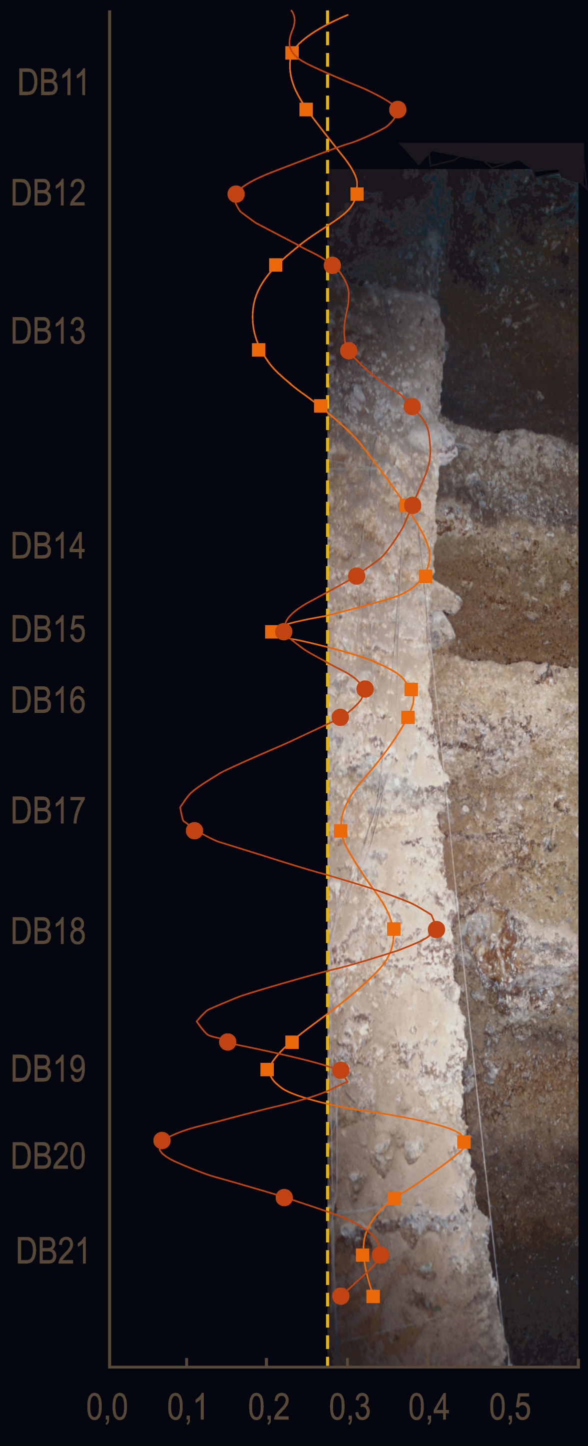
Opera Instituti Archaeologici Sloveniae

13

babe I



Divje babe I

1. del / Part 1

uredil / edited by

Ivan Turk

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DIVJE BABE I
Paleolitsko najdišče mlajšega pleistocena v Sloveniji
I. del: Geologija in paleontologija
DIVJE BABE I
Upper Pleistocene Palaeolithic site in Slovenia
Part I: Geology and Palaeontology

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ZALOŽBA
Z R C

LJUBLJANA 2007

Knjigo posvečam spominu na B. S.
I dedicate this volume in memory of B. S.

Urednik / Editor

PREDGOVOR

Zgolj naključje je, da je ta knjiga izšla natanko leto dni pred 80. obletnico prvih paleolitskih raziskav v Sloveniji. Ob takšni priložnosti se običajno vprašamo, kje je danes naš paleolitik in kakšna prihodnost se mu obeta? Odgovor ni ravno spodbuden. Peščica strokovnjakov, ki je od leta 1928 aktivno delovala v Sloveniji, je le s težavo in nemalokrat z veliko zamudo dohajala množico specialistov v drugih deželah. Danes, ko se paleolitske raziskave povsod naglo posodabljajo, in nas njihovi izvajalci vsakodnevno presenečajo z novimi odkritji in zasipavajo z literaturo, pa to sploh ni več mogoče. Vendar je knjižnih objav, ki bi celostno obravnavale posamezno paleolitsko najdišče, v svetu malo. Ker je v Sloveniji to že tretja takšna knjiga, smo lahko na to upravičeno ponosni. Toliko bolj, ker v njej močno prevladujejo domači avtorji, njihova dela pa so, vsaj tako upam, kakovostno povsem primerljiva s podobnimi deli v tujini.

Prvi del novega monografskega zbornika o Divjih babah I bistveno dopolnjuje knjigo *Moustérienska "koščena piščal" in druge najdbe iz Divjih bab I v Sloveniji* (1997) in na nekaterih področjih tudi temeljni članek M. Brodarja *Kultura iz jame Divje babe I* (1999), ki bo dopolnjen, če bo, predvsem v načrtovanem drugem delu zbornika. Knjiga, ki uvaja v slovensko paleolitsko arheologijo standardne statistične metode in nekatere druge novosti, poskuša kljub vsemu slediti vse hitrejšemu razvoju v paleolitski arheologiji. Nastala je na podlagi izkušenj njenega urednika, pridobljenih v 20 letih terenskih in kabinetnih raziskav na tem najdišču, in potrpežljivega sodelovanja s kolegi iz različnih naravoslovnih področij. Večinoma je plod izvirnih zamisli in postopkov, ki niso bili deležni večje finančne podpore. Nasprotno, ko so raziskave leta 1997 zaradi nepričakovane najdbe piščali dosegle vrhunec popularnosti in je bilo treba pripraviti solidno objavo, ki bi vključevala tudi kronostratigrafijo, je bila gladko zavrnjen predlog za financiranje samostojnega kronostratigrafskega projekta z utemeljitvijo, da ne sodi med tedaj prednostne arheološke projekte nacionalnega pomena. Sledilo je deset suhih let, v katerih je v neformalnem sodelovanju z različnimi strokovnjaki s področja kronologije in stratigrafije nastala ta knjiga. V njej so med drugim objavljeni izsledki treh doktoratov (Ivana Turka, Irene Debeljak, Boruta Toškana) in enega magisterija (Boruta Toškana) ter diplome (Janeza Turka). Sodeč po sredstvih, ki so jih pristojni namenili za izid knjige, suhih let še ne bo kmalu konec.

Venda je treba priznati nekaj. Glavni izvajalec projekta je ves čas njegovega trajanja, tako kot mnogi drugi, užival privilegiran položaj raziskovalca in prejemal redne dohodke. Da je sploh lahko opravljal svoj poklic, se mora zahvaliti predvsem svojemu predhodniku in prvemu vodju izkopavanj v Divjih babah I inž. dr. Mitju Brodarju. Ko mu je ta leta 1980 dal možnost sodelovati pri raziskavi takrat še nepomembnega najdišča in pozneje voditi lastna izkopavanja, vse na podlagi njegove dolgoletne pasivne udeležbe pri izkopavanjih pomembnih paleolitskih najdišč v Sloveniji in nekdanji Jugoslaviji, se je začela oblikovati smer v slovenskem paleolitiku, ki jo najbolje predstavlja ta monografija. Za primerjavo med novim in starim načinom dela lahko služita dve monografiji o Potočki zijalki, prva izpod peresa Srečka Brodarja in Mitje Brodarja, druga, novejša, izpod peresa skupine slovenskih in avstrijskih avtorjev.

Kaj lahko se zgodi, da pričujoča monografija marsikomu ne bo všeč. Iskalci napak in pomanjkljivosti bodo zanesljivo prišli na svoj račun. Morda se bo celo našel kdo, ki bo trdil, da ni znanstvena, ker se v večjem delu, ki ga je prispeval urednik, sploh ne naslanja na izsledke drugih raziskovalcev in operira z zelo omejenim številom podatkov, ki se nanašajo na druga, podobna najdišča. Vendar, kaj sploh je znanost, če lahko uporabim to besedo? V tem primeru čim bolj objektivno podajanje in analiziranje dejstev, ugotovljenih z raziskavo na terenu. Ta dejstva je bilo treba vgraditi v sistem najdišča, ki je omogočil, da smo jih vsi sodelujoči razložili skladno z drugimi sodelavci po svojih najboljših močeh. Pri tem bi se lahko zgledovali po drugih avtorjih in se sklicevali na ugotovitve različnih avtoritet. Vendar tega večinoma nismo storili, ker smo bili prepričani, da rešitev za razlago, podkrepljeno z dokazi, tiči v samem najdišču in ne zunaj njega. Treba jo je bilo samo odkriti. Ali se nam je to posrečilo ali ne, bodo presodili drugi, predvsem tisti, ki bodo poskušali spodbiti naše trditve. Sicer pa se v znanosti tako ali drugače ne da nič dokazati enkrat za vselej, da se samo spodbiti, kot mi je dejala ena od avtoric te knjige. Na koncu, sicer nikoli dokončanega dela, smo dobili v vsakem primeru bolj ali manj sprejemljivo umetno predstavo o najdišču in razlago, ki bi lahko bila daleč od resničnosti. Kakšna je ta razlaga, je odvisno predvsem od načina dela oz. metode, tako na terenu, kot pozneje v kabinetu, od načina razmišljanja in od iznajdljivosti ter ustvarjalnosti posameznika. Potem so tu še vplivi časa in okolja, v katerem živimo, in ustvarjamo in naša dovzetnost za te vplive, ali jim sledimo ali ne. Vse to pripelje do možnosti za različne kombinacije in razlage ugotovljenih dejstev in dejavnikov, ki so vplivali nanje. Odpotovati v preteklost in preveriti stvari pri izvoru pa za zdaj ni mogoče in bolje, da ni, ker bi bili potem lahko razočarani nad svojimi znanstvenimi dosežki.

Naj se na koncu, kot urednik, zahvalim vsem piscem poglavij in sodelavcem, ki so mi pomagali pri nastanku te knjige. Tudi tistim, ki niso zmogli dokončati svojega poglavja, vendar so pokazali dober namen. Kljub številnim težavam, različnim pogledom in interesom posameznikov, je bilo delo z njimi prijetno, in kar je najpomembnejše – vsemu navkljub smo ostali prijatelji. Hvala za dobro opravljeno delo in veliko sreče v prihodnje pri podobnih arheoloških projektih.

V Ljubljani, julija 2007 *Urednik*

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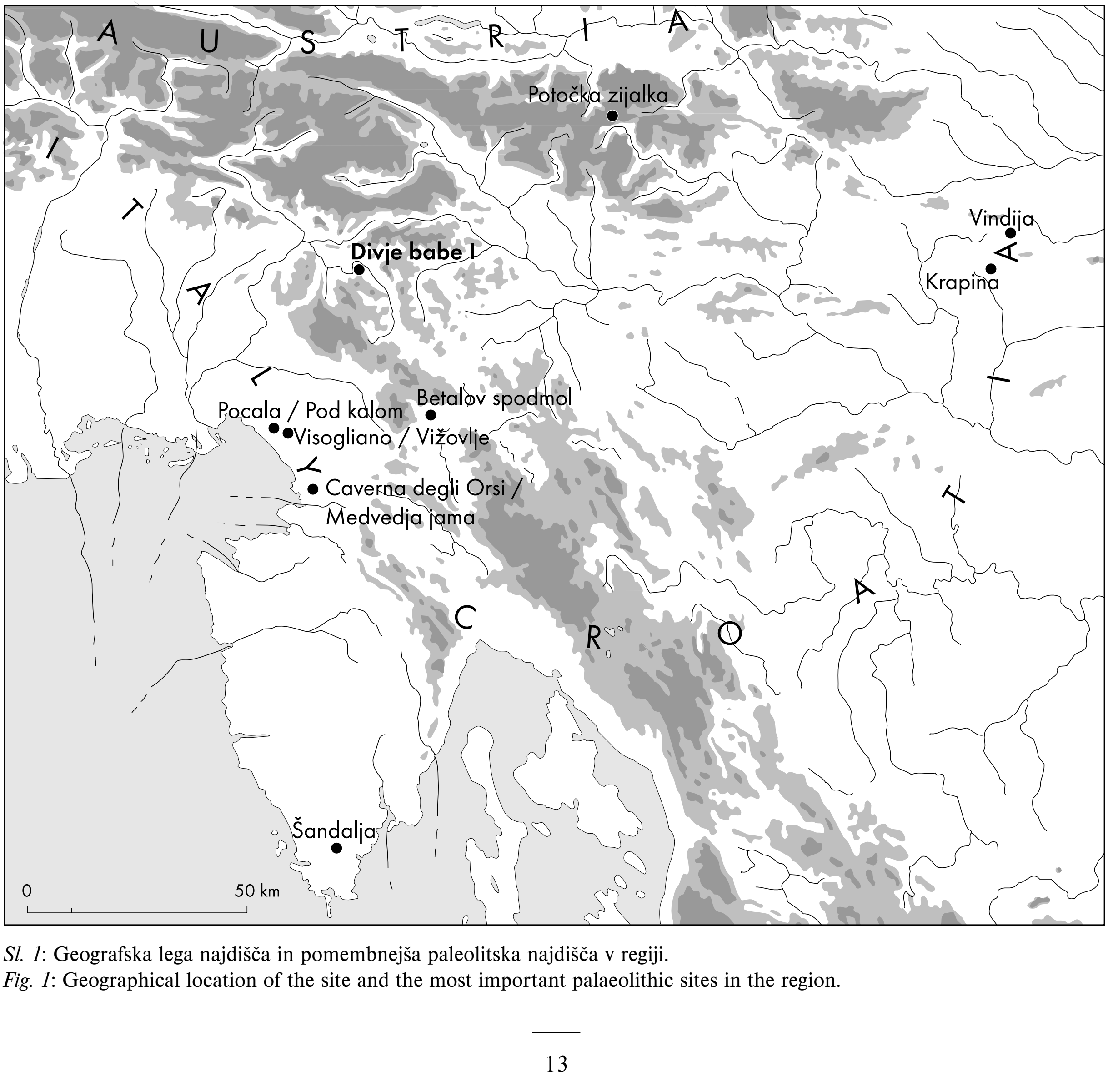
UVOD

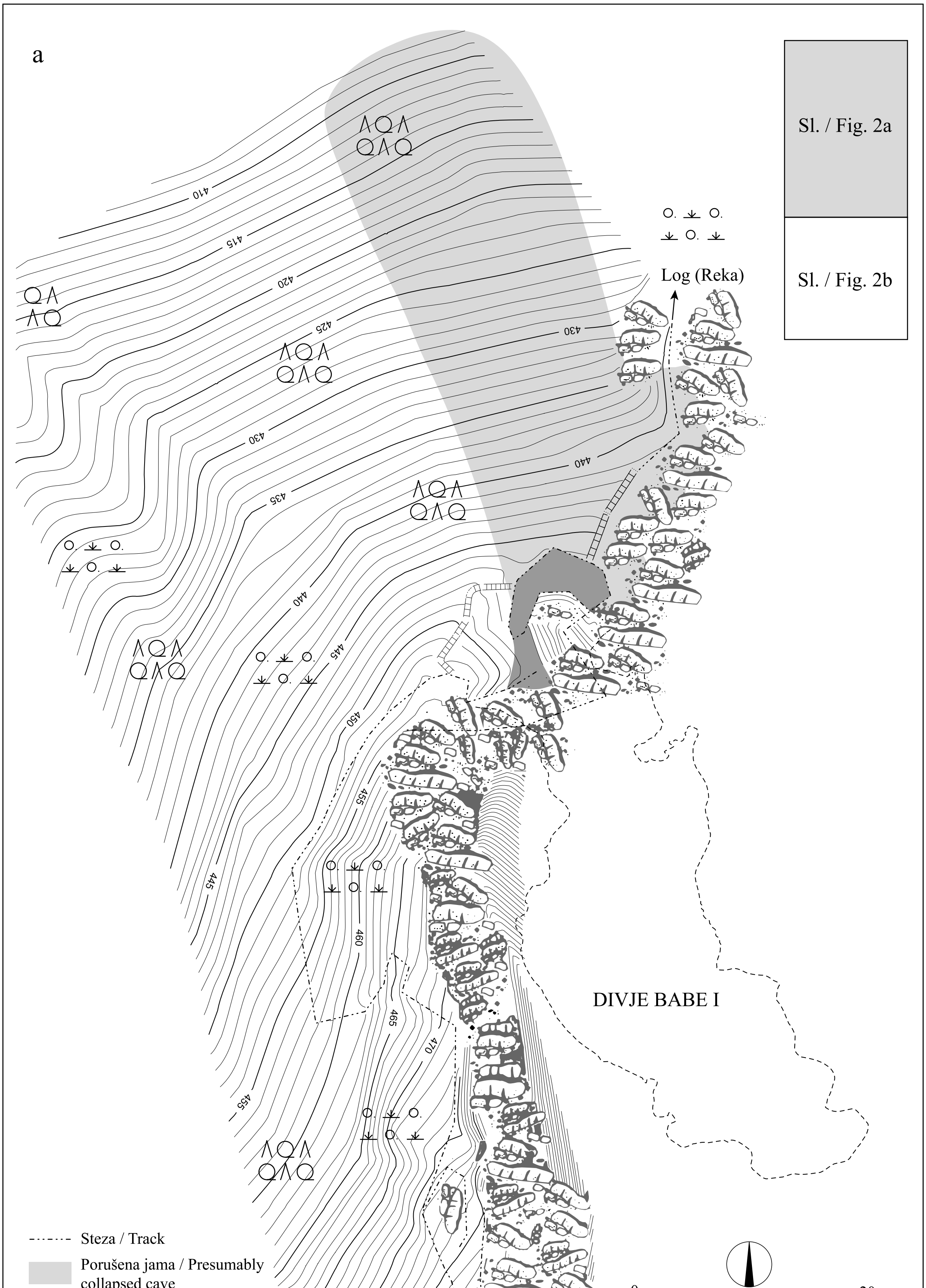
IVAN TURK

Najdišče Divje babe I (GaussKrugerjeve koordinate y = 416555,77 m, x = 108160,75 m) v dolini Idrijce v zahodni Sloveniji leži na nadmorski višini 450 m (natančneje 448,25 m) pod robom Šebreljske planote (600–700 m n. v.), ki je del predalpskega hribovja v najjugovzhodnejšem delu Alp (*sl. 1*). Nekoliko južneje se razprostirajo najsevernejši obronki Dinarskega gorstva.

Glede na temperaturo spada širša okolica najdišča danes v območje submediteranske klime (Ogrin 1998, 111). Submediteranski je tudi padavinski režim, za katerega je značilen vrhunec padavin v jesenskem času (predvsem novembra). Na podlagi razmerja med padavinami (povprečno 1800 $\mathrm{mm}^{-\mathrm{leto}}$ – Zupančič, 1998, 99) in evapotranspiracijo (povprečno 572 $\mathrm{mm}^{-\mathrm{leto}}$) ima širša



Sl. 1: Geografska lega najdišča in pomembnejša paleolitska najdišča v regiji.
Fig. 1: Geographical location of the site and the most important palaeolithic sites in the region.


a
Sl. / Fig. 2a
Sl. / Fig. 2b
Log (Reka)
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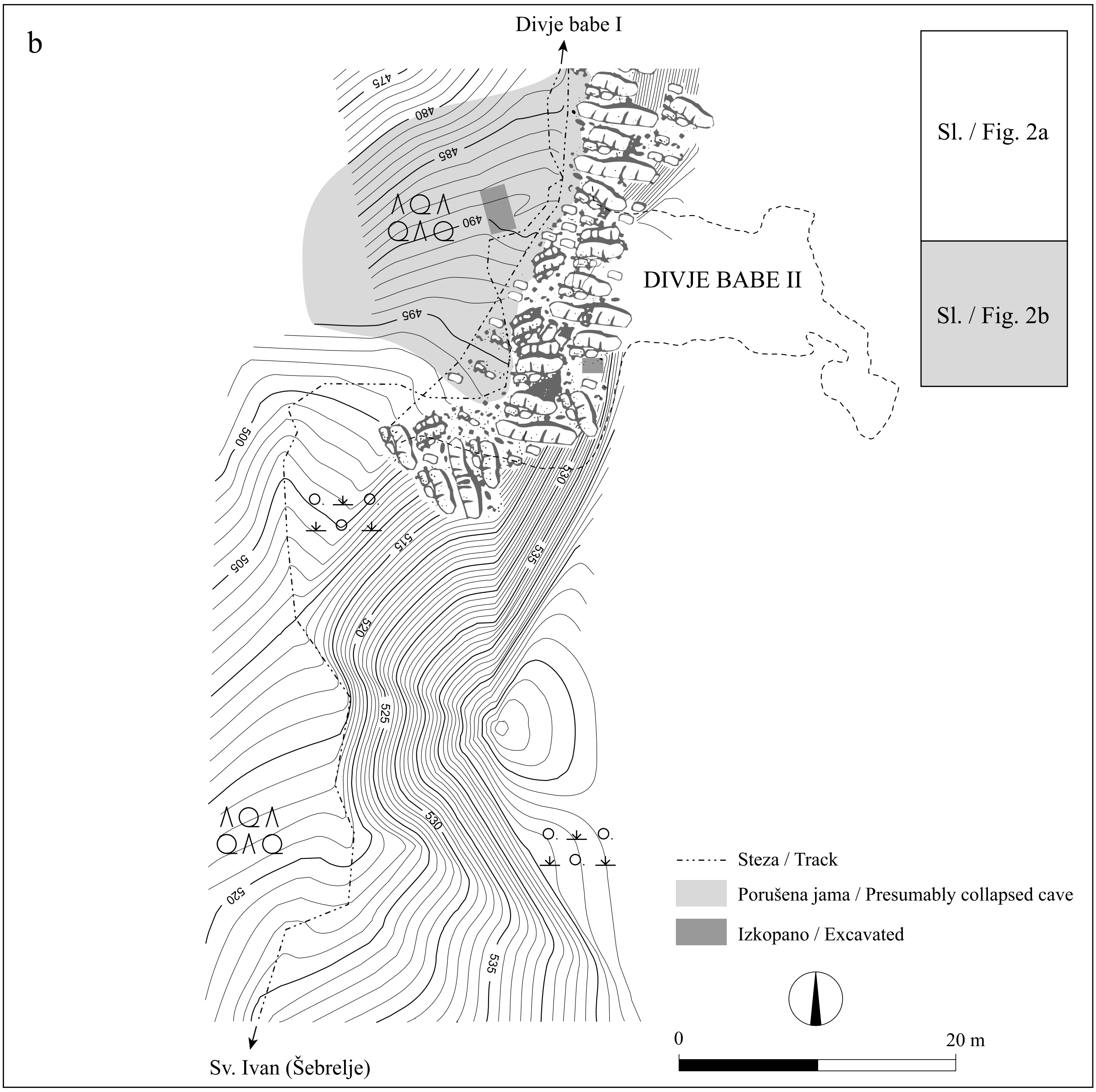
DIVJE BABE I
Steza / Track
Porušena jama / Presumably collapsed cave
Izkopano / Excavated
0
20 m



Sl. 2a, b: Geodetski posnetek terena z jamo Divje babe I in II. Glej obsežno pobočno nasutje pred vhodom v Divje babe I, ki se konča na živoskalnih izdanjkih 50 m nižje, kjer je domnevno dno jame. Načrt jame Divje babe II je izdelal Franjo Drole, Inštitut za raziskovanje krasa ZRC SAZU. Vir: Temeljni topografski načrt 1:1000, © Geodetska uprava Republike Slovenije.
Fig. 2a, b: Topography of the caves Divje babe I and II. See huge talus slope at the cave entrance to Divje babe I. Original cave floor is presumably at the outcrops of dolomite rock 50 m below datum. Plan of the cave Divje babe II by Franjo Drole, Karst Research Institute ZRC SAZU. Source: Basic topographic plan 1:1000, © Geodetska uprava Republike Slovenije.

okolica najdišča zelo vlažno klimo, ki je danes značilna za alpsko in dinarsko višavje v tem delu Evrope. Najdišče meji na jugu na območje polsušne klime v zaledju Tržaškega zaliva, ki prehaja v območje sušne (mediteranske) klime priobalnega pasu Jadranskega morja (Gams 1998, 34). Vsi našteti klimatski režimi se zvrstijo na razdalji komaj 50 km in pri največji višinski razliki 1.500 m v Trnovskem gozdu. Klimatski gradient je najočitnejši v trajanju snežne odeje (Gams, 1998 33; Ovsenik-Jeglič 2000, zemljevid), zato lahko tu pričakujemo največje spremembe, če bi se znižala današnja povprečna temperatura. Trajanje snežne odeje bi se v takem primeru občutno podaljšalo. To bi neposredno vplivalo na sezonski odtok podzemne vode. Domnevno bi poleg jesenskega maksimuma, ki je posledica padavin, nastal še spomladanski maksimum, ki bi bil posledica taljenja debelejše snežne odeje (toda glej poglavje 7 v tem zborniku, op. 3).

Divje babe I so približno 45 m dolga in 15 m široka horizontalna jama (poglavje 1 v tem zborniku: *sl. 1.3*). Jamski rov, ki je danes več kot 12 m na debelo zapolnjen s skoraj izključno avtohtonimi klastičnimi sedimenti, ki so se odložili pretežno v obdobju OIS (MIS) 5 in OIS (MIS) 3 (*Oxygen/Marine Isotope Stage*), se je izoblikoval v masivnem kordevolskem dolomitu v bližini knežkega preloma (glej poglavje 2 v tem zborniku). Geneza jame ni raziskana. Glede na potencialno debelino sedimentov, med 13 in 50 m, bi lahko sklepali, da je jama relativno stara (*sl. 2a, 3*).

Prva sistematična izkopavanja so bila v letih 1978 (sondiranje) in 1980–1986 pod vodstvom Mitje Brodarja. Ivan Turk in Janez Dirjec sta leta 1989 začela nova izkopavanja v osrednjem delu jame in jih predčasno končala leta 1999. Vse terenske akcije skupaj bi brez prekinitev trajale poldrugo leto.

Izkopavanja v Divjih babah I lahko na podlagi uporabljene terenske tehnike razdelim v dve fazi, ki sta se odvijali v letih 1978–1986 in 1989–1999 v različnih predelih jame in z uporabo različnih tehnik in metod.

Za prvo fazo (1978–1986) je bila značilna uporaba t. i. sestavljenke horizontalne in vertikalne tehnike izkopavanja (S. Brodar 1958, 277; Osole 1965, 144). Bistvo te tehnike je bilo odstranjevanje večjih blokov sedimentov, plast za plastjo po različno debelih režnjih, ki pa nikoli niso bili tanjši od 20 cm. Posamezen blok je bil širok 1m. Na tej razdalji so bili sistematično dokumentirani profili, vendar šele potem, ko je bil blok odkopan do konca. Vse pomembnejše najdbe so dobile koordinate, preostale pa so se vodile po plasteh v bloku oz. po profilih (prim. Osole 1990). Profili so služili za stratigrafijo, podroben opis sedimentov po plasteh in vzorčevanje. Zaradi variabilnosti profilov je za končni opis plasti služil t. i. normalni profil, ki je bil lahko najpopolnejši profil, ali sestavljenka iz več profilov. Na podlagi vseh podatkov v vseh profilih je bila podana razlaga najdišča. Razen najdb s koordinatami in vzorcev, podatki niso bili kvantificirani, tako da je šlo večinoma za kvalitativne baze podatkov oz. opise.

Izsledke prve faze, ki je potekala v vhodnem delu jame, je delno objavil I. Turk s sodelavci (Šercelj, Culiberg 1991; Turk, Dirjec 1991; Turk *et al.* 1988, 1989a,b,c, 1990, 1992; Turk 1988, 1997a), predvsem pa M. Brodar (1999), ki je vodil prvo fazo. M. Brodar je poleg drugega podal tudi temeljito razlago in kronologijo paleolitskih najdb. Rešitev vprašanja o pomenu in vlogi najdišča je bila z Brodarjevo objavo nakazana do takšne mere, da bi po njegovem morali nadaljevati z izkopavanji v

Sl. 3: Pogled na pobočje in steno pred vhodom v Divje babe I. Glej izdanjke dolomita na koncu pobočja. Fotografija T. Lauko, Narodni muzej Slovenije.
Fig. 3: View on the talus slope and cliff at the cave entrance. See outcrops of dolomite rock by the end of talus slope. Photography by T. Lauko, National Museum of Slovenia.

globino do skalnega jamskega dna in dobiti potrditev za njegova predvidevanja o izjemnem pomenu paleolitskih najdb (M. Brodar 1999).

Druga faza izkopavanj pod vodstvom J. Dirjeca in I. Turka ni sledila Brodarjevim željam in intuiciji, temveč je bila usmerjena v izboljšave izsledkov prve faze izkopavanj. Zato sem se odločil izkopavanje nadaljevati v osrednjem predelu jame in za to pridobiti J. Dirjeca. Izkopavanja v vhodnem delu po mojem mnenju niso bila izvedena na primeren način, za kar je bilo več razlogov. Glavni je bila slaba organiziranost in tehnična opremljenost terenske ekipe, kar lahko opravičim z nepoznavanjem potenciala najdišča. Ko je bil ta med raziskavo dognan in ko so bile odkrite nekatere izjemne najdbe, smo se lažje organizirali in opremili s podporo sponzorjev in donatorjev. Zaradi različnih tehnik in metod rezultati obeh faz izkopavanj, žal, niso enostavno primerljivi in jih je treba obravnavati ločeno. Osebno menim, da so trenutno edino zanesljive razlage rezultatov druge faze.

Za drugo fazo izkopavanj (1989–1999) je značilna tehnika izkopavanj po kvadratih velikosti 1x1 m in vodoravnih režnjih debeline 12 cm ter spiranje vseh sedimentov brez izjeme na sitih s premerom luknjic 10 mm, 3 mm in 0,5 mm. Težišče raziskovanja se je s preučevanja sedimentov in njihove vsebine predvsem v profilih premaknilo na celoten raziskovani prostor, omejen s profili. Za nekatere podrobnosti glej Turk (2003a, 2006) ter poglavje 1 v tem zborniku.

Izsledke druge faze izkopavanj sta delno objavila I. Turk s sodelavci ali brez njih (Lau *et al.* 1997; Bastiani *et al.* 2000; Paunović *et al.* 2002; Turk 2003a, b, 2006; Turk, Bastiani 2000; Turk *et al.* 2001; 2002b, 2003a, b, 2005a, b, 2006) kakor tudi M. Brodar (1999). V sklop teh objav sodi tudi monografija "Mousterienska piščal" (Turk 1997a), v kateri je bilo najdišče preliminarno obdelano do vključno plasti 8. V takšno objavo sem bil prisiljen zaradi odmevne najdbe najstarejše domnevne piščali. Najdba je močno vplivala na organizacijo in izvedbo poizkopavalnega postopka. Po njeni zaslugi smo prišli tudi do za nas brezplačnih ESR-datacij najdiščnega profila. Nova monografija, ki obravnava tudi in predvsem starejše plasti, raziskane po najdbi piščali leta 1995, je bila zato nujno potrebna. Ker se je z izboljšavami terenske tehnike zelo povečal obseg najdb in podatkov, sem sklenil novo monografijo izdati v dveh delih: naravoslovnem in arheološkem. Naravoslovni del se mi zdi pomembnejši od arheološkega, ker najdišče lahko bolje umestim v čas in prostor s pomočjo naravoslovnih znanosti kot s pomočjo arheologije. Za slednje se je trudil predvsem M. Brodar (1999). Prepričan sem, da bodo za njim to poskušali še mnogi. Vendar brez upoštevanja kronologije, ki temelji na izbranih naravoslovnih dejstvih, po mojem ne bodo prišli daleč. Z izidom prvega dela monografije je opravljen najtežji del naloge v sklopu projekta Divje babe I. Najtrši oreh je bila nedvomno kronologija, nekoliko manj trd pa sedimentologija in fosilni ostanki jamskega medveda. Arheološki del bo bistveno lažji in ga lahko napiše vsak, ki se le malo spozna na artefakte in paleolitsko problematiko. Vir informacij bodo najdbe, ki jih hrani Narodni muzej Slovenije, in temeljna dokumentacija, vključno z risbami vseh artefaktov, ki jo hrani arhiv Inštituta za arheologijo ZRC SAZU. V duhu časa je te najdbe v bistvu že objavil in interpretiral M. Brodar (1999) v izčrpni študiji *Kultura iz jame Divje babe I*. Ali se bomo odločili za objavo vsega arheološkega gradiva in njegovo reinterpretacijo (glej Bastiani *et al.* 2000; Turk, Bastiani 2000; Paunović *et al.* 2002), med drugim tudi v okviru kronostratigrafije, podane v tem zborniku, je stvar premisleka oz. odločitve, ali so arheološke najdbe del sistema najdišča Divje babe I ali ne. V kolikor niso, je Brodarjeva objava, kot dopolnilo in popravek naše prve začasne objave (Turk, Kavur 1997), dovolj in ni kaj dodati. Dvoznačnost rezultatov oz. neskladnost med arheologijo in naravoslovjem pa lahko pojasnimo z različnima sistemoma.

Za razumevanje okoliščin, v katerih je potekala raziskava, in za načrtovanje bodočih podobnih raziskav, so pomembni podatki o terenskih stroških, ki se običajno ne navajajo. Od razpoložljivih sredstev za terenske in druge raziskave je običajno odvisen "izplen" oz. rezultat raziskave. Zato lahko skromna sredstva delno opravičijo skromne rezultate določene terenske akcije. Po mnenju nekaterih so bila izkopavanja v Divjih babah I med najdražjimi.

V letih 1980–1984 smo odkopali in preiskali približno 53 m^3 sedimentov plasti 2 do 5. Delo na terenu smo opravili v 824 urah. Samo 5 % časa smo namenili za terensko pripravo. Skupni stroški brez priprave in osebnih dohodkov M. Brodarja in I. Turka so bili 1.790 EUR (3.580 DEM) ali 2,35 EUR (4,7 DEM) na uro[1]. Za terensko obdelavo kubičnega metra sedimenta smo porabili povprečno 15,5 ure in 33,7 EUR (67,5 DEM). Stroški za terensko opremo so bili neznatni.

V letih 1989–1994 smo odkopali in preiskali okoli 155 m^3 sedimentov plasti 2 do 5 in za to porabili 7.136 terenskih ur. Dodatnih 1.760 ur smo porabili za elektrifikacijo jame (800 m električnega voda) in gradnjo tovorne žičnice (400 m dolžine in 230 m višine). Za terensko pripravo smo tako porabili 20 % časa. Skupni stroški s pripravo in brez osebnih dohodkov J. Dirjeca in I. Turka so znašali 27.317 EUR (54.635 DEM) ali 3 EUR (6,1 DEM) na uro. Za terensko obdelavo kubičnega metra sedimenta, ki smo ga transportirali na razdaljo 400 m z višinsko razliko 230 m, smo porabili povprečno 51 ur, kar je zneslo 141,5 EUR (283 DEM). Stroški za terensko opremo, vključno z bivalnim kontejnerjem vred, ki smo jo uporabljali deset let, so znašali 4.250 EUR (8.500 DEM). K

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[1] Preračunano po takrat veljavnem tečaju DEM za mesec julij, ko so potekala vsa izkopavanja prve in druge faze.

Sl. 4: Del terenske ekipe leta 1998. Od leve proti desni: Marko Lajovic, Matija Dirjec, Frédéric Blaser, Mila Jelovšek, Ivan Turk, Janez Dirjec, Barbara Turk in Nuša Turk. Fotografija F. Stele.
Fig. 4: Part of the field team 1998. From left to right: Marko Lajovic, Matija Dirjec, Frédéric Blaser, Mila Jelovšek, Ivan Turk, Janez Dirjec, Barbara Turk and Nuša Turk. Photograph F. Stele.

temu je treba prišteti stroške za izdelavo novega vitla, ker se prvi, ki nam ga je izdelal kooperant Soškega gozdnega gospodarstva Tolmin S. Trušnevec, ni obnesel. Stroški novega vitla, ki sem ga leta 1995 skonstruiral in izdelal sam s pomočjo ing. M. Klanjšeka, mojstra I. Mivšeka in V. Marna, so bili 2.125 EUR (54.305 DEM).

Za primerjavo lahko navedem, da je ekipa S. Brodarja v Betalovem spodmolu porabila v letih 1947–1953 za odkop in pregled enega kubičnega metra sedimentov približno 27 ur (Osole 1990, 10), v Potočki zijalki pa v letih 1928–1935 približno 5 ur (S. Brodar 1931, 154). Za najnovejša izkopavanja v Potočki zijalki o tem nimam podatka.

Vsi stroški izkopavanj v Divjih babah I, vključno s pripravami vred, vendar brez osebnih dohodkov vodij in nakupa terenske opreme, so znašali 76.050 EUR (152.100 DEM). Približno pol tega denarja je bilo povrnjenega z brezplačnimi radiometričnimi analizami, narejenimi v Kanadi in ZDA po zaslugi urednika tega zbornika. Vsaka datacija AMS ^{14}C bi sicer stala 900 kanadskih dolarjev ena, ESR-datacija pa 300–500 USD ena[2]. Na ta način nam je bil prihranjen enormen strošek 29.700 kanadskih dolarjev in 12.600–21.000 ameriških. Radiometrični datumi so bili osnova za kronologijo najdišča. Brez njih bi bila razlaga piščali in drugih koščenih ter kamenih najdb še bolj problematična, kot je. Pri tem moram poudariti, da so bile Divje babe I eno prvih paleolitskih najdišč v Evropi, ki je bilo sistematično in neodvisno datirano najprej z metodo AMS ^{14}C (Nelson 1991, tab. 1; glej Taylor 1987, 94, kjer se Erle D. Nelson omenja med pionirji določanja ^{14}C-starosti z uporabo akceleratorja) in nato še z elektronsko spinsko resonanco ali ESR (Lau *et al.* 1997)[3]. Vodilna strokovnjakinja na področju datiranja z metodo ESR Bonnie A. B. Blackwell in njena ekipa se je nato 12 let ukvarjala z Divjimi babami I. Rezultati njihovega dela so prikazani v celoti v tem zborniku in pomenijo prelomnico v kronologiji paleolitskih jamskih najdišč v Sloveniji in širši regiji.

Od začetka izkopavanj pa do izida te knjige smo za zaščito in predstavitev najdišča ter strokovne analize porabili še 35.000 EUR ali 1.346 EUR letno, kar je precej manj kot se pričakuje iz razmerja med trajanjem izkopavanja in izvajanjem analitskega poizkopavalnega postopka. Iz tega sledi, da je bilo vsega denarja sproti komaj za izkopavanja, pri čemer smo se morali na terenu popolnoma odreči gostinsko-turistični ponudbi in se prebijati v lastni režiji kot smo vedeli in znali[4].

Paleolitska najdišča so tem pomembnejša, koliko bolj so izjemne najdbe in kolikor bolj je velik njihov ce-

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[2] Cene so komercialne in ne dosegajo dejanskih stroškov datiranj Divjih bab I, ki so bila opravljena v okviru posebej za to oblikovanega programa v Kanadi in Ameriki.

[3] V Franciji je bilo v tem času med 35 radiometrično datiranimi musterjenskimi najdišči samo 5 datiranih z metodo ESR (Valladas *et al.* 1999).

[4] Pri tem gre velika zasluga našim neprofesionalnim kuharicam, ki so poimensko navedene v seznamu terenskih ekip po letih izkopavanj. Na tem mestu se jim še enkrat najlepše zahvaljujem za dobro opravljeno delo v težavnih razmerah.

lotni interpretativni potencial. Divje babe I se ponašajo z obojim. Medtem ko so izjemne najdbe stvar naključja in sreče, so interpretativne možnosti najdišča odvisne predvsem od iznajdljivosti izkopavalcev, ki nosijo veliko odgovornost za to, ali jih bodo znali in hoteli izkoristiti ali ne. V vsakem primeru se lahko zatečejo zgolj k privlačnim najdbam in se tako izognejo mučnim in dolgotrajnim raziskavam najdišča kot sistema. V bistvu raziskave gradiva izkopavanj t. i. ključnih najdišč niso nikoli končane. To nam potrjujejo številni primeri. Zato si ne delam utvar, da sta ta in načrtovani drugi del monografije zadnja temeljita objava najdišča. Pa tudi moji terenski dosežki niso vrhunska storitev, ki se ne da preseči. Vsak, ki se bo malo bolj potrudil, bo lahko terensko raziskavo izpeljal bolje.

Pleistocenska najdišča lahko med drugim razvrstim po tem, kakšne možnosti ponujajo za približke nekdanjega okolja. Ker se okolje spreminja sočasno skupaj s klimo, so te spremembe izrednega pomena za kronologijo. Jamska najdišča imajo v tem nedvomno prednost pred planimi zaradi specifičnega mikrookolja. Mnenja o takšni umestitvi posameznih jamskih najdišč so lahko deljena, ker je objektivno oceno mogoče podati šele na podlagi temeljite analize najdišča kot sistema. Za kaj takega avtorji izkopavanja običajno niso usposobljeni, niti nimajo časa, sredstev in volje. Ker tega nihče ne more storiti sam, mora to omogočiti drugim. Najdišč ne raziskujemo zase, temveč predvsem za druge, ki se ukvarjajo s podobno problematiko in so jo sposobni ustrezno reševati. Zgodba se z nami ne konča, temveč se začne. Zato je kakršna koli pomoč strokovnih kolegov vedno dobrodošla, prav tako konstruktivna kritika rezultatov dela.

Divje babe I sodijo med okoljsko zelo občutljiva najdišča. Za to je več razlogov.

Sedimenti so zelo debeli, pretežno avtohtoni in avtigeni ter nadvse primerni za pregledovanje na sitih po predhodnem spiranju z vodo. Sedimentno okolje je idealno za ohranitev vseh vrst fosilnih najdb.

Sedimentološke raziskave so omogočile prepričljivo oceno paleoklime. Kako zanesljiva je takšna ocena, bo znano, ko bo nova sedimentološka metoda uporabljena celostno namesto delno. To žal ni mogoče brez obsežnih novih izkopavanj. Na pol poti je obtičala tudi geokemijska analiza. Mineraloške in druge analize sedimentov niso bile niti začete. Vendar možnost zanje obstaja. Ohranjen je *in situ* profil celotnega raziskanega dela najdišča, v Narodnem muzeju Slovenije pa je shranjenih 3.790 vzorcev drobnih frakcij sedimentov, ki pokrivajo celotno izkopno polje v osrednjem predelu jame. Sedimenti vhodnega dela jame do vključno plasti 14 so za analitske postopke izgubljeni za vedno, ker so bili v celoti odstranjeni, ne pa tudi sedimenti od plasti 14/15 navzdol, ki so bili odstranjeni samo na pobočju pred jamo.

Številne analitske možnosti ponuja več kot milijon fosilnih ostankov jamskega medveda, razporejenih zvezno po vsem profilu. Na njihovi osnovi je bilo narejenih nekaj dobrih študij, predvsem zob, ki se nanašajo na sestav fosilne populacije jamskega medveda v Divjih babah I (Debeljak 2002c). Biometrija, patologija, izotopi in še kaj čakajo na boljše čase. Prepričan sem, da so ostanki jamskega medveda skupaj s sedimenti najboljši vir za oceno nekdanjega okolja. To, kar se je dogajalo med jamskim in rjavim medvedom, pa je dobra vzporednica za to, kar se je zgodilo med neandertalcem in modernim človekom. Vse najdbe jamskega medveda s stratigrafsko ločljivostjo 12 cm (= 1.100 let) so shranjene v Narodnem muzeju Slovenije.

Poleg jamskega medveda so pestro zastopani tudi fosilni ostanki drugih živalskih vrst, čeprav skoraj nikoli zvezno v profilu najdišča. Slednje zmanjšuje njihovo izpovedno moč.

Rastlinski ostanki so se ohranili bodisi fosilizirani (pelod, les) bodisi zogleneli (les, stebla, semena). Vsi rastlinski ostanki so bili številnejši pri vhodu, kjer se je pelod pojavljal zvezno v profilu, oglje pa nezvezno. Ko smo pozneje izboljšali terensko metodo, v notranjosti jame peloda v profilih nismo več našli v zadovoljivih količinah. Vendar še vedno ostaja možnost, pridobiti pelod na ekstenziven način iz 3.790 stratigrafsko pobranih vzorcev sedimentov v bočni smeri, ki pokrivajo celoten osrednji del jame. Vse dosedanje vzorčevanje peloda je namreč potekalo izključno v profilih. Vsi vzorci oglja, lesa in peloda so shranjeni v Narodnem muzeju Slovenije.

Ostanki mehkužcev niso bili sistematično pobrani in obdelani, čeprav smo nanje naleteli v osrednjem predelu jame. Ker ni šlo za večje količine, ki bi bile zvezno porazdeljene v profilu, znanstvena škoda za moluskologijo ni prevelika.

Zaradi prezgodnje smrti sodelavke Maje Paunović, so ostali neobdelani ostanki plazilcev in dvoživk, ki smo jih sistematično pobirali skupaj z ostanki malih sesalcev v osrednjem predelu jame. Njihovo pojavljanje v profilu je nezvezno.

Ostanki ptic so redki in nezvezno porazdeljeni v profilu. Njihov prispevek k oceni nekdanjega okolja je pomemben predvsem kot dopolnilo k drugim paleookoljskim kazalcem.

Sistematično so bili pobrani in obdelani številni ostanki malih sesalcev, vendar samo v osrednjem predelu jame. V vhodnem delu jame, žal, nismo bili pozorni nanje do vključno plasti 13. Globlje plasti je še vedno mogoče raziskati. Verjetno ni treba posebej poudariti kako pomembni so lahko mali sesalci za oceno nekdanjega okolja. Žal v profilu ne nastopajo zvezno in ne vedno v zadostni količini, da bi nam dali popolno sliko razvoja nekdanjega okolja.

Vse ostanke mehkužcev, plazilcev, dvoživk, ptic in malih sesalcev hrani Narodni muzej Slovenije.

Ostanki velikih sesalcev brez jamskega medveda so bili tako kot mali sesalci deležni sistematične obdelave.

Sl. 5: Ivan Turk s sodelavko Bonnie A. B. Blackwell, ki ima veliko zaslug za učinkovito reševanje in smiselno razlago sistema paleolitskega najdišča Divje babe I. Fotografija M. Turk.
Fig. 5: *Fig. 5*: Ivan Turk with colleague Bonnie A. B. Blackwell, who was greatly instrumental in effectively solving and sensibly explaining the system of the Divje babe I palaeolithic site. Photograph M. Turk.

Njihov prispevek k oceni nekdanjega okolja je pomemben kot dopolnitev k drugim paleookoljskim kazalcem. Ostanki velikih sesalcev so maloštevilni, vendar pestri, če jih obravnavamo diahrono. V profilu so porazdeljeni nezvezno. Hranijo se v Narodnem muzeju Slovenije.

Zbir vseh fosilnih ostankov ter lega najdišča na stičišču mediteranske in celinske klime, alpskega in dinarskega sveta, bistveno prispevata k njegovi okoljski občutljivosti, ki bo eden glavnih kriterijev pri odločanju o bodočih paleolitskih raziskavah v širši regiji (glej Woodward, Goldberg 2001). Če k temu prištejem še neizkoriščene možnosti, ki jih bo treba odkriti, se strinjam z M. Brodarjem (1999), da je najdišče vredno raziskovati naprej in to tako na podlagi obstoječega gradiva kot na terenu. Bodočim raziskovalcem zato želim vsaj toliko sreče, kot sem jo imel sam pri sicer nehvaležnem delu, ki ga nikakor ne bi želel ponoviti.

PRI IZKOPAVANJIH V DIVJIH BABAH I SO SODELOVALI:

1978: idrijski jamarji in Turk Ivan. **1980**: Blažon Marjan, Dirjec Janez, Jocif Janez, Jocif Matej, Josipovič Draško, Medlobi Marjan, Oražen Sašo, Tušar Tončka in Turk Ivan. **1981**: Dirjec Janez, Josipovič Draško, Knific Damjan, Turk Ivan, Tušar Tončka, Zavrtanik Jernej in Žajdela Darko. **1982**: Dirjec Janez, Josipovič Draško, Knific Damjan, Turk Ivan, Tušar Tončka in Zavrtanik Jernej. **1983**: Dernovšek Tomaž, Dirjec Janez, Frelih Marko, Josipovič Draško, Knific Damjan, Martinšek Avgust, Ivan Turk in Tušar Tončka. **1984**: Dernovšek Tomaž, Dirjec Janez, Jež Marina, Knific Damjan, Likar Gregor, Majcen Martin, Martinšek Avgust, Mikuž Vasja, Pavšič Jernej, Turk Ivan, Tušar Tončka in Verbič Helena. **1985**: Baznik Nada, Belač Ivan, Dirjec Janez, Jerina Roman, Knific Damjan, Knific Majda, Križnar Naško, Martinšek Avgust in Turk Ivan. **1986**: Bavec Uroš, Dirjec Božena, Dirjec Janez, Dirjec Janez jun., Jerina Roman, Knific Damjan, Knific Majda, Kregar Jože, Martinšek Avgust, Mestek Franc in Turk Ivan. (**1988**): Butinar Breda, Butinar Peter, Butinar Primož, Dirjec Janez, Knific Damjan, Mestek Franc in Turk Ivan. **1989**: Dirjec Janez, Dirjec Janez jun., Jelovšek Mila, Knific Damjan, Veluščeк Anton in Ivan Turk. **1990**: Blažič Borut, Debeljak Irena, Dirjec Janez, Dirjec Janez jun., First Srečko, Knific Damjan, Martinšek Avgust in Žontar Jerneja. **1991**: Bavec Uroš, Blažič Borut, Dirjec Janez, Dirjec Janez jun., Jelovšek Mila, Knific Damjan in Ivan Turk. **1992**: Bavec Miloš, Bavec Uroš, Dirjec Janez, Dirjec Janez jun., Dirjec Matija, Drolc Dejan, Jelovšek Mila, Ogorelec Aleš, Sajko Iztok, Turk Ivan, Turk Janez in Turk Matija. **1993**: Dirjec Janez, Dirjec Janez jun., Dirjec Matija, Jelovšek Mila, Obid Boštjan, Obid Robi, Pirih Boštjan, Anže Rak, Gašper Rak, Jernej Rak, Rupar Andrej, Šturm Zdravko, Turk Ivan, Turk Janez, Turk Nuša, Turk Matija in Turnšek Matej. **1994**: Bavec Miloš, Dirjec Janez, Dirjec Janez jun., Dirjec Matija, Jelovšek Mila, Leban Irena, Rak Anže, Rupar Andrej, Štemberger Filip, Šturm Dušan, Turk Ivan, Turk Janez, Turk Nuša in Turk Matija. **1995**: Dirjec Janez, Dirjec Janez jun., Dirjec Matija, Jelovšek Mila, Kavur Boris, Likar Matija, Rak Anže, Rak Gašper, Rupar Andrej, Šturm Janko, Turk Ivan, Turk Janez, Turk Nuša in Turk Matija. **1997**: Dirjec Janez, Dirjec Janez jun., Dirjec Matija, Jelovšek Mila, Kavur Boris, Knific Andrej, Lajovic M., Pirih Boštjan, Rak Anže, Rupnik Janez, Turk Barbara, Turk Ivan, Turk Janez, Turk Nuša in Turk Matija. **1998**: Blaser Frédéric, Dirjec Janez, Dirjec Janez jun., Dirjec Matija, Debeljak Irena, Kavur Boris, Kralj Andreja, Lajovic Marko, Leban Andrej, Rak Anže, Rupnik Janez, Šturm Dušan, Tinta Albina, Turk Barbara, Turk Ivan, Turk Janez, Turk Nuša in Turk Matija. **1999**: Bernard-Guelle Sébastién, Blaser Frédéric, Dirjec Janez, Dirjec Janez jun., Dirjec Matija, Knific Andrej, Leban Andrej, Rak Anže, Rupnik Janez, Šturm Dušan, Tinta Albina, Turk Barbara, Turk Ivan, Turk Janez, Turk Nuša in Turk Matija.

ZAHVALA

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Izkopavanja so podprla naslednja podjetja: Astra veletrgovina Ljubljana, Avtoprevoz Tolmin, **Elektro Primorska Tolmin**, Fructal Ajdovščina, IMP črpalke Ljubljana, Iskra commerce Ljubljana, Javna razsvetljava Ljubljana, Jugotekstil Ljubljana, Kmetijska zadruga Idrija, Kmetijski kombinat Slovenske Gorice Ptuj, Kolinska Ljubljana, Ledis Ljubljana, Ljubljanska banka Ljubljana, Ljubljanske mlekarne Ljubljana, Luma Ljubljana, Mercator-Sadjezelenjava Ljubljana, Olma Ljubljana, Parkhiša Ljubljana, Petrol Ljubljana, Podravka Ljubljana, SCT Ljubljana, Rotomatika Spodnja Idrija, Rudnik Idrija, Slovenica Ljubljana, Slovenijales Ljubljana, Slovenijavino Ljubljana, Teol Ljubljana, **Zidgrad Idrija**, Žito Ljubljana, posamezniki: P. Grašič orodjarstvo in plastika Škofja Loka, A. Piskar, F. Rebolj, O. Črnilogar, I. Turk, krajani Šebrelj in Reke ter ustanove: Ministrstvo za obrambo RS in Muzej Idrija.

Prevodi so bili opravljeni s pomočjo raziskovalnega sklada Znanstvenoraziskovalnega centra SAZU in donacije SAZU ter Korporacija Hidria. Slovenski tekst je bil lektoriran z denarjem, ki ga je urednik zaslužil z delom pri projektu Arheološki park Divje babe I, občine Cerkno in Idrijsko-Cerkljanske razvojne agencije. Drugih posebnih virov financiranja, žal, ni bilo, ker Divje babe I niso bile nikdar v rangu samostojnih projektov nacionalnega pomena.

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INTRODUCTION

(Summary)

IVAN TURK

The Divje babe I site (GaussKruger co-ordinates y = 416555,77 m, x = 108160,75 m) in the Idrijca valley in western Slovenia lies at an altitude of 450 m (exactly 448,25 m), beneath the edge of the Šebrelje plateau (600–700 m.a.s.l.), which is part of the foothills in the most south-easterly part of the Alps (*Fig. 1* and Chapter 3 in this volume, *Fig. 3.1*). Slightly further to the south extend the most northerly flanks of the Dinaric mountains.

Today, the region around the site is located within the submediterranean climate zone (Ogrin 1998) or in humid temperate morphoclimatic zone after Tricart, Cailleux (1965, 265 ss). A characteristic peak in precipitation occurs in autumn (above all November). With a mean annual precipitation of 1800 mm/yr and only 572 mm/yr evapotranspiration, the region experiences a humid climate, typical of the Alpine and Dinaric elevations in this part of Europe (Zupančič 1998). To the south, the region abuts the hinterland around the Gulf of Trieste, which has a semi-dry submediterranean climate that becomes drier (typical mediterranean climate) closer to the Adriatic Sea (Gams 1998, 34). These climatic regimes are within a distance of barely 50 kilometres and a maximum height difference of 1500 m is reached in mountains between the Adriatic sea and the site. The climatic gradient is most expressed in the duration of the snow cover (Gams, 1998 33; Ovsenik-Jeglič 2000, map). The greatest change in snow cover would therefore occur if today's average temperatures were to fall. During climatic minimum the duration of snow cover would be appreciably lengthened in the site region. This would directly influence the seasonal groundwater flow, producing a peak in groundwater flow during the spring due to the snow melt, in addition to the autumnal maximum due to precipitation (but see Chapter 7 in this volume, footnote 3).

Divje babe I is a horizontally developed cave approximately 45 m long and 15 m wide (Chapter 1 in this volume, *Fig. 1.3*). The cave was formed in massive Triassic Cordevolian dolomite along faults associated with the Kneža Fault (see Chapter 2 in this volume). The cave tunnel is filled with more than 12 m thick, almost exclusively autochthonous clastic sediment that was predominantly deposited in OIS/MIS (Oxygen/Marine Isotope Stage) 5 and 3 (see Chapter 6 in this volume). The cave's origin has not been studied but the potential thickness of the sediment, between 13 m and 50 m, suggests an old cave system (*Fig. 2a* and *3*).

First sistematic excavations by Mitja Brodar ran at cave entrance in 1978 (test trench) and from 1980 to 1986. Ivan Turk and Janez Dirjec began new excavations within the cave in 1989, which continued until 1999. Complete field work was done in 17 months from1980 to 1999.

1. IZHODIŠČA, TEHNIKA IN METODA DELA PRI RAZISKOVANJU NAJDIŠČA DIVJE BABE I

IVAN TURK

Arheologija, paleontologija in geologija so po splošni razlagi zgodovinske vede, ki preučujejo »materialne« ostanke ter sledi dogajanja v času in prostoru[1]. S stališča omenjenih ved sta čas in prostor v bistvu ena kategorija, ker ju je v praksi težko ločiti. Na primer: v prostoru lahko istočasno potekajo različni dogodki, ki imajo različne posledice. Možno je tudi obratno, da so v istem prostoru zabeležini dogodki iz različnega časa, ki so imeli prav tako različne posledice. To se lahko zgodi, če sedimentacija zastane. S tem v zvezi se postavlja vprašanje, kje so meje sočasnosti, kaj je sočasno in kaj ni. Te meje so popolnoma odvisne od časovne ločljivosti[2]. Večja kot je časovna ločljivost, verjetnejša je sočasnost in obratno. Časovna ločljivost je premo sorazmerna s hitrostjo sedimentacije, ki je ne morem meriti brez upoštevanja fizične (absolutne) kategorije časa. Poleg fizičnega časa obstaja tudi relativni čas. Temeljna metoda za zaznavanje relativnega časa je stratigrafska. Vendar stratigrafskih enot ne morem neposredno enačiti s časom kot fizično kategorijo, tudi če čas določim radiometrično ali kako drugače. Ker se stvari v času neprestano spreminjajo, je logično da se spreminjajo tudi podatki v stratigrafskem stolpcu. Variacije, ki so vezane na čas, so tem podrobnejše, kolikor večja je časovna ločljivost, ki je odvisna od debeline stratigrafskih enot in hitrosti sedimentacije. V želji po čim večji časovni ločljivosti stratigrafskega zapisa Divjih bab I sem dal podrobno datirati profil in ga hkrati sedimentološko, paleontološko in arheološko analiziral. Iste analize sem ponovil v bočni smeri v vseh plasteh na površini 21 m^2 oz. 25 m^2. Ker predstavljajo najdišče različni sklopi najdb, je naloga izkopavalca, da te sklope smiselno poveže v sistem[3]. Orodje, ki mu to omogoča, je nedvomno stratigrafija. Kako to orodje uporablja pa je odvisno od iznajdljivosti posameznika.

Sl. 1.1: Spiranje sedimentov ob potoku pod jamo. Fotografija I. Turk.
Fig 1.1: Rinsing sediments by the stream below the cave. Photograph I. Turk.

Čeprav igra prostor v geologiji, paleontologiji in arheologiji zaradi narave terenskega dela in poizkopavalnih postopkov pomembno vlogo pri variabilnosti, se stvari dejansko spreminjajo samo v času. Vprašanje je, kako ločiti istočasne razlike v prostoru od sprememb v času. Ločevanje je delno mogoče samo, če vključimo v analizo poleg časa oz. stratigrafije tudi prostor. Vendar je treba čas in prostor obravnavati skupaj, nikakor ne ločeno, kot se je to počelo in se še vedno marsikje počne, ko se najprej analizira profil kot tak, potem pa se

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[1] Čas v arheološki praksi običajno predstavlja stratigrafski stolpec, prostor, kjer se je v preteklosti nekaj dogajalo, pa izkopno polje.

[2] Pomena časovne ločljivosti za interpretacijo najdišč se je stroka začela zavedati šele po odkritju radiometričnih postopkov, s katerimi je bilo mogoče posamezna najdišča neodvisno datirati (glej Woodward, Goldberg 2001).

[3] Pod sistemom razumem splet fizičnega in relativnega časa.

Sl. 1.2a, b: Pregledovanje sedimentov in pobiranje najdb na terenu (a) in v laboratoriju (b). Fotografija M. Zaplatil.
Fig. 1.2a, b: Examining sediments and collecting finds in the field (a) and in the laboratory (b). Photographs by M. Zaplatil.

skuša na tej podlagi kronološko razložiti celotno najdišče[4].

Ločevanja sočasnih sprememb v prostoru od sprememb v času je potrebno tako znotraj najdišč kot med najdišči, kadar jih želimo med seboj povezati. Če tega vprašanja najprej ne rešimo zadovoljivo na najdišču, ga tudi ne bomo nikoli zadovoljivo rešili med najdišči s pomočjo analogij. Žal raziskovalci običajno uberemo obratno pot in iščemo razlage na podlagi primerjav. Dokončne rešitve zastavljenega vprašanja v okviru posameznega najdišča ni – so samo boljše ali slabše rešitve.

Zahtevi po skupni obravnavi prostora in časa sem leta 1989 prilagodil tehniko izkopavanja, pregledovanja sedimentov (*sl. 1.1, 1.2a, b*) in način dokumentiranja. Namesto prejšnjega izkopavanja po blokih od profila do profila in režnjih, ki so se prilagajali debelini plasti, sem uvedel dosledno izkopavanje po kvadratih velikosti 100x100 cm, in režnjih, debelih 12 cm[5]. Te osnovne pro-

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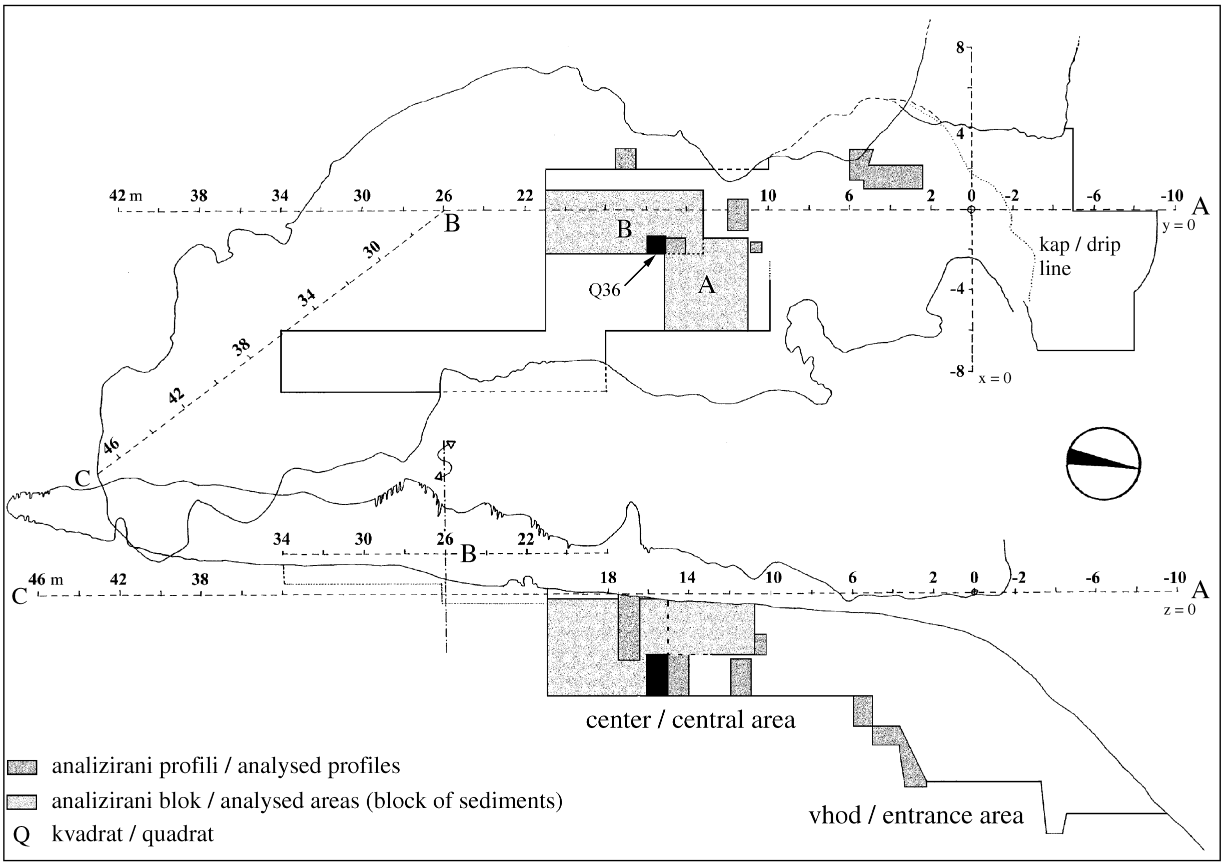
[4] Pod profilom razumem presek plasti na določenem mestu v najdišču. To je profil v ozkem pomenu besede. Profil v širokem pomenu besede je stratigrafija najdišča.

[5] Globine 36 režnjev, merjene od relativne ničle, so bile naslednje (v centimetrih): 0 (-28), 1 (-42), 2 (-54), 3 (-67), 4 (-82), 5 (-94), 6 (-106), 7 (-117), 8 (-129), 9 (-141), 10 (-153), 11 (-165), 12 (-177), 13 (-189), 14 (-201), 15 (-213), 16 (-225), 17 (-237), 18 (-249), 19 (-261), 20 (-273), 21 (-285), 22 (-297), 23 (-309), 24 (-321), 25 (-333), 26 (-345), 27 (-357), 28 (-369), 29 (-381), 30 (-393), 31 (-405), 32 (-417), 33 (-429), 34 (-441), 35 (-453) in 36 (-465).



Sl.1.3: Tloris in profil jame z označenim izkopnim poljem, vzorčevanimi površinami in profili. Risba D. Josipovič. Vnos podatkov I. Turk.

Fig. 1.3: Ground plan and longitudinal section of cave with excavation trench, sampling areas and profiles marked. Sketch by D. Josipovič. Data entered by I. Turk.

storsko-stratigrafske dokumentacijske enote sem lahko poljubno sestavljal v večje enote, ki ustrezajo geološkim plastem v stratigrafskem stolpcu. Geološke plasti so bile tako kot režnji od nekdaj arbitrarno določene na terenu, ne da bi bil njihov pomen vnaprej znan. Ta se je opredelil šele po končanem izkopavanju na podlagi bolj ali manj podrobne analize sedimentov in njihove vsebine. Bistvena razlika med režnji in plastmi je v tem, da so režnji objektivno določeni z globinami, plasti pa subjektivno, na podlagi izkušenj.

Moji predhodniki so v stratigrafiji izhajali izključno iz geoloških plasti v profilih. Študiju profilov se je posvečalo veliko pozornosti, vendar to ni dalo zadovoljivih rezultatov[6]. Prostorska variabilnost, ki je bila sicer znana, saj se profili spreminjajo že na kratko razdaljo, ni bila ustrezno preučena in se zato ni upoštevala pri interpretaciji najdišča. Zato si upam trditi, da je veliko kronoloških in drugih sklepov neveljavnih, vključno s sklepi izkopavanj v Divjih babah I v letih 1980–1986, ki temeljijo na subjektivno določenih geoloških plasteh med profili, v katere smo vključili najdbe.

Geološke plasti so nedvomno primerno izhodišče za stratigrafsko analizo, vendar imajo več pomanjkljivosti, ki so lahko zelo moteče. Največja pomanjkljivost je ta, da plasti lahko zanesljivo določim samo v profilu, pa še tu med plastmi običajno ni ostrih meja. Določevanje plasti bočno med profili je zato skrajno subjektivno početje. Temu ustrezno je nezanesljivo umeščanje najdb v plasti in analiziranje ter interpretiranje najdišča po plasteh. Različna debelina plasti lahko vpliva na količino najdb in posledično na njihovo kakovost. Te nevarnosti pri enakomerno debelih režnjih ni. Tradicionalno obravnavanje vseh najdb v Divjih babah I in drugih paleolitskih najdiščih na podlagi geoloških plasti ni pripomoglo k razlikovanju najdb glede na razlike med plastmi. Če predpostavljamo, da so različne plasti nastale v različnih okoljih, bi moralo to sistematično odsevati tudi v vseh najdbah, pa običajno ne ali pa kvečjemu v izjemah, ki jih poiščemo v ta namen.

Zato sem se na koncu faze izkopavanj M. Brodarja v Divjih babah I odločil za objektivnejše stratigrafsko razvrščanje vseh najdb na podlagi t. i. sedimentacijskih nivojev (Turk 2003a). Nov pristop ni odpravil geološ-

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[6] Značilen primer je Betalov spodmol, ki ima zelo zapleteno stratigrafijo, ki kljub številnim dokumentiranim profilom ni bila nikoli zadovoljivo pojasnjena (prim. S. Brodar 1953 in Osole 1990).

Tab. 1.1a, b: Korelacija med sedimentacijskimi nivoji, kvadrati in režnji. Lokacijo izbranih površin A in B prikazuje *sl. 1.3.* a) Prvi štirje nivoji so s površinsko nezasigane površine A. b) Vsi ostali nivoji so s površinsko zasigane površine B.
Pojasnilo: Skrajni levi stolpec v tabeli vsebuje globine izkopavalnih režnjev v cm. Ostali stolpci vsebujejo oznake kvadratov, tako kot so si sledile v tlorisu (glej Turk 1997, sl. 1.3). Vodoravna odebeljena črta med režnji in kvadrati pomeni stopnico med posameznimi režnji, ki tvorijo sedimentacijski nivo. Namen stopničenja je slediti nagibu geoloških plasti, ki znaša lateralno 4 cm/1 meter. Številčne oznake režnjev 1–36 so ob strani okvirja vsakega sedimentacijskega nivoja.
Tab. 1.1a, b: Correlation among sedimentation levels, quadrats and cuts. Location of selected areas A and B is shown in *Fig.1.3.* a) The first four levels are from superficially uncemented area A. b) All other levels are from superficially cemented area B.
Explanation: The extreme left hand column in the table contains depths of excavated cuts in cm. Other columns contain the denotations of quadrats as they follow on the groundplan (see Turk 1997, Fig. 1.3). The horizontal thick line between the cuts and quadrats means steps between individual cuts which make up the sedimentation levels. The purpose of the gradation is to follow the dip of the geological layers, which amounts laterally to 4 cm/1 meter. Numerical labels of cuts 1–36 are beside the box of each sedimentation level.

a

	Sedimentation level: -20 cm					
1	-42	63	56	49	42	35
		62	55	48	41	34
		62a	55a	48a	41a	34a
2	-54	62b	55b	48b	41b	34b
		62c	55c	48c	41c	34c

	Sedimentation level: -32 cm					
2	-54	63	56	49	42	35
		62	55	48	41	34
		62a	55a	48a	41a	34a
3	-67	62b	55b	48b	41b	34b
		62c	55c	48c	41c	34c

	Sedimentation level: -44 cm					
3	-67	63	56	49	42	35
		62	55	48	41	34
		62a	55a	48a	41a	34a
4	-82	62b	55b	48b	41b	34b
		62c	55c	48c	41c	34c

	Sedimentation level: -56 cm					
4	-82	63	56	49	42	35
		62	55	48	41	34
		62a	55a	48a	41a	34a
5	-94	62b	55b	48b	41b	34b
		62c	55c	48c	41c	34c

b

	Sedimentation level: -68 cm			
2	-54	40	31	32
		39	28	29
3	-67	38	25	26
		37	22	23
		36	19	20
4	-82	35	16	17
		34	13	14

	Sedimentation level: -81 cm			
3	-67	40	31	32
		39	28	29
4	-82	38	25	26
		37	22	23
		36	19	20
5	-94	35	16	17
		34	13	14

	Sedimentation level: -94 cm			
4	-82	40	31	32
		39	28	29
5	-94	38	25	26
		37	22	23
		36	19	20
6	-106	35	16	17
		34	13	14

	Sedimentation level: -106 cm			
5	-94	40	31	32
		39	28	29
6	-106	38	25	26
		37	22	23
		36	19	20
7	-117	35	16	17
		34	13	14

	Sedimentation level: -117 cm			
6	-106	40	31	32
		39	28	29
7	-117	38	25	26
		37	22	23
		36	19	20
8	-129	35	16	17
		34	13	14

	Sedimentation level: -129 cm			
7	-117	40	31	32
		39	28	29
8	-129	38	25	26
		37	22	23
		36	19	20
9	-141	35	16	17
		34	13	14

	Sedimentation level: -141 cm			
8	-129	40	31	32
		39	28	29
9	-141	38	25	26
		37	22	23
		36	19	20
10	-153	35	16	17
		34	13	14

	Sedimentation level: -153 cm			
9	-141	40	31	32
		39	28	29
10	-153	38	25	26
		37	22	23
		36	19	20
11	-165	35	16	17
		34	13	14

	Sedimentation level: -165 cm			
10	-153	40	31	32
		39	28	29
11	-165	38	25	26
		37	22	23
		36	19	20
12	-177	35	16	17
		34	13	14

	Sedimentation level: -177 cm			
11	-165	40	31	32
		39	28	29
12	-177	38	25	26
		37	22	23
		36	19	20
13	-189	35	16	17
		34	13	14

	Sedimentation level: -189 cm			
12	-177	40	31	32
		39	28	29
13	-189	38	25	26
		37	22	23
		36	19	20
14	-201	35	16	17
		34	13	14

	Sedimentation level: -201 cm			
13	-189	40	31	32
		39	28	29
14	-201	38	25	26
		37	22	23
		36	19	20
15	-213	35	16	17
		34	13	14

continued...

Tab. 1.1a, b (nadaljevanje / cont.)

	Sedimentation level:			-213 cm
14	-201	40	31	32
		39	28	29
15	-213	38	25	26
		37	22	23
		36	19	20
16	-225	35	16	17
		34	13	14

	Sedimentation level:			-225 cm
15	-213	40	31	32
		39	28	29
16	-225	38	25	26
		37	22	23
		36	19	20
17	-237	35	16	17
		34	13	14

	Sedimentation level:			-237 cm
16	-225	40	31	32
		39	28	29
17	-237	38	25	26
		37	22	23
		36	19	20
18	-249	35	16	17
		34	13	14

	Sedimentation level:			-249 cm
17	-237	40	31	32
		39	28	29
18	-249	38	25	26
		37	22	23
		36	19	20
19	-261	35	16	17
		34	13	14

	Sedimentation level:			-261 cm
18	-249	40	31	32
		39	28	29
19	-261	38	25	26
		37	22	23
		36	19	20
20	-273	35	16	17
		34	13	14

	Sedimentation level:			-273 cm
19	-261	40	31	32
		39	28	29
20	-273	38	25	26
		37	22	23
		36	19	20
21	-285	35	16	17
		34	13	14

	Sedimentation level:			-285 cm
20	-273	40	31	32
		39	28	29
21	-285	38	25	26
		37	22	23
		36	19	20
22	-297	35	16	17
		34	13	14

	Sedimentation level:			-297 cm
21	-285	40	31	32
		39	28	29
22	-297	38	25	26
		37	22	23
		36	19	20
23	-309	35	16	17
		34	13	14

	Sedimentation level:			-309 cm
22	-297	40	31	32
		39	28	29
23	-309	38	25	26
		37	22	23
		36	19	20
24	-321	35	16	17
		34	13	14

	Sedimentation level:			-321 cm
23	-309	40	31	32
		39	28	29
24	-321	38	25	26
		37	22	23
		36	19	20
25	-333	35	16	17
		34	13	14

	Sedimentation level:			-333 cm
24	-321	40	31	32
		39	28	29
25	-333	38	25	26
		37	22	23
		36	19	20
26	-345	35	16	17
		34	13	14

	Sedimentation level:			-345 cm
25	-333	40	31	32
		39	28	29
26	-345	38	25	26
		37	22	23
		36	19	20
27	-357	35	16	17
		34	13	14

	Sedimentation level:			-357 cm
26	-345	40	31	32
		39	28	29
27	-357	38	25	26
		37	22	23
		36	19	20
28	-369	35	16	17
		34	13	14

	Sedimentation level:			-369 cm
27	-357	40	31	32
		39	28	29
28	-369	38	25	26
		37	22	23
		36	19	20
29	-381	35	16	17
		34	13	14

	Sedimentation level:			-381 cm
28	-369	40	31	32
		39	28	29
29	-381	38	25	26
		37	22	23
		36	19	20
30	-393	35	16	17
		34	13	14

	Sedimentation level:			-393 cm
29	-381	40	31	32
		39	28	29
30	-393	38	25	26
		37	22	23
		36	19	20
31	-405	35	16	17
		34	13	14

	Sedimentation level:			-405 cm
30	-393	40	31	32
		39	28	29
31	-405	38	25	26
		37	22	23
		36	19	20
32	-417	35	16	17
		34	13	14

	Sedimentation level:			-417 cm
31	-405	40	31	32
		39	28	29
32	-417	38	25	26
		37	22	23
		36	19	20
33	-429	35	16	17
		34	13	14

	Sedimentation level:			-429 cm
32	-417	40	31	32
		39	28	29
33	-429	38	25	26
		37	22	23
		36	19	20
34	-441	35	16	17
		34	13	14

	Sedimentation level:			-441 cm
33	-429	40	31	32
		39	28	29
34	-441	38	25	26
		37	22	23
		36	19	20
35	-453	35	16	17
		34	13	14

	Sedimentation level:			-453 cm
34	-441	40	31	32
		39	28	29
35	-453	38	25	26
		37	22	23
		36	19	20
36	-465	35	16	17
		34	13	14

kih plasti, ki so ostale predmet raziskav neposredno v profilih, je pa odstranil motečo subjektivnost in uvedel večjo preglednost poizkopavalnega postopka.

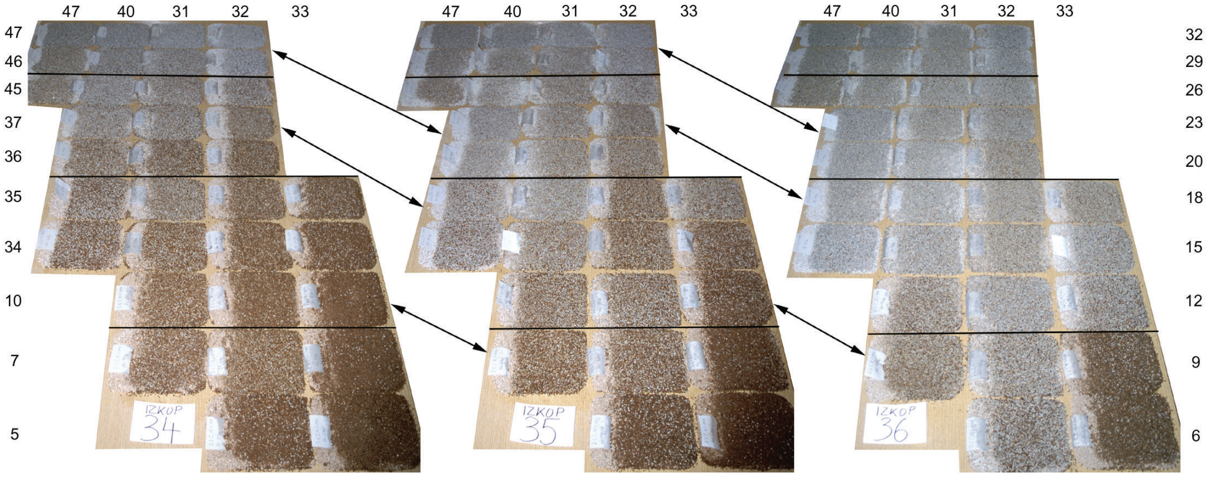
Za uspešno raziskovalno delo je treba upoštevati vse kategorije časa kot tudi preplet časa in prostora. V ta namen sem osnovne prostorsko-stratigrafske enote na posebej izbrani površini (*sl. 1.3*) v poizkopavalnem postopku združil v sedimentacijske nivoje, ki zajemajo na terenu določene plasti in upoštevajo tudi njihov upadni kot. Ključ, po katerem so sestavljeni stratigrafski nivoji, je prikazan v *tabeli 1.1a, b* (*sl. 1.4*). Ker ti stratigrafski nivoji dobro nadomeščajo lastnosti plasti, povezava teh s plastmi v profilu ni nujno potrebna, je pa mogoča na podlagi primerjanja rezultatov istih analiz v bloku sedimentov in v profilu (Turk 2006). V obeh primerih gre v bistvu za preučevanje stratigrafskega stolpca z različno veliko prostornino in različno prostorsko variabilnostjo.

V zborniku uporabljamo oba stratigrafska pristopa, čeprav dajem sam prednost sedimentacijskim nivojem pred plastmi iz navedenih razlogov. Ker smo v prvi, Brodarjevi fazi izkopavanj (1979–1986) uporabljali samo plasti, smo v nekaterih poglavjih zaradi primerljivosti obeh faz izkopavanj analizirali najdbe predvsem po plasteh. Korelacija med sedimentacijskimi nivoji in plastmi je objektivno mogoča samo na podlagi profilov, nikakor pa ne v bočni smeri za vsak posamezni nivo. Bočno lahko sedimentacijske nivoje enačimo s plastmi samo približno (*glej sl. 1.4*).

Stratigrafski stolpec, razdelan v 37 sedimentacijskih nivojih (Turk 2003a), sem s sodelavci preučil v bloku sedimentov s prostornino 95 m^3, ki omogoča najneposrednejše primerjave vseh podatkovnih baz. Blok sedimentov (*sl. 1.3*) predstavlja 5 % celotne prostornine vseh sedimentov v jami do globine, kjer smo leta 1999 končali izkopavanja. Kljub majhnemu prostorninskemu deležu, je blok reprezentativen za celotno najdišče, saj razen redkih izjem vsebuje veliko število podatkov, kar minimizira standardno napako. Poleg tega imajo vsi sedimentacijski nivoji enake prostornine in približno enak sestav sedimentov, tako da je slika večinskih najdb po nivojih utežena. Izjema so nivoji z izjemno velikimi bloki, ki imajo malenkost manjšo prostornino. Tako imajo nivoji –68 cm, –81 cm, –94 cm in –369 cm prostornino manjšo za 4,8 %, nivo –405 cm in –417 cm za 9,6 % in nivo –429 cm za 14,2 %. Večje komplekse breče v plasti 8 sem preučil s pomočjo mest, kjer sediment izjemoma ni bil cementiran.

V bloku sedimentov je mogoče preučiti variacije v času in prostoru na dva načina: prvič, na podlagi maksimalne časovne ločljivosti po režnjih oz. stratigrafskih nivojih; drugič, na podlagi zmanjšane časovne ločljivosti po združenih stratigrafskih nivojih. Prostor in čas lahko poljubno oblikujemo in tako povečujemo ali zmanjšujemo možnosti za nadzor variabilnosti v obeh kategorijah hkrati. Prejšnja terenska tehnika in dokumentacija tega ni omogočala. Zato ni bilo možno objektivno preučevati variabilnosti podatkovnih baz.

Podatkovna baza je lahko kvantitativna in kvalitativna. Večina starih baz je kvalitativnih, kar je razvidno iz objavljenih del, kjer se le redko navajajo kvantitativni podatki, še redkeje pa so bili takšni podatki analizirani z ustreznimi statističnimi metodami. Medtem ko lahko pri kvantitativnih podatkih objektivno ocenimo napako in zanesljivost, je pri kvalitativnih to mogoče samo na subjektivni ravni. Pri subjektivnih ocenah igra pogosto glavno vlogo argument moči oz. avtoritete.



Sl. 1.4: Bočni prehod dveh geoloških plasti v režnjih 34 (–441 cm), 35 (–453 cm) in 36 (–465 cm), kot se kaže v frakciji sedimenta 0,5–3 mm. Takšnih prehodov nismo mogli opaziti na terenu v tlorisu izkopnega polja.Vodoravne črte označujejo položaj stopnic v sedimentacijskih nivojih, poševne pa povezujejo kvadrate in režnje sedimentacijskega nivoja. Številke so oznake kvadratov. Fotografije I. Turk.

Fig. 1.4: Lateral transition of two geological layers in cuts 34 (–441 cm), 35 (–453 cm) and 36 (–465 cm) as seen in sedimentary fraction 0.5–3 mm. We were not able to observe such transitions in the ground plan of excavated area.Horizontal lines show the position of steps in sedimentation levels. Oblique lines show correlation between individual sedimentation level and quadrats or cuts. Numbers mean denotations of near quadrats. Photographs I. Turk.

Tab. 1.2: Kostni ostanki v kumulativno večajoči se površini sedimentacijskega nivoja -81 cm. Začetna površina je velika 1 m^2, končna pa 21 m^2. Debelina sedimentacijskega nivoja je bila 12 cm. Prostornino sedimenta v m^3 dobimo, če številke v prvem stolpcu pomnožimo z 0,12.

Pojasnilo: Pri površini veliki 20 m^2 ni podatkov, ker je bil v dvajsetem kvadratu velik podorni blok.

Tab. 1.2: Bone remains in cumulatively increasing areas of sedimentation level -81 cm. The initial area is 1 m^2 and the final one 21 m^2. The thickness of the sedimentation level was 12 cm. We get the volume of sediments in m^3 by multiplying the number in the first column by 0.12.

Explanation: There are no data for the area of 20 m^2, because there was a large rockfall boulder in the twelth quadrat.

Sum of quadrats in level -81 cm	Complete (kg)	Fragments, all (kg)	Complete (count)	Fragments, all (count)	Maxillae adul.+juv. (count)	Mandibulae adul.+juv. (count)	Ossa hyoidea adul.+juv. (count)	Diaphyses, adul. (count)	Epiphyses adul. (count)	Complete limb bones (count)*	Metapodia adul.+juv. (count)
1	0.11	0.34	11	42	1	2	0	0	0	0	7
2	0.24	0.76	22	93	2	3	1	0	0	0	9
3	0.37	1.05	35	132	2	7	2	0	0	0	12
4	0.51	1.43	49	213	3	8	2	0	1	0	18
5	0.84	2.46	69	290	3	14	3	1	1	0	27
6	0.94	2.95	78	361	5	15	6	1	1	0	26
7	1.23	4	104	467	7	24	9	1	1	0	32
8	1.55	4.79	133	574	8	25	11	1	1	0	40
9	1.71	5.44	152	661	8	28	12	1	1	0	44
10	2.63	6.13	194	768	10	29	14	1	3	1	48
11	2.92	6.82	224	875	11	37	19	1	3	1	59
12	2.98	7.44	234	956	12	38	22	1	3	1	64
13	3.16	8.18	250	1065	16	44	26	1	3	1	68
14	3.92	10.1	312	1262	21	51	30	1	4	1	86
15	4.24	11	337	1373	21	55	34	1	4	1	91
16	4.38	11.6	353	1446	22	63	34	1	5	1	94
17	4.47	12	367	1508	22	64	36	1	5	1	101
18	4.57	12.6	378	1563	22	65	38	1	5	1	105
19	4.73	13.2	401	1639	25	67	40	1	5	1	111
20											
21	4.74	13.4	402	1668	25	67	42	1	5	1	112

* Mišljeni so humerus, radius, ula, femur, tibia in fibula.

* Humerus, radius, ula, femur, tibia and fibula are meant.

Vpliv velikosti prostora oz. vzorca na variabilnost sem preveril na razmerjih nekaterih podatkov, ki so obravnavani v poglavju 12. To sem storil tako, da sem kumulativno povečeval velikost prostora oz. vzorca v določenem sedimentacijskem nivoju. Izbral sem nivo z majhnim številom najdb (*tab. 1.2*) in nivo z velikim (*tab. 1.3*).

Odnosi med podatki se v tem primeru zelo spreminjajo do določene velikosti vzorca, potem pa se variabilnost umiri. To se zgodi nekako pri 13 m^2 (*sl. 1.5a, b; 1.6a, b*). Izjema je odnos med zgornjo in spodnjo čeljustnico (*sl.1.6a, b*). Na podlagi izsledkov preizkusa sklepam, da so vzorci sedimentacijskih nivojev, pobrani na površini 21 m^2 večinoma primerni za analizo, ker ne podlegajo vplivom prostorsko pogojene variabilnosti.

Za konec še nekaj besed o konceptu najdišča kot zaokrožene celote, in iz tega izhajajočega načina dela v poizkopavalnem postopku.

Vsako najdišče deluje kot sistem, tj. povezana celota v času in prostoru, ki se različno odziva na spremembe v okolju[7]. Zato ni dovolj, da se ugotovi neka variacija in se z njo razloži vse drugo. Ugotoviti in povezati je treba čim več variacij v sistemu. V tej zvezi je pomembno vprašanje, ali se geostratigrafija ujema z biostratigrafijo. Stratigrafsko preverjanje z uporabo bivariatnih statističnih metod je bilo zaradi majhnega števila sedimentacijskih nivojev v Divjih babah I mogoče največ za dva stratigrafska kompleksa. Zato sem v praksi primerjal samo podatke za facies A in B, ki sem ju določil na podlagi temeljitih analiz velikega števila različnih sedimentoloških podatkov[8]. Poleg sistemskih variacij obstajajo tudi variacije, ki so metodološke narave. Zato je bistveno lažje ugotoviti različnost med najdišči kot znotraj njih, še lažje pa je ugotoviti podobnost znotraj najdišč in med njimi. Primerjave med najdišči imajo to pomanjkljivost, da so brez neposrednega stratigrafskega nadzora in zato bolj ali manj izgubljene v času. Rešitve ne prinašajo niti radiometrične metode datiranja, zaradi premajhne časovne ločljivosti in možnosti napake.

Pri ugotavljanju različnosti ali podobnosti s pomočjo statističnih postopkov se soočamo z vprašanjem količine in kakovosti. Večina podatkov o najdiščih, ki so deležni statistične obdelave, se nanaša na količino. Z razčlenitvijo ali stratifikacijo vzorca oz. vzorcev ne dobimo novih rezultatov v količinskem smislu, temveč zgolj potrditev že znanih. Stratifikacija vzorca oz. vzorcev nima nič s stratigrafijo kot časovno kategorijo. S pomočjo stratifikacije lahko preučimo tudi kakovostno stran vzorca oz. vzorcev. Pri tem se pojavi dodatno vprašanje, koliko je kakovost povezana s količino, tj. velikostjo vzorca oz. vzorcev.

To je samo nekaj temeljnih dilem, ki spremljajo arheološko delo in se pokažejo v vsej ostrini pri objav-

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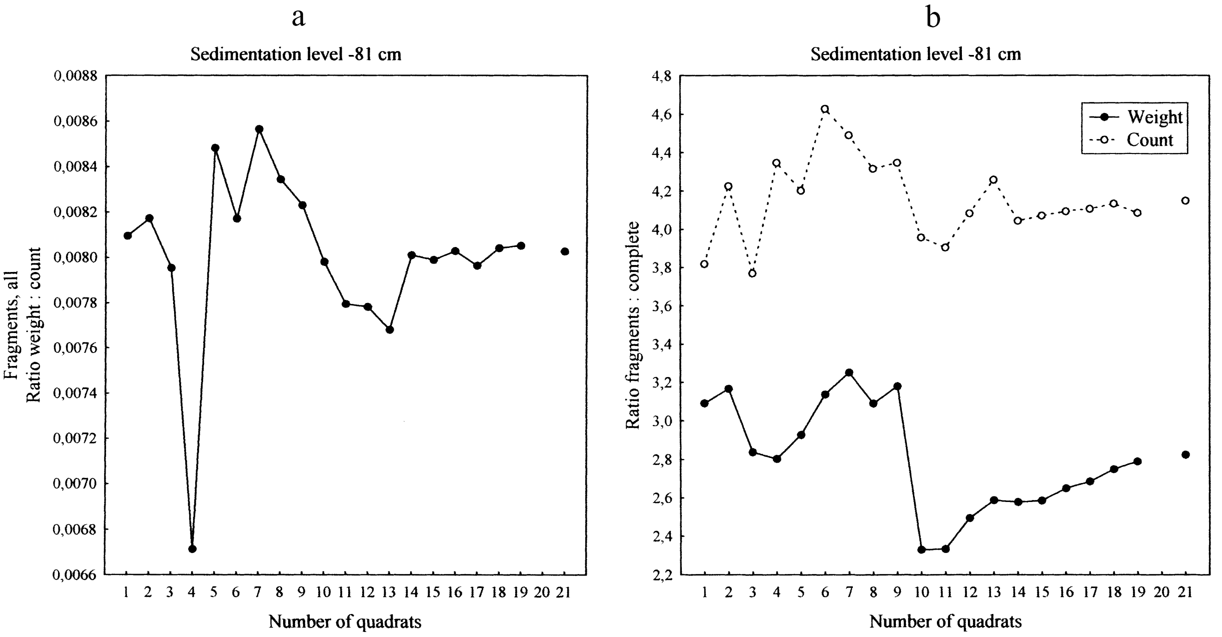
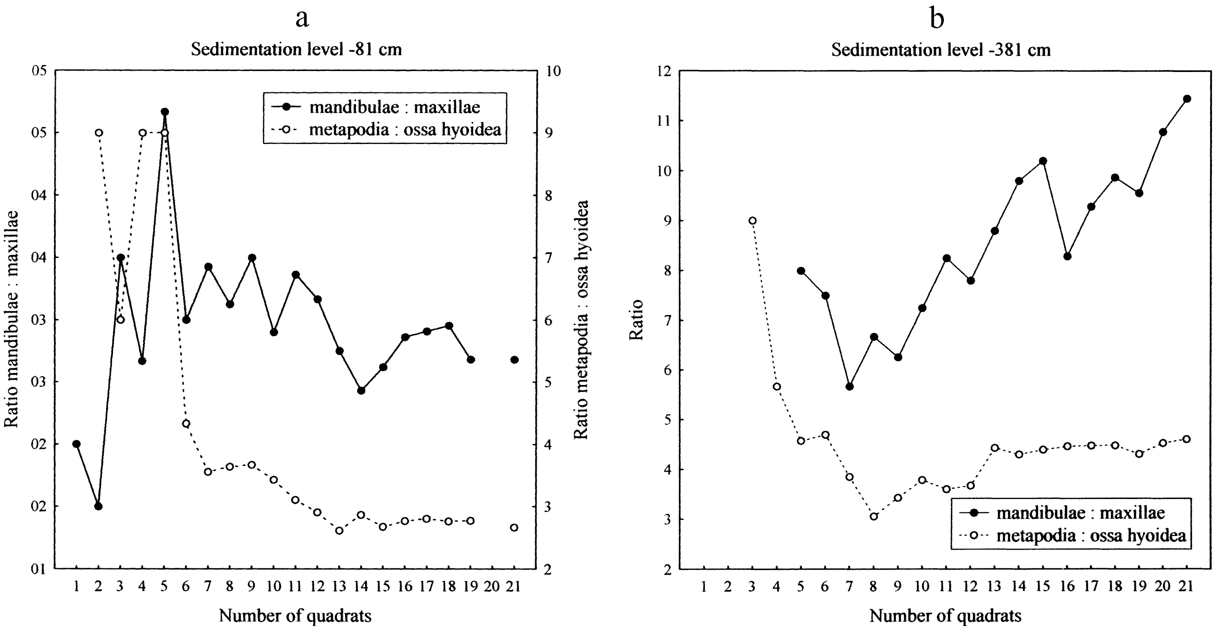
[7] V zvezi s tem je govora o t. i. okoljski občutljivosti najdišča (Woodward, Goldberg 2001), tj. kako se je najdišče odzivalo na spremembe okolja in klime v preteklosti. Za Divje babe I lahko trdim, da sodijo med okoljsko zelo občutljiva najdišča. Zato bi jih bilo vsekakor vredno v bodoče temeljiteje raziskati, kar je bila tudi moja želja, vendar mi ni uspelo raziskovalnega projekta umestiti v rang projektov "nacionalnega pomena" in si tako zagotoviti potrebna sredstva.

[8] Glej delo TURK, I. in sodelavci 2002, *Elaborat Divje babe I, izkopavanja 1989-1999, 1. Tekst,* 142 str., 130 slik, 37 tabel, *2. Osnovni stratigrafski in sedimentološki podatki,* 139 str. prilog, *3. Osnovna stratigrafska in sedimentološka dokumentacija*, 103 fotografije, 13 risb, ki ga hrani arhiv Inštituta za arheologijo ZRC SAZU.



Sl. 1.5a, b: Spreminjanje razmerja med težo vseh fragmentov in njihovim številom glede na velikost vzorca v sedimentacijskem nivoju -81 cm (a) in spreminjanje razmerja teža kostnih fragmentov : teža celih kosti ter število kostnih fragmentov : število celih kosti glede na velikost vzorca v sedimentacijskem nivoju -81 cm (b).
Fig 1.5a, b: Changing ratios between the weight of all fragments and their number in relation to the size of sample in sedimentation level -81 cm (a) and changing ratio of the weight of bone fragments : weight of whole bones, and number of bone fragments : number of whole bones in relation to the size of sample in sedimentation level -81 cm (b).



Sl. 1.6a, b: Spreminjanje razmerja med številom zgornjih čeljustnic in spodnjih ter razmerja med številom metapodijev in podjezičnih kosti v sedimentacijskem nivoju -81 cm (a) in -381 cm (b).
Fig. 1.6a, b: Changing ratios between the number of maxillas and mandibles (upper and lower jaws), and between the number of metapodia and hyoidea in sedimentation levels -81 cm (a) and -381 cm (b).

Tab. 1.3: Kostni ostanki v kumulativno večajoči se površini sedimentacijskega nivoja −381 cm. Začetna površina je velika 1 m^2, končna pa 21 m^2. Debelina sedimentacijskega nivoja je bila 12 cm. Prostornino sedimenta v m^3 dobimo, če številke v prvem stolpcu pomnožimo z 0,12.

Tab. 1.3: Bone remains in cumulatively increasing areas of sedimentation level −381 cm. The initial area is 1 m^2 and the final one 21 m^2. The thickness of the sedimentation level was 12 cm. We get the volume of sediments per m^3 by multiplying the number in the first column by 0.12.

Sum of quadrats in level -381 cm	Maxillae adul.+juv. (count)	Mandibulae adul.+juv. (count)	Ossa hyoidea adul.+juv. (count)	Metapodia adul.+juv. (count)
1	0	1	0	3
2	0	1	0	3
3	0	2	1	9
4	0	5	3	17
5	1	8	7	32
6	2	15	10	47
7	3	17	13	50
8	3	20	19	58
9	4	25	21	72
10	4	29	23	87
11	4	33	30	108
12	5	39	30	110
13	5	44	30	133
14	5	49	34	146
15	5	51	36	158
16	7	58	41	183
17	7	65	46	206
18	8	79	52	233
19	9	86	58	250
20	9	97	59	267
21	9	103	61	281

ljanju rezultatov terenskih raziskav kot primarnega podatkovnega vira, ki potem omogoča različne sklepe. Če se jih zavedamo in se trudimo, da bi jih rešili, bomo morda prispevali k napredku stroke, drugače pa ...

Odkrivanje sistema najdišča in njegovega ozadja, kot so klima, vedenje živali in ljudi itd., je potekalo v treh korakih, ki niso bili načrtovani, temveč sproti improvizirani na podlagi izsledkov različnih bolj ali manj posrečenih poskusov, katerih cilj je bil razvozljati sistem.

Dela sem se lotil tam, kjer je bilo mogoče zbrati največ zveznih podatkov, to je pri sedimentih, kar velja za vsa paleolitska najdišča. Sedimenti so bili tako ključ pri odkrivanju sistema in njegovih zakonitosti.

Naslednji korak je bila analiza različnih zveznih in nezveznih podatkov v profilu z namenom ugotoviti, kateri podatki najbolje opredeljujejo posamezne dele sistema in njihova ozadja.

Ko so bili ti podatki določeni, sem jih lahko multivariatno analiziral za vsak del sistema in njegovo ozadje posebej in ugotovil, kako zanesljivo opredeljujejo ozadje sistema. To je bil zadnji korak v odkrivanju sistema najdišča, ki je omogočil tudi zanesljivo razlago posameznih ozadij (glej predvsem poglavji 5 in 12 v tem zborniku).

Sistemska rešitev je bila v pomoč vsem sodelavcem tega zbornika, ki bi sicer tavali v temi in bili prepuščeni sami sebi. Ker so imeli opraviti z nezveznimi podatki, ne bi nikoli prodrli v sistem najdišča. Brez sistema pa ni mogoče spraviti na skupni imenovalec različne raziskave, ki se dandanašnji vršijo v paleolitskih najdiščih. Lahko bi našteli vrsto starih in novih monografskih objav, ki jim to ni uspelo.

Glavno orodje, ki sem ga zadnja leta uporabljal skupaj z nekaterimi sodelavci, so bile, zaradi obsežnih podatkovnih baz , statistične metode oz. tehnike. Pri delu sem uporabljal program STATISTICA, verzija 6.0 in tam zbrane parametrične in neparametrične tehnike. Seveda ni šlo brez multivariatnih tehnik, kot so diskriminantna funkcijska analiza (DFA), analiza glavnih komponent z možnostjo klasifikacije podatkov (PCCA) in večdimenzionalnega skaliranja (MDS). Zlasti slednje se je pokazalo kot zelo uporabno in učinkovito v večini primerov.

1. INTRODUCTION TO TECHNIQUES AND METHODS OF WORK IN STUDYING THE DIVJE BABE I SITE

IVAN TURK

Archaeology, palaeontology and geology are generally understood as historical sciences that study »material« remains and traces of events in time and space[1]. From the point of view of the aforementioned sciences, time and space are essentially a single category, since it is difficult to divide them in practice. For example: various events can take place at the same time in a space, which have various effects. The converse is also possible, that events from different times are recorded in the same space, which similarly have various effects. This can happen if there is a halt in sedimentation. The question is thus raised in this connection of what are the boundaries of the contemporaneity, what is contemporary and what is not. These boundaries are entirely dependent on temporal resolution[2]. The higher the temporal resolution, the greater the probability of contemporaneity, and the reverse. Temporal resolution is directly proportional to the sedimentation rate, which I cannot measure without respecting the physical (absolute) category of time. In addition to physical time, there is also relative time. The basic method of marking relative time is stratigraphic. However, stratigraphic units cannot be directly equated with time as a physical category, even if the time is determined radiometrically, or in any other way. Since things constantly change over time, it is logical that data in a stratigraphic column also change. Variations that are bound to time are more detailed the higher the temporal resolution, which depends on the thickness of the stratigraphic units and sedimentation rates. In order to obtain the greatest possible temporal resolution of the stratigraphic record of Divje babe I, I had to date the profile in detail and, at the same time, analyse it sedimentologically, palaeontologically and archaeologically. I repeated the same analyses in a lateral direction in all layers over a surface area of 21 m^2 or 25 m^2. Since sites represent various groups of finds, the task of the excavator is to connect these groups sensibly into a system[3]. Stratigraphy is undoubtedly the tool that enables him to do this. How he uses this tool depends on the inventiveness of the individual.

Although space plays an important role in variability in geology, palaeontology and archaeology, because of the nature of fieldwork and post-excavation procedures, things actually only change with time. The question is how to distinguish simultaneous differences in space from changes in time. A distinction is partly possible only if we include also space in the analysis, in addition to time or stratigraphy. However, time and space must be dealt with together, never separately as has been and in places still is done, when the profile as such is first analysed, and an attempt is then made on this basis chronologically to explain the site as a whole[4]. The question of separating simultaneous changes in space from changes in time is present both within sites and between sites, in a case when we wish to connect them. If I do not resolve this question first satisfactorily at the site, I will never satisfactorily solve it between sites on the basis of comparison. There is no final solution to the question raised in the context of an individual site – there are only better or worse solutions.

In 1989, I adapted the requirement for the common treatment of space and time to the techniques of excavation, examining sediments (*Fig. 1.1, 1.2a, b*) and the documentation method. Instead of the former excavation by blocks from profile to profile and cuts adapted to the thickness of the layer, I introduced consistent excavation by quadrats 100 x 100 cm and cuts of 12

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[1] Time in archaeological practice is normally represented by a stratigraphic column, the space in which something happened in the past in the excavation field.

[2] The profession began to be aware of the concept of temporal resolution for the interpretation of sites after the discovery of radiometric procedures, by which it was possible to date an individual site independently (see Woodward, Goldberg 2001).

[3] I understand system to mean the complex of relative and physical time.

[4] By profile, I understand the cross-section of layers at a specific place in the site. This is profile in the narrow sense of the term. Profile in the wider sense of the term is the stratigraphy of the site.

cm[5]. I can easily compose these basic spatial-stratigraphic documentary units into larger units that correspond to geological layers in the stratigraphic column. Geological layers, just like former cuts, were arbitrarily determined in the field, without their significance being previously known. This was only determined after completion of excavation, on the basis of more or less detailed analysis of the sediments and their contents. The crucial difference between cuts and layers is that cuts are objectively defined by depth and layers subjectively on the basis of the experience of the individual.

My predecessors derived in stratigraphy exclusively from geological layers in the profiles. They devoted great attention to the study of profiles, even though this did not give them satisfactory results[6]. Spatial variability, which was actually recognised, since profiles changed over even a very short distance, was not adequately studied and thus not taken into account in the interpretation of sites. I therefore dare to claim that a large number of chronological and other conclusions are invalid, including conclusions on the excavations in Divje babe I in 1980 – 1986, which are based on subjectively determined geological layers within profiles, in which we included finds.

Geological layers are undoubtedly a suitable starting point for stratigraphic analysis, but they have major deficiencies, which can be very troubling. The major deficiency is that I can only determine layers in a profile and, even here, there is normally no sharp boundary between layers. Determining layers laterally between profiles is thus an extremely subjective business. The placing of finds in layers and analysing and interpreting sites by layers is correspondingly unreliable. The different thickness of layers can affect the quantity of finds and, consequently, also their quality. There are not such risks with an equal thickness of cuts. The traditional treatment of all finds in Divje babe I and other palaeolithic sites on the basis of geological layers did not contribute to distinguishing finds in relation to differences between layers. If I presume that the various layers were created in different environments this would have to be systematically reflected also in all finds but is not normally reflected or is reflected at most only in exceptions, which we seek for this purpose.

So, in the final phase of M. Brodar's excavations in Divje babe I, I decided on a more objective stratigraphic classification of all finds on the basis of sedimentation levels (Turk 2003). The new approach did not do away with geologic layers, which remained the subject of study directly in profiles, but it did away with the disturbing subjectivity and introduced greater transparency of the excavation procedure.

For successful research work it is necessary to respect the whole category of time as well as the interweaving of time and space. For this purpose, I combined the basic spatial-stratigraphic units in a specially chosen area (*Fig. 1.3*) in the post-excavation procedure, into sedimentation levels, which on site cover specific layers and also take into account their dip. The key by which stratigraphic levels are composed is shown in *Tab. 1.1a, b* (*Fig.1.4*). Because stratigraphic levels well substitute the properties of the layers the link with layers in the profile is not absolutely necessary, but is possible on the basis of comparison of the results of the same analyses in the block of sediments and in the profile (Turk 2006). In both cases, it is essentially studying stratigraphic columns with different sizes of volume and different spatial variabilities.

We use both stratigraphic approaches in this volume, although I personally give precedence to sedimentation levels over layers for the aforementioned reasons. Because we used only layers in the first, Brodar's phase of the excavation (1979–1986), in some chapters, for the sake of comparability of the two phases of the excavation we analysed finds mainly by layers. The correlation between sedimentation levels and layers is objectively possible only on the basis of profiles, but never in a lateral direction for each individual level. Laterally, we can equate sedimentation levels with layers only approximately (*see Fig. 1.4*).

Together with colleagues, I studied the stratigraphic column, divided into 37 sedimentation levels (Turk 2003) in a block of sediments with a volume of 95 m^3, which enables the most direct comparison of all databases. The block of sediments (*Fig.1.3*) represents 5% of the total volume of sediments to the depth at which we completed excavations in 1999. Despite the small volumetric share, the block is representative of the entire site since, except for rare exceptions, it contains a great deal of data that minimises standard error. In addition, all sedimentation levels have the same volume and approximately the same composition of sediments, so that the picture of the majority of finds is weighted by levels. Levels with exceptionally large blocks, which have a slightly smaller volume, are an exception. Levels –68 cm, –81 cm, –94 cm and –369 cm have 4.8 % smaller volumes, levels –405 cm and –417 cm have 9.6 % and level –429 cm has a 14.2 % smaller volume. I studied larger complexes of breccia in layer 8 with the aid of a place at which, exceptionally, the sediment was not cemented.

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[5] Depths of 36 cuts, measured from datum, were the following (in centimetres): 0 (–28), 1 (–42), 2 (–54), 3 (–67), 4 (–82), 5 (–94), 6 (–106), 7 (–117), 8 (–129), 9 (–141), 10 (–153), 11 (–165), 12 (–177), 13 (–189), 14 (–201), 15 (–213), 16 (–225), 17 (–237), 18 (–249), 19 (–261), 20 (–273), 21 (–285), 22 (–297), 23 (–309), 24 (–321), 25 (–333), 26 (–345), 27 (–357), 28 (–369), 29 (–381), 30 (-393), 31 (–405), 32 (–417), 33 (–429), 34 (–441), 35 (–453) and 36 (–465).

[6] A typical example is Betalov spodmol, which has a very complex stratigraphy, and despite numerous documented profiles this was never satisfactorily explained. (see S. Brodar 1953 and Osole 1990).

It is possible to study variations in time and space in two ways in a block of sediments: firstly, on the basis of maximum temporal resolution by cuts or sedimentation levels; secondly, on the basis of reduced temporal resolution by combined sedimentation levels. We can arbitrarily form space and time and thus increase or reduce the capability of control of variability in both categories simultaneously. The previous fieldwork technique and documentation did not allow this. It was thus not possible to study objectively the variability of databases.

A database can be quantitative or qualitative. The majority of old bases are qualitative, which is clear from published works, where only rarely are quantitative data cited, and even more rarely are such data analysed with appropriate statistical methods. While with quantitative data I can objectively assess error and reliability, with qualitative data this is only possible on the subjective level. With subjective assessments, the main role is played by argument of power or authority.

I checked the effect of the size of the space or sample on variability in the ratios of some data which had been analysed in Chapter 12. I did this by cumulatively increasing the size of the space or sample in a specific sedimentation level. I selected a level with a small number of finds (*Tab. 1.2*) and one with a large number (*Tab. 1.3*).

Ratios among data in this case greatly vary up to a certain size of sample, at which point the variability becomes more even. This happens at around 13 m^2 (*Fig. 1.5a, b; 1.6a, b*). The ratio between upper and lower jaw is an exception (*Fig.1.6a, b*). On the basis of the results of experiment, I conclude that samples of sedimentation levels collected on an area of 21 m^2 are for the most part suitable for analysis, since they are not subject to the influence of spatially conditioned variability.

Finally, a few words about the concept of a site as a concluded whole and the method of work deriving from this in the post-excavation procedure.

Each site operates as a system, i.e., a connected whole in time and space, which is responding differently to the environmental changes[7]. It is not therefore enough to establish some variation and explain all others by it. It is necessary to find and connect as many variations as possible in the system. In this connection, the question is important of whether the geostratigraphy corresponds to the biostratigraphy. Stratigraphic checking with the use of bivariate statistical methods, because of the small number of sedimentation levels in Divje babe I was possible for two stratigraphic complexes at most. So, in practice I compared only data for facies A and B, which I defined on the basis of thorough analyses of a large number of various sedimentological data[8]. In addition to systemic variations, there also exist variations that are of a methodological nature. It is therefore essentially easier to establish differences between sites than within them, and even easier to find similarities within sites and between them. Comparisons between sites have the deficiency that they are without direct stratigraphic control and thus more or less lost in time. Not even radiometric methods of dating, which have too little temporal resolution and because there is the possibility of error, provide a solution.

In establishing differences or similarities with the aid of statistical procedures, we are confronted with the question of quantity and quality. The majority of data on sites that are subject to statistical processing relate to quantity. With the articulation, or stratification, of a sample or samples I do not obtain new results in the quantity sense, but only confirm what is already known. Stratification of a sample or samples has nothing in common with stratigraphy as a temporal category. An additional question is thus raised of how far quality is connected with quantity, i.e., the size of the sample or samples.

These are only some of the dilemmas associated with archaeological work, which appear in all sharpness with the publication of the results of fieldwork as primary data sources that then enable various conclusions. If we are aware of them and attempt to resolve them we will perhaps contribute to progress in the profession, otherwise ...

Discovering the system of the site and its background, such as climate, the behaviour of people and animals etc., took place in three steps, which were not planned, but improvised at the time on the basis of the results of various more or less fortuitous attempts, the aim of which was to disentangle the system.

I commenced the work where it was possible to collect the most numerous continuously distributed data, i.e., with sediments, which applies for all sites. Sediments were the key in discovering the system and its laws.

The next step was analysis of the various continuous and discontinuous data in the profile in order to discover which data best define individual parts of the system and their backgrounds.

When these data were determined, I could multivariate analyse them for each part of the system and its

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[7] In this connection one speaks of the environmental sensitivity of a site (Woodward, Goldberg 2001), i.e. how the site responds to changes in the environment and climate in the past. I can say for Divje babe I that it belongs among environmentally very sensitive sites. So it would certainly be worth doing more thorough research in the future, which was also my wish but I did not succeed in having the research project classified among projects of "national importance" and thus ensuring the necessary funds.

[8] See the work of TURK, I. *et al.* 2002, *Elaborat Divje babe I, izkopavanja 1989-1999, 1. Tekst,* 142 p., 130 pictures, 37 tables, *2. Osnovni stratigrafski in sedimentološki podatki,* 139 pp. with databases, *3. Osnovna stratigrafska in sedimentološka dokumentacija*, 103 photographs, 13 drawings, kept in the archives of the Institute of Archaeology ZRC SAZU.

background individually and find how reliably they define the background of the system. This was the last step in discovering the system of the site, which also enabled a reliable explanation of individual backgrounds (see mainly Chapters 5 and 12 in this volume).

The systemic solution was of assistance to all those cooperating in this volume, who would otherwise have groped in the dark and would have been left to themselves. Since they were dealing with data of a discontinuous nature, they would never have pierced the system of the site; and without a system it is not possible to agree a common denominator of the various studies which are today carried out at palaeolithic sites. I know a number of monograph publications that have not succeeded in this.

Because of the mass of collected data, the main tools applied by me and some of my associates were statistical methods or techniques. I used the program STATISTICA, version 0.6 in the work and the parametric and non-parametric techniques collected there. It was not, of course, done without multivariate techniques, such as discriminant function analysis (DFA), principle component and classification analysis (PCCA) and multidimensional scaling (MDS). The latter in particular proved to be very useful and effective in the majority of cases.

2. KRATEK GEOLOŠKI ORIS OKOLICE NAJDIŠČA DIVJE BABE I

JOŽE ČAR

Jama Divje babe I se je nastala v zgornjetriasnem cordevolskem dolomitu karnijske starosti (*sl. 2.1*). Kamnina je neplastnat, kristalast, močno porozen, srednje do svetlo siv, tu in tam skoraj bel, poznodiagenetski dolomit. V vršnem delu grebena nad jamo, v okolici cerkve sv. Ivana (*sl. 2.1*), postane ta dolomit plastnat, organogen in temnejši. Zelo verjetno je že srednjekarnijske julske starosti, kar pa bi bilo treba dokazati s podrobnejšimi raziskavami fosilnega materiala.

Po podatkih K. Ciglarja in drugih (1970) lahko cordevolski dolomit iz območja Reke sedimentološko označimo kot svetlosiv intrasparitni algni dolomit s 97,7 % karbonatov. Vzorec vsebuje številne intraklaste in pelete. Kemični sestav cordevolskega dolomita iz Šebrelj in Stopnika ter klastov dolomita, najdenih v različnih plasteh Divjih bab I, je prikazan v *tab. 2.1*.

V Šebreljah se od regionalnega Knežkega preloma (Buser 1986), ki poteka v smeri jugovzhod-severozahod, odcepi do 200 m široka, iz več prelomov sestavljena prelomna cona Šebreljskega preloma v smeri sever–jug (*sl. 2.1*). Notranje cone posameznih prelomov so zapleteno zgrajene iz zdrobljenih, porušenih in razpoklinskih con. V zdrobljenih conah najdemo kompaktne kataklastične breče, v porušenih conah pa slabo sprijet dolomitni tektonski zdrob in večje dolomitne odlomke. Porušene in zdrobljene cone so omejene z dobro vidnimi drsnimi ploskvami. V njih so se oblikovali strmi, morfološko ostri žlebovi, ki brazdajo pobočje med Idrijco in cerkvijo sv. Ivana v smeri sever–jug (*sl. 2.2*). Razpoklinske cone so vidne na grebenih in vmesnih conah. Kažejo se v ozkih stopnjastih izravnavah v smeri poteka razpok.

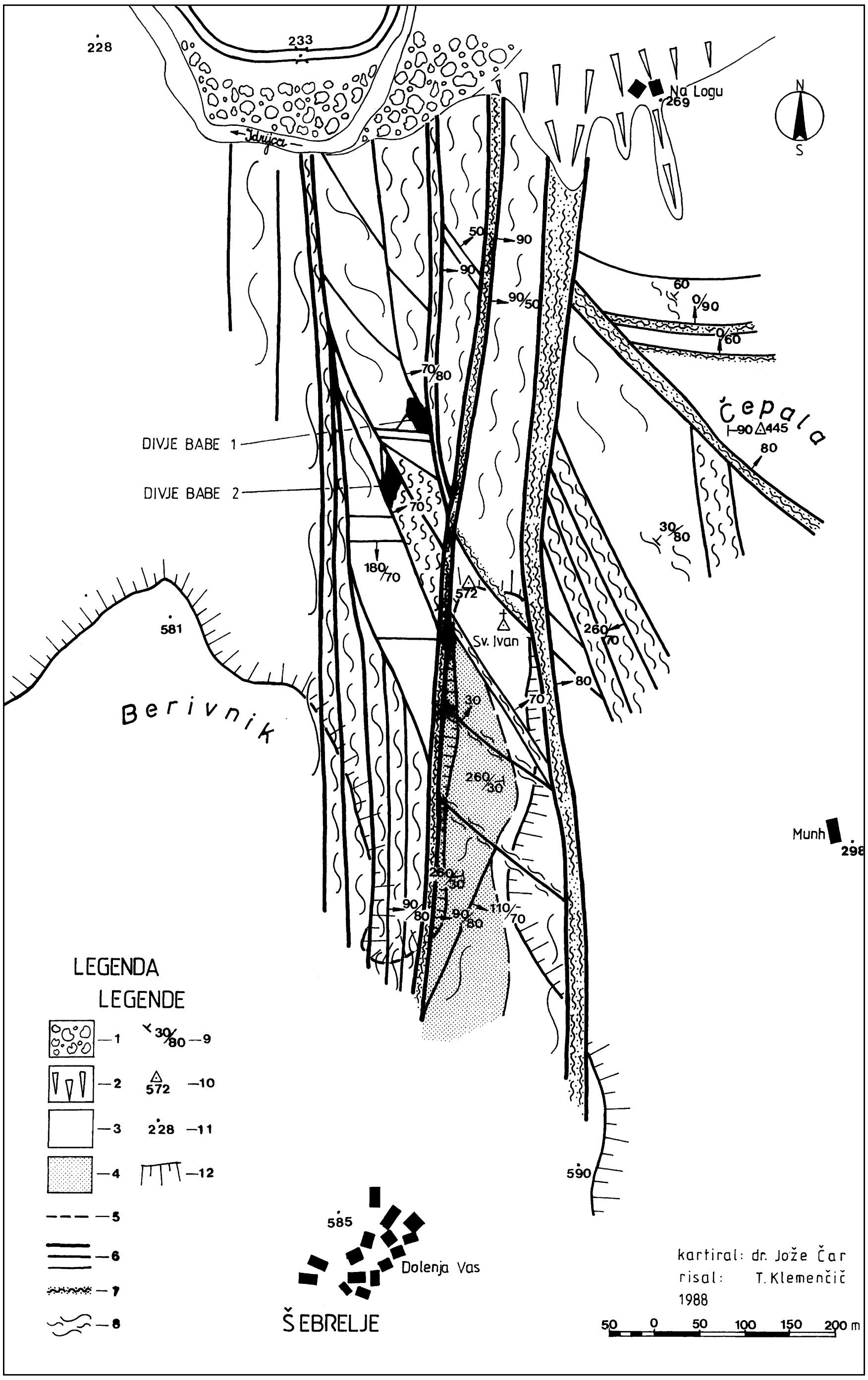
Tab. 2.1: Kemijska sestava cordevolskega dolomita iz Šebrelj in Stopnika (Mlakar *et al.* 1969) ter dolomitnih klastov, velikih 40–60 mm, v sedimentnem profilu Divjih bab I po še neobjavljenih podatkih D. Skaberneta in I. Turka. Podatki za Divje babe I so povprečje 35 vzorcev iz 23 različnih plasti.
Tab. 2.1: Chemical composition of Cordevolian dolomite from Šrebelje and Stopnik (Mlakar *et al.* 1969) and dolomite clasts, 40–60 mm, in the sedimentary profile of Divje babe I according to unpublished data from D. Skabernet and I. Turk. Data for Divje babe I are an average of 35 samples from 23 different layers.

Lab no. Locality	1458 Šebrelje	1495 Stopnik	ACME Divje babe I
CaO (%)	31.9	32.8	31.5
MgO (%)	21.8	20.6	19.6
SiO_2 (%)	0.12	0.67	0.94
Al_2O_3 (%)	0.48	0.25	0.79
Fe_2O_3 (%)	0.08	0.08	0.08
LOI (%)	44.9	44.6	45.7
Humidity 105° C	0.19	0.25	-

Znotraj opisanega Šebreljskega prelomnega sistema sever–jug vidimo še sekundarne pretrte cone, ki dosegajo stopnjo porušenih in razpoklinskih con. Imajo smer severozahod-jugovzhod in povezujejo močnejše cone v smeri sever–jug. Manj izrazit je tercialni sistem prelomnih ploskev v smeri sever–jug in vzhod–zahod.

Mehanska in kemična odpornost cordevolskega dolomita je odvisna predvsem od njegovih petrografskih lastnosti in stopnje pretrtosti. Na številnih mestih so poznodiagenetske spremembe v dolomitu zelo močne. Izginile so vse primarne strukturne in teksturne značilnosti in vidimo le debelokristalno dolosparitno kamnino. Dolomit je torej spremenjen v tako imenovani saharoidni dolomit, v katerem so kristalčki slabo povezani, tako da razpada v kristalni drobir. Pri tem imajo dodatno veliko razgrajevalno vlogo različno močno pretrte cone, predvsem zdrobljene cone. V primeru, ko je cordevolski dolomit v pozni diagenezi doživel manj sprememb, je kamnina temnejša in drobnozrnata. Če v takem primeru dolomit ni bil močneje pretrt, je sorazmerno dobro odporen proti atmosferskim vplivom in posamezni, različno veliki odlomki, ne razpadejo, temveč se postopno zaoblijo in jih načenja le zmrzal.

Na obsežnem območju med Stopnikom, Šebreljami in Krniškim grebenom ležijo na površju pisane srednjetriasne ladinijske plasti. Najpogostejši so različki vulkanoklastičnih kamnin. Med njimi prevladujejo zeleni in zelenkasto sivi piroklastični peščenjaki in meljevci z vložki kislih ali bazičnih tufov ter v superpozicijsko zgornjih delih pelitske kamnine, ki prehajajo pri Šebreljah bočno v črne meljevce in skrilavce z lečami črnega apnenca. V vulkanoklastičnih kamninah so v obliki različno velikih leč zelenkastosivi piroklastični prodnati peščenjaki in pisani debelozrnati konglomerati s tufitskim vezivom, tako imenovani stopniški konglomerat. Sredi vulkanoklastičnih kamnin leži mogočen masiv kremenovega keratofirja in mandljastega diabaza (po no-



Sl. 2.1: Geološke razmere v bližnji okolici Divjih bab I. Legenda: 1-prodni nanos, 2-pobočni grušč, 3-neplastnat cordevolski dolomit, 4-plastnat julski (?) dolomit, 5-postopen litološki prehod, 6-različno močne prelomne linije, 7-zdrobljene in porušene cone, 8-različno goste razpoklinske cone, 9-smer in vpad plasti in prelomnih ploskev, 10-trigonometrijske točka, 11-absolutna nadmorska višina, 12-morfološko izrazit rob Šebreljske planote.

Fig. 2.1: Geological conditions in the near vicinity of Divje babe I. Legend: 1-gravel deposit, 2-talus slope, 3-massive Cordevolian dolomite, 4-layered Julian (?) dolomite, 5-gradual lithological transition, 6-various strong fault lines, 7-broken zones, 8-variously dense fissured zones, 9-direction and dip of layers and fault planes, 10-trigonometric point, 11-absolute altitude, 12-morphologically pronounced edge of Šebrelje plateau.

Sl. 2.2: Pobočje z vhodom v Divje babe I. Vidijo se drsne ploskve ter sistem erozijskih žlebov ob porušenih in zdrobljenih conah. Fotografija C. Narobe.
Fig. 2.2: Slope with entrance to Divje babe I. Fault surfaces and the system of erosion gulleys beside the broken zones can be seen. Photograph C. Narobe.

vejših podatkih verjetno bazalt) s prehodnimi magmatskimi kamninami. Vleče se iz doline Idrijce pri Stopniku pa vse do Pisanc na Krniškem grebenu. Magmatske kamnine, kot tudi piroklastiti, so na številnih mestih močno okremenjeni (Čar, Skaberne 2003) in kamnine dobijo gosto 'roženčevo' strukturo. Opisane kamnine so nedvomno lahko izvor neobičajnega, različno obarvanega drobirja v jamskih sedimentih Divjih bab I.

2. BRIEF GEOLOGICAL DESCRIPTION OF THE SURROUNDINGS OF DIVJE BABE I

JOŽE ČAR

Divje babe I cave was formed in Upper Triassic Cordevolian dolomite of Carnian age (*Fig. 2.1*). The rock is unlayered, crystalline, strongly porous, medium to light grey, here and there almost white, late diagenetic dolomite. In the upper part of the ridge above the cave, in the vicinity of the church of Sv. Ivan (*Fig. 2.1*), the dolomite becomes layered, organogenic and darker. It is very probably already of Middle Carnian Julian age, but this needs to be proved by more detailed investigation of fossil material.

According to the data of K. Ciglar *et al.* (1970) Cordelovian dolomite from the region of Reka can be sedimentologically characterised as light grey intrasparite algaeic dolomite with 97.7% carbonates. The sample contains numerous intraclasts and pellets. The chemical composition of Cordelovian dolomite from Šebrelj and Stopnik and clasts of dolomite found in various layers of Divje babe I is shown in *Tab. 2.1.*

At Šebrelje, the zone of the north-south directed Šebrelje fault, is up to 200 m wide and consists of a number of faults. The Šebrelje fault branches off the regional Kneža fault, which runs in a southeast-northwest direction (Buser 1986) (*Fig. 2.1*). The interior zones of individual faults are a complex assemblage of crushed, fragmented and fissured zones. Crushed zones are characterised by compact cataclastic breccia, cohesive dolomite grit and larger dolomitic fragments. The fragmented and crushed zones are bounded by clearly visible fault slickensides. Sheer, morphologically sharp grooves, that furrow the slopes between the Idrijca river and the church of Sv. Ivan in a north-south direction, have been created in them (*Fig. 2.2*). Fracture zones are observable on ridges and in intermediate zones. Morphologically they are expressed as a series of narrow planations oriented parallel to the fractures.

Within the described Šebrelje fault system, further secondary crush zones can be seen north-south, which reach the level of fragmented and fracture zones. They have a northwest-southeast direction and link the more powerful zones in a north-south direction. Less expressed is the Tertiary system of fault planes in north-south and east-west directions.

The mechanical and chemical resistance of Cordelovian dolomite depends mainly on its petrographic attributes and the extent of fracturing. In numerous places, the late diagenetic changes in the dolomite are very strong. They have lost all primary structural and textural characteristics and only thick crystal dolospiritic rocks can be seen. The dolomite is thus changed into so-called saharoid dolomite in which the crystals are poorly bound, so that it disintegrates into crystal debris. The various strong crush zones, have an additional major fragmenting role. In the case of Cordelovian dolomite experiencing fewer changes in late diagenesis, the rock is darker and more granular. If in such a case the dolomite was not strongly crushed, it is relatively well resistant to atmospheric effects and the individual, variously sized fragments do not disintegrate but are gradually rounded and only frost starts their disintegration.

In an extensive layers between Stopnik, Šebrelje and Krniški greben colourful middle Triassic Ladinian layers lie on the surface. The most frequent are variants of volcano-clastic rocks. Green and greenish-grey piroclastic sandstones and grits predominate among them, with insertions of acidic or basal tuff and, superimposed, the upper parts of pelitic rocks, which transform at Šebrelje laterally into black grits and slates with lenses of black limestone. In the volcano-clastic rocks they are found in the form of various sized lenses of greenish-grey piroclastic, gravelly conglomerate. In the middle of the volcano-clastic rocks lies a mighty massif of flint keratophyre and almond-shaped diabase (probably basalt) with transitional magmatic rocks. It stretches from the valley of the Idrijca at Stopnik all the way to Pisance on Krniški greben. Magmatic rocks, as well as piroclastic are greatly calcified in numerous places (Čar, Skaberne 2003) and the rocks obtain a dense 'quartzite' structure. The described rocks could undoubtedly be the origin of the unusual, variously coloured debris in the cave sediments in Divje babe I.

3. PLEISTOCENSKI SEDIMENTI NA ŠEBRELJSKI PLANOTI NAD NAJDIŠČEM DIVJE BABE I

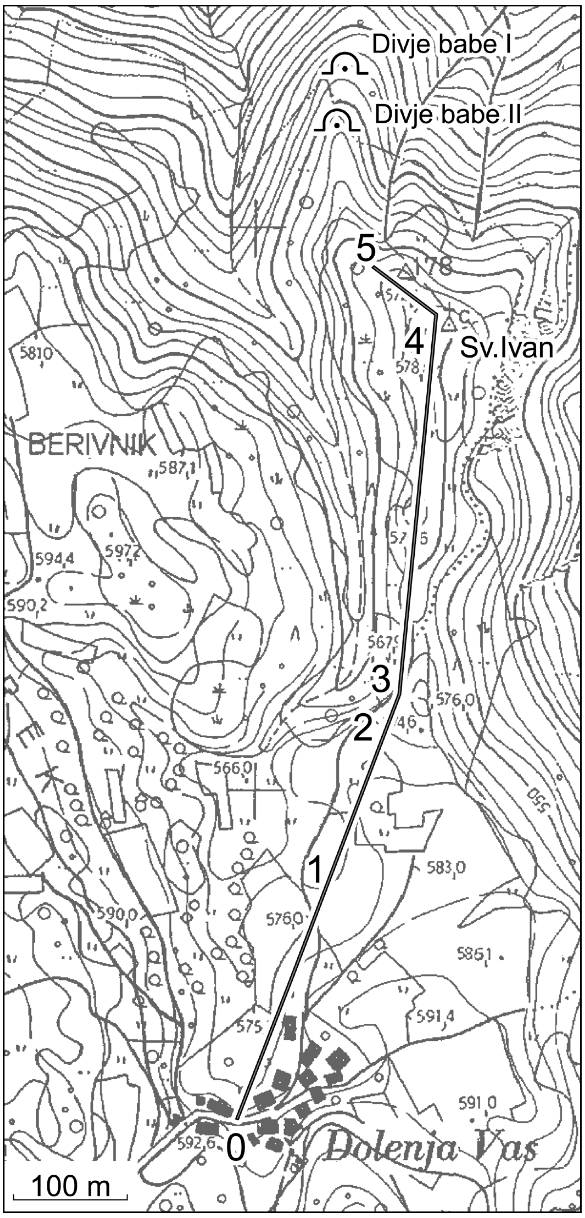
IVAN TURK in JANEZ TURK

Izvleček

Na planoti nad jamo smo grobo preiskali 700 m dolg pedološki profil do globine 0,8 m pod površjem. Ugotovili smo dve ilovnati plasti, ki so ju mestoma prekinjali ostanki fosilnih tal in krioklastični grušč ter bloki. Na matični dolomitni kamnini z ostanki paleokrasa leži rdeča neplastovita ilovica s posameznimi močno preperelimi in zaobljenimi dolomitnimi klasti (*sl. 3.3*). Nad njo je plast grušča in blokov ter ostanki paleotal (*sl. 3.4, 3.5*). Še višje je plast rjave, neplastovite ilovice, ki leži večinoma konformno na plasti redeče ilovice. Čisto na vrhu je plast ruše. Obe ilovnati plasti smo geokemijsko preiskali (*tab. 3.1*).

Neposredno nad jamo ni ilovnate preperine, pač je zopet na pobočjih pod jamo. Jamski sedimenti praktično ne vsebujejo ilovice, so pa delno obogateni z glavnimi kemijskimi prvinami, ki jih vsebujejo obe ilovinati plasti na planoti nad jamo.

Sl. 3.1: Šebreljska planota v ospredju, slikana z juga. Cerkev sv. Ivana Krstnika je skrajno desno. Še bolj desno je dolina Sevnice, za planoto pa globoko zarezana dolina Idrijce. V ozadju, od leve proti desni, Šentviška planota, Police, Bukovo in Kojca (1303 m), ki ju od Šebreljske planote ločuje dolina Idrijce. V zadnjem planu so Julijske Alpe in Triglav (2864 m) Fotografija Stane Klemenc, Dia studio, Ljubljana.
Fig. 3.1: Šebrelje plateau in the foreground, viewed from the south. The church of. St. Ivan Krstnik (St. John the Babtist) is on the extreme right. Further to the right is the valley of the Sevnica, and behind the plateau is the deeply cut valley of the Idrijca river. In the background, from left to right, Šentviška gora plateau, the villages of Police and Bukovo and mountain of Kojca (1303 m), separated from Šebrelje plateau by the Idrijca valley. On the horizon are Julian Alps and their highest mountain, Triglav (2864 m) Photograph Stane Klemenc, Dia studio, Ljubljana.



Sl. 3.2: Potek profila od točke 0 do 5. Vir: TTN 10, 1980 © Geodetska uprava Republike Slovenije.
Fig. 3.2: Course of profile from point 0 to 5. Source: TTN 10, 1980 © Geodetska uprava Republike Slovenije.

Za razumevanje geneze sedimentov v profilu Divjih bab I so pomembni predvsem sedimenti na Šebreljski planoti, ki leži južno nad jamo (*sl.3.1*). Njihova točna starost se za zdaj ne da ugotoviti. Najdbi levalva jedra in odbitka domnevno v ilovnati plasti pri cerkvi sv. Janeza Krstnika nakazujeta vsaj predholocensko starost sedimentov[1]. Nad samo jamo teh sedimentov ni, in to zaradi strmih pobočij in delovanja erozije v preteklosti, so pa v neposrednem zaledju jame. Ker se voda, ki danes prenika v Divje babe I, ne napaja iz vodonosnikov na Šebreljski planoti, ni pričakovati nanosa sedimentov iz zaledja[2].

Leta 2005 je bil narejen profil od Dolenje vasi do cerkve sv. Ivana Krstnika in naprej do grebena nad Divjimi babami I v dolžini 700 m in z globino 0,8 m. Potekal je približno v smeri S–J in je bolj ali manj sledil kolovozu, ki vodi iz vasi do cerkve. Profil je na več mestih dosegel matično dolomitno podlago, tako da se je dalo dovolj dobro ugotoviti stratigrafijo, čeprav spodnja plast ni bila povsod v celoti odkopana, ker so sedimenti v kotanjah debelejši od 0,8 m.

Lateralno se profil deli v dva dela (*sl. 3.2*). Prvi del, med točko 0 in 2, je v neizraziti kotanji pod vasjo, kjer so njive. Kotanja ima izhod v grapo na SZ. Teren je nagnjen v smeri JV–SZ, medtem ko se v smeri S najprej spušča, nato pa dviga. Drugi del, med točko 2 in 4, poteka po hrbtu, ki je nekoliko dvignjen nad omenjeno kotanjo, in se konča pri cerkvi sv. Ivana Krstnika. V tem delu so na več mestih izdanjki dolomita. Pri največjem od njih se odcepi mulatjera za Reko. Hrbet pada na zahodu v grapo V koritih, na vzhodu pa v dolino Sevnice.

Plasti v profilu si od spodaj navzgor sledijo takole:

- Plast 1. Matična dolomitna kamnina. Zelo pretrta in površinsko preperela z močno zaobljenimi robovi. Na enem mestu je bil viden ostanek paleokrasa (*sl. 3.3*), ki smo ga ugotovili tudi na pobočju pod jamo na travniku, imenovanem Črt.

- Plast 2. Rdeča, neplastovita ilovica, ponekod plastična, drugje trda in strukturirana (*yellowish red*, 5YR4/6, suha), tako, da se lomi v grude. Plast leži neposredno na matični dolomitni podlagi in izpolnjuje vse večje strukture v njej. V plasti so posamezni dolomitni klasti, predvsem velikosti blokov. Zanje je značilno, da so močno zaobljeni in globinsko preperели. Njihova površina je mokasta. Veliko je popolnoma preperelih klastov oz. t. i. fantomskega grušča. V porah med grudami so bili ponekod majhni karbonatni prodniki, različnih barv, skupaj s črnim blatom. V plasti nismo ugotovili nobenih najdb.

Plast je najizrazitejša v drugem delu profila med točkama 3 in 4, sega pa tudi do točke 5. Tu je tudi zelo debela, tako da ji nismo prišli do dna. V prvem delu profila je ohranjena samo pri točki 2, kjer je teren raven. Domnevamo, da gre za zelo staro preperino neke tople in vlažne dobe.

- Plast 3. Neplastovit grušč, ki je nastal s preperevanjem dolomitnih izdanjkov, pomešan z rjavo ilovico, ponekod tudi rdečo, na katero nalega, domnevno diskonformno. Ta plast je zaradi narave nastanka najizrazitejša v bližini izdanjkov dolomita med točko 2 in 3. Južno od useka kolovoza v izdanek dolomita pri točki 3 se je plast začela ob izdanjku, kjer je bila najdebelejša in končala ok. 5 m vstran, kjer se je izklinila, potem ko se je vedno bolj tanjšala in spuščala z oddaljenostjo od izdanjka (*sl. 3.4*). Sestavljal jo je srednje zaobljen grušč različnih

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[1] Ti in druge najdbe, ki so prišle na dan pri kopanju več kot 700 m dolgega jarka, bodo objavljene v drugem delu monografije.

[2] Ustmen podatek Jože Čar, Idrija.

Sl. 3.3: Ostanek »paleokrasa« v profilu na Šebreljski planoti. Fotografija I. Turk.
Fig 3.3: Remnant of buried karst feature in the profile on Šebrelje plateau. Photograph I. Turk.

Sl. 3.4: Dolomitni izdanjek (levo spodaj) in dolomitni klasti (plast 3) na meji plasti 2 in 4. Fotografija I. Turk.
Fig. 3.4: Dolomite outcrop (lower left) and dolomite clasts (Layer 3) on the boundary of Layers 2 and 4. Photograph I. Turk.

debelin. Plast je evidentno nastala zaradi delovanja zmrzali in se odlagala predvsem na pobočjih ob izdanjkih.

Na pobočjih pod jamo in na Logu nad Idrijco je ta plast zelo debela (2 m in več) in dejansko predstavlja fosilna melišča (Turk 1997a, sl. 1.4). Kljub debelini grušči niso plastoviti.

- Plast 4a. Ostanki paleotal (pogreben horizont A_0), pomešanih z gruščem (*sl. 3.5*). Plast je pri točki 3 prekrita z izdatnim sedimentom plasti 4. Pri točki 2 je tik pod rušo, od katere jo loči samo tanka plast 4. Starost tal se ne da oceniti, vsekakor so starejša od plasti 4.
- Plast 4. Rjava, neplastovita ilovica, večinoma plastična, ponekod pa trda in strukturirana (*light yellowish brown*, 10YR6/4, suha). V plasti so posamični dolomitni klasti, za katere je značilno, da so močno zaobljeni, vendar niso globinsko prepereli. Površina klastov je gladka, včasih reliefno izjedkana in ima rjavo glineno impregnacijo. Po barvi in preperelosti se ločijo od klastov v plasti 2. Med njimi so tudi talni zmrzlinski klasti. Tako reliefno izjedkani klasti kot talni zmrzlinski klasti so značilni za jamski profil Divjih bab I (glej poglavje 5 v tem zborniku).

Plast smo lahko sledili po celotnem profilu. Najdebelejša je v prvem delu, kjer tvori sedanja tla. Večinoma nalega neposredno na plast 2, domnevno konformno. Vendar meja med obema ilovnatima plastema ni ostra, temveč zabrisana. Domnevno predstavlja horizont B gozdnih tal. Ugotovili smo jo tudi na pobočju pod jamo, kjer je najdebelejša (do 1,5 m) v kotanjah na travniku, imenovanem Črt.

- Plast 5. Ruša oz. humus (horizont A_0).

Navedeno zaporedje plasti je idealno in bi ga praktično zelo težko našli na enem mestu. Zaradi erozije in drugih vzrokov so običajno prisotne le nekatere od naštetih plasti. Primeri, ko imamo rušo oz. humus neposredno na matičnem dolomitu, niso redkost. Tako je zlasti na skalnem grebenu nad jamo. Ker v jamskih sedimentih nismo ugotovili ilovice, je moral biti teren neposredno nad jamo v mlajšem pleistocenu podoben današnjemu. V nasprotnem primeru bi imeli nad jamo enako ilovico, kot jo dobimo že pri cerkvi sv. Ivana Krstnika, kjer se teren izravna, in vse do Dolenje vasi.

Obe ilovici smo mineraloško pregledali in ugotovili naslednje:

Rdeča ilovica v plasti 2 ima na prvi pogled zelo enotno mineralno sestavo. Ilovico gradijo temno rdeča mineralna zrna, ki so zaradi diagenetskih sprememb težko določljiva. Zrna niso enotna, temveč jih gradi več med seboj povezanih manjših zrn, kar kaže, da gre za strukturne agregate nekih zelo razvitih tal. Menimo da gre za močno spremenjena kremenova in karbonatna zrna, ki se sicer tudi pojavljajo v ilovici, a so zelo redka. Zaradi močne spremenjenosti zrn mora biti ilovica zelo starega izvora.

Sl. 3.5: Paleotla v plasti 4. Fotografija I. Turk.
Fig. 3.5: Palaeosoil buried in Layer 4. Photograph I. Turk.

Tab. 3.1: Geokemijski sestav plasti 2 in 4. Analizo je opravil *ACME analytical laboratories LTD* v Kanadi.
Tab. 3.1: Geochemical composition of layers 2 and 4. The analysis was performed by *ACME analytical laboratories LTD* in Canada.

Group 4A

Layer	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	P_2O_5 (%)	LOI (%)
4	57	18	6.2	1.8	0.9	0.7	1.2	0.08	12.7
2	39.9	25.7	10.4	2.3	0.8	0.2	1.3	0.07	18.3

Group 1DX

Layer	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	As (ppm)	Cd (ppm)	Hg (ppm)	Se (ppm)
4	13.6	34.4	61	34.2	12.7	0.7	0.22	<0.5
2	31.2	42	85	64	23.7	1.1	0.27	<0.5

Group 4B

Layer	Ga (ppm)	Nb (ppm)	Rb (ppm)	Sr (ppm)	Th (ppm)	U (ppm)	Zr (ppm)	Y (ppm)
4	22.1	23.5	76.3	84.5	18.4	5	345.3	70.3
2	30.1	19.3	97.5	51.5	24.5	4.5	165.8	194.1

Group 4B

Layer	La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Gd (ppm)	Tb (ppm)
4	76.3	126	17.5	66	13.6	2.3	11.9	1.8
2	132.3	153.5	37.2	150.4	33.5	6.6	32.8	5.4

Rjava ilovica v plasti 4 ima dokaj pestro mineralno sestavo. V njej so zelo številna organska zrna, kar polovica vseh zrn jih je. Številna so tudi kremenova zrna, karbonatna so redkejša. Pojavljajo se tudi rdeča zrna, podobna kot tista v rdeči ilovici in ki nastajajo iz kremenovih, ter karbonatnih zrn zaradi dolgotrajnega preperevanja, oziroma diageneze.

Geokemijski sestav plasti 2 in 4 je lahko zanimiv v primerjavi z geokemijskim sestavom drobne sedimentne frakcije v profilu Divjih bab I. Zato v *tab. 3.1* podajava vrednosti nekaterih glavnih in slednih prvin. Tako deleži slednih kot glavnih prvin v obeh plasteh se bistveno razlikujejo od deležev teh prvin v profilu Divjih bab I (glej podpoglavje 5.4. v tem zborniku).

3. PLEISTOCENE SEDIMENTS ON ŠEBRELJE PLATEAU ABOVE THE SITE OF DIVJE BABE I

IVAN TURK and JANEZ TURK

Abstract

On the plateau above the cave, we roughly investigated a 700 m long pedological profile to a depth of 0.8 m below the surface. We found two clayey layers, which were broken in places by the remains of fossil soils and cryoclastic rubble and blocks. On the bedrock of dolostone with the remnants of buried karst lies red unlayered clay with individual strongly weathered and rounded dolomite clasts (*Fig. 3.3*) Above it is a layer of angular dolomite fragments and the remains of palaeosoil (*Fig. 3.4, 3.5*). Still higher is a layer of brown, unlayered clay, which lies for the most part conformably on a layer of red clay. Right at the top is a layer of humus. We investigated both clay layers geochemically (*Tab. 3.1*).

There are no clay sediments directly above the cave but they are again on the slopes below the cave. The cave sediments contain practically no clay, but are partly enriched with the main chemical elements characteristic for both clay layers on the plateau above the cave.

4. STRATIGRAFIJA NAJDIŠČA DIVJE BABE I

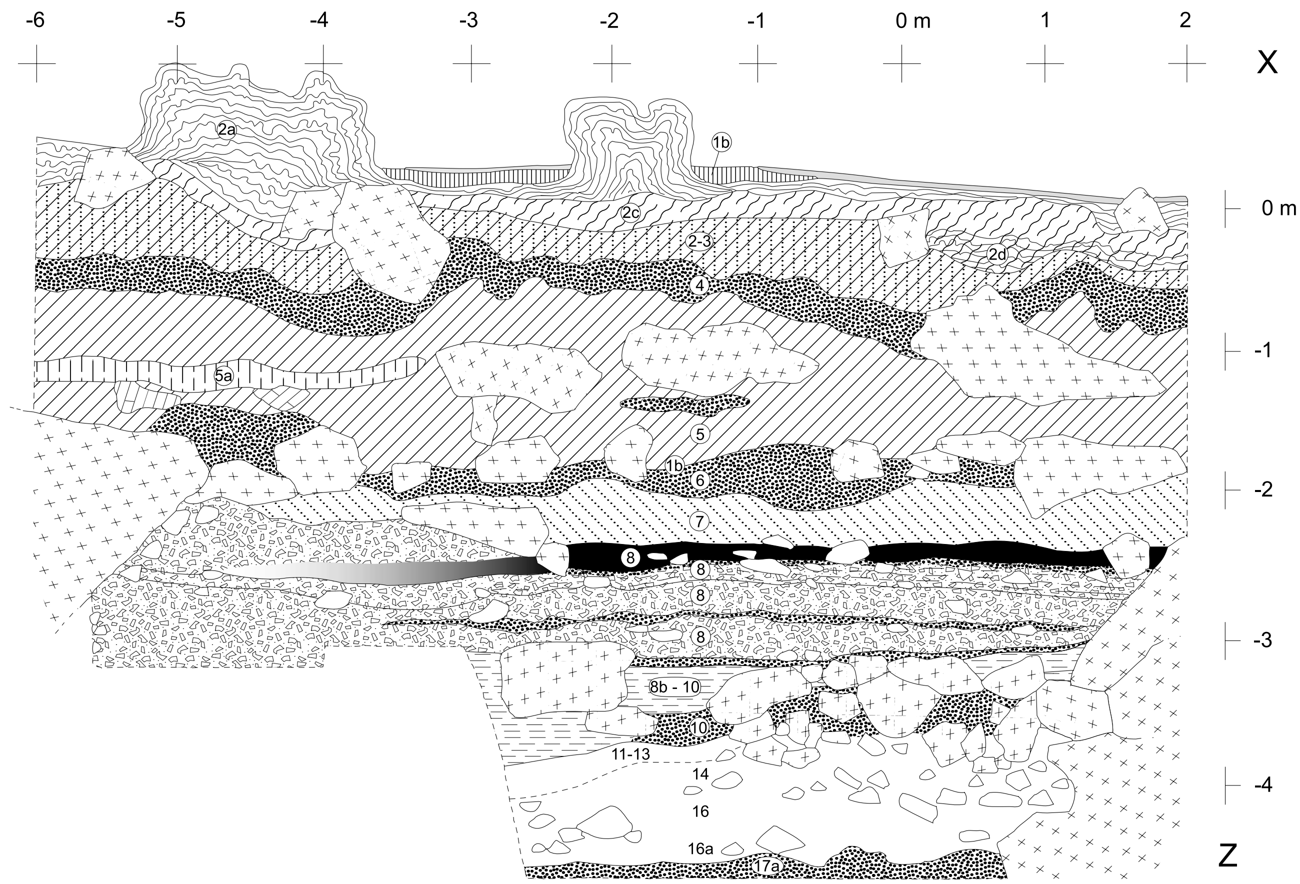
IVAN TURK

Divje babe I so najdišče z izredno debelo sedimentno zapolnitvijo. Zaradi skoraj izključno naravnih sedimentov je stratigrafija dokaj enostavna. Profil je sestavljen iz številnih bolj ali manj vodoravno odloženih geoloških plasti, ki so bile lahko posedimentno deformirane.

Med izkopavanji sem uporabljal barvo kot glavni kriterij za določevanje plasti. Pri tem je treba poudariti, da je barva predvsem posledica kemičnega procesa oksidacije. Tako je bilo mogoče bolj ali manj uspešno slediti posameznim plastem od pobočja pred jamo daleč v njeno notranjost (prim. Turk *et al.* 1989b, pril. 1–2; Brodar 1999, sl. 1). Vse barve sem določil pri dnevni svetlobi s pomočjo lestvice *Munsel soil color charts*, in sicer na bolj ali manj vlažnih vzorcih drobne frakcije v plasteh. Kot vse drugo, variira tudi barva plasti, vendar ne toliko, da bi lahko resno podvomili o pravilnosti določitve plasti po tem kriteriju. Drugi kriteriji za sprotno terensko določevanje plasti niso bili primerni za vizualno klasifikacijo zaradi prevelike variabilnosti sedimentov. Pri terenskih opisih sem jih sicer večkrat uporabil, vendar jih tu ne bom upošteval, ker so neprimerno manj zanesljivi od pozneje pridobljenih laboratorijskih podatkov na podlagi preučevanja sedimentnih vzorcev in variabilnosti podatkovnih baz, ki jih ta preučevanja omogočajo. Zato bom pri opisu plasti navedel predvsem laboratorijske izsledke in zelo splošne terenske ugotovitve.

Celoten profil, ki ga prikazujejo slike enega vzdolžnega profila (*sl. 4.1a, b*) in treh prečnih (*sl. 4.2a, b; 4.3a, b* in *4.4*), sem na podlagi vidnih in analitsko ugotovljenih teksturnih značilnosti začasno razdelil v tri dele:

Sl. 4.1a: Profil y = 2 m. Fotografija I. Turk.
Fig. 4.1a: Profile y = 2 m. Photograph I. Turk.



Sl. 4.2a: Profil x = 21 m. Risba I. Turk (svinčnik) in D. Knific Lunder (tuš). Legenda v s*l. 4.1a.*
Fig. 4.2a: Profile x = 21 m. Drawing I. Turk (pencil) and D. Knific Lunder (ink). Legend in *Fig. 4.1a*.

zgornji, srednji in spodnji. Zgornji del obsega plasti 2–6, srednji plasti 7–15 in spodnji plasti 16a–23[1]. Za zgornji in srednji del profila je značilna večja količina blokov, peska, melja in gline (frakcij >65 mm in < 0,5 mm) ter manjša količina debelo- do srednjezrnatega grušča (frakcija <40>10 mm) in srednje- do drobnozrnatega grušča (frakcija <10>3 mm). V preostalih frakcijah (<65>40 mm in <3>0,5 mm) ni bistvenih razlik v profilu (glej podpoglavje 5.1 v tem zborniku: *sl. 5.1.1a, b*). Zgornji del profila vsebuje največ melja in gline (frakcija <0,5 mm), srednji pa največ blokov (frakcija >65 mm).

Plasti 2–8 so bile že opisane v publikaciji *Moustérienska "koščena piščal" in druge najdbe iz Divjih bab I v Sloveniji* (Turk 1997a). Zato opisa, razen za kompleks plasti 8, ne bom ponavljal. Kratki opisi vseh plasti so bili tudi že dvakrat objavljeni (Turk et al. 1989b; Brodar 1999). Ker je medtem predvsem v spodnjem delu profila prišlo do nekaterih bistvenih startigrafskih in kronoloških sprememb bom opise, ki se nanašajo predvsem na vzorčevane profile, datirane z metodo ESR, od vključno plasti 8a ponovil. Od zgoraj navzdol si plasti sledijo (*sl. 4.1- 4.4*):

- Plast 8a je skupaj z drugimi variantami (8c in 8b) del kompleksa plasti 8, za katerega so med drugim značilni veliki podorni bloki, ki segajo od samega pobočja pred jamo pa vse do zadnjega večjega profila v jami (x = 21 m). Plast 8a je za plastjo 2 in 7 tretja cementirana plast od zgoraj navzdol. Za podrobnosti glej Turk, Bastiani 2000. V trdno brečo so zlepljeni predvsem grušč vseh debelin kot tudi posamezni bloki. Vsi dolomitni klasti so močno prepereli, napokani in prevlečeni s fosfatnimi skorjami ali prevlekami. Posamezni dolomitni klasti so zelo zaobljeni. Kjer ni skorij, je površina hrapava in "mokasta". Fosfatne prevleke so ponekod prekrite s tankim slojem sige. Barva breče in skorij: 10 R 3/4 (temno rdeča, *dusky red*).

- Plast 8c je edina plast v profilu, ki je v osrednjem predelu jame sestavljena predvsem iz močno zaobljenih blokov z minimalno količino grušča, peska in melja (glej podpoglavje 5.1 v tem zborniku: *sl. 5.1.1a, b*). Kljub poram in vakuolam med bloki (*"open work"* anglo-ameriških avtorjev) so ti trdno zloženi in se le s težavo izluščijo. Enako velja za kosti, ki jih je v plasti veliko. Plast je najlepše ohranjena pod policami (*sl. 4.5*). Običajno ni cementirana in vsebuje veliko reliefno korodiranih

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[1] Takšna delitev profila se je pozneje pokazala kot neustrezna. Stratigrafska meja med zgornjim in srednjim delom profila je bila pravilno postavljena, ni pa bil pravilno razmejen srednji in spodnji del, kjer meja dejansko poteka med plastjo 12 in 13. Nove dele profila sem imenoval facije A, B in C.

Sl. 4.2b: Profil x = 21 m. Fotografija I. Turk.
Fig. 4.2b: Profile x = 21 m. Photograph I. Turk.

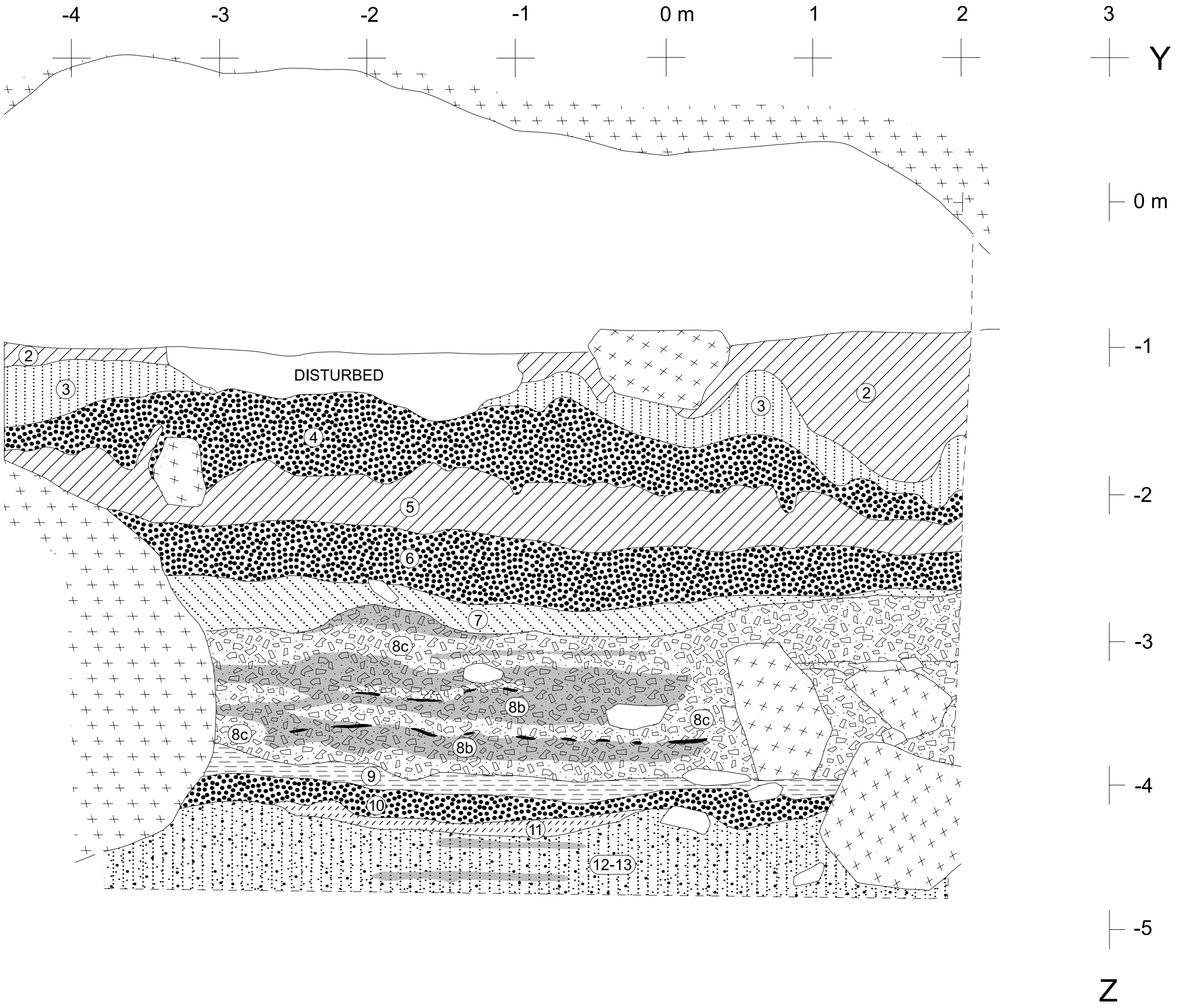
klastov. Večina klastov ima fosfatne prevleke in trdne, gladke površine. Barva breče in prevlek: 10 R 3/4 (temno rdeča, *dusky red*).

- Plast 8b. Tako sem označil močno variabilen, nesprijet del kompleksa plasti 8. Plast 8b vsebuje v centralnem predelu jame v peščeni frakciji največ agregatov od vseh plasti, razen plasti 8b-10. Tanke vodoravne plasti dolomitnega grušča se menjavajo z vodoravnimi plastmi agregatov v debelini peska. Značilnosti dolomitnih klastov so podobne kot v plasti 8a. Pridružujejo se jim popolnoma preperеli ('fantomski') klasti (*"fantôme" d' éboulis* po Lavillu 1975, 32), ki so ponekod posedimentno razpadli v tanke plasti peska in melja (Turk, Bastiani 2000). Veliko je tudi reliefno korodiranih klastov. Za plast so značilni stratigrafski nizi, ki vsebujejo malo fragmentirane kosti. Česa podobnega nismo zasledili v nobeni drugi plasti. V njej so bila tudi najbolje ohranjena ognjišča. Izjemoma nastopajo lokalne skorje z menjavajočimi se laminami rdečega fosfata in rumenkastega kalcita (*sl. 4.6*). Barva osnove: 7.5YR 4/6 (temno rjava, *strong brown*).

- Plast 8b-10 je edina plast v profilu, v kateri peščeno-meljasta osnova (frakcija <3>0,5 mm) prevladuje nad srednje- in drobnozrnatim gruščem (frakcija <10>3 mm) (glej podpoglavje 5.1 v tem zborniku: *sl. 5.1.1b*). Osnovo sestavljajo skoraj izključno agregati. Plast vsebuje veliko reliefno korodiranih klastov. Zelo značilne so glinene prevleke na klastih. Barva osnove: 10YR 5/4 (rumenkasto rjava, *yellowish brown*). Barva je edinstvena v celotnem profilu.

- Plast 10 je druga po vrsti cementirana plast z velikimi podornimi bloki. Brečo lateralno večkrat prekinjajo nesprijete usedline, ki so značilno sivo obarvane. Posebno značilna je primes mulja. Izjemoma nastopajo lokalne skorje z menjavajočimi se laminami rdečega fosfata in rumenkastega kalcita (*sl. 4.6*). Veliko je debelega, korozijsko močno zaobljenega grušča z gladko površino. Takšnega grušča in blokov je največ pod policami. Plast 10 je najbolj gruščnata plast v profilu. Prevladuje srednje debelozrnat grušč. Barva osnove: 10YR 6/3 (svetlo rjava, *pale brown*).

- Plast 11 se od krovne plasti razlikuje predvsem po navidezno manj sivi barvi osnove. Od vključno plasti 11 do vključno plasti 15 je bilo razlikovanje plasti zaradi precej enotne barve in teksture zelo oteženo in včasih nezanesljivo. Barvni odtenki so bolje kot s prostim očesom vidni na barvnih fotografskih posnetkih. Težave,



Sl. 4.3a: Profil x = 6 m. Risba I. Turk (svinčnik) in D. Knific Lunder (tuš). Legenda v s*l. 4.1a.*
Fig. 4.3a: Profile x = 6 m. Drawing I. Turk (pencil) and D. Knific Lunder (ink). Legend in *Fig. 4.1a*.

povezane z razlikovanjem plasti, sem na terenu nemalokrat rešil z združevanjem plasti v pare. V paru je zanesljivo zastopana vsaj ena plast, če ne obe.

- Plast 12 je plast z navidezno bolj sivo barvo osnove, ki je podobna kot v plasti 10 (10YR 6/3 – svetlo rjava, *pale brown*). Zaznavne so močnejše teksturne spremembe v smeri zmanjševanja velikosti zrn grušča in blokov (*sl. 4.7*; glej tudi podpoglavje 5.1 v tem zborniku: *sl. 5.1.9*).

- Plast 13 ima podobne teksturne lastnosti kot plast 12, vendar temnejšo (na videz manj sivo) barvo osnove (10YR 4/4 – temno rumenkasto rjava, *dark yellowish brown*).

- Plast 14 je podobna krovni plasti, vendar je bolj peščena in za spoznanje svetlejša (na videz bolj siva). Grušč je bistveno manj zaobljen kot v krovnih plasteh. Barva osnove: 10YR 6/3 (svetlo rjava, *pale brown*).

- Plast 15 ima več krioklastičnega grušča, večina zrn je večja kot v plasteh 13 in 14 (glej podpoglavje 5.1 v tem zborniku: *sl. 5.1.9*), barva je svetlejša kot v krovni plasti. Barva osnove: 10YR 7/2 (svetlo siva, *light gray*).

- Plast 16 je ena redkih plasti v profilu, ki vsebuje izključno krioklastični grušč, zato je dobro prepoznavna. Grušč je skoraj brez osnove (*"éboulis secs"* francoskih avtorjev) in večinoma cementiran v brečo. Del grušča ima izrazite fosfatne prevleke. Za plast so značilni tudi zelo veliki podorni bloki, in sicer tako v vhodnem kot osrednjem predelu jame. Barva breče: 5YR 3/4 (temno rdečkasto rjava, *dark reddish brown*) in 2.5YR 3/4 (temno rdečkasto rjava, *dark reddish brown*). Barva prevlek: 10R 3/4 (temno rdeča, *dusky red*).

- Plast 16a je lateralna različica plasti 16. Vsebuje več osnove, klasti so zopet bolj zaobljeni in večinoma niso cementirani. Le ponekod so cementirani s pretežno kalcitnim vezivom. V plasti so sledovi krioturbacije. Barva osnove: 10YR 6/3 (svetlo rjava, *pale brown*). Plast po svojih lastnostih in stratigrafskem odnosu do plasti 16 spominja na plast 2c in njen stratigrafski ekvivalent plast 2.

- Plast 17a$_1$ ima podobno teksturo in morfologijo klastov kot krovna plast. Ni cementirana, vendar dobesedno nasičena z drobnimi delci domnevno sekundarne-

Sl. 4.3b: Profil x = 6 m. Fotografija C. Narobe, Slovenska akademija znanosti in umetnosti.
Fig. 4.3b: Profile x = 6 m. Photograph C. Narobe, Slovene Academy of Sciences and Arts.

ga kalcita, ki pri spiranju dajo belo obarvano odplako. V plasti so sledovi krioturbacije. Osnova je rahlo sive barve, kar bi lahko pomenilo več organskih primesi in redukcijsko okolje. Barva osnove: 2.5Y 7/2 (svetlo siva, *light gray*).

- Plast 17 je rumenkasto rjava plast med sivo obarvano krovnino in talnino. Barva osnove: 10YR 5/4 (rumenkasto rjava, *yellowish brown*).

- Plast $17a_2$ je v skoraj vseh pogledih podobna plasti $17a_1$. Pomembno je, da smo v njej prvič v profilu od zgoraj navzdol našli osamljen odlomek skorje sige. Ta se zaradi nečistoč, žal ne da radiometrično datirati. Plast vsebuje v spodnjem delu popolnoma preperel ('fantomski') grušč, ki ob dotiku razpade v pesek in melj (*"fantôme" d'éboulis* po Lavillu 1975, 32). Značilna je tudi primes mulja. Barva osnove: 10YR 7/2 (svetlo siva, *light gray*).

- Plast $17a_3$ je v zgornjem delu svetlejša, v spodnjem delu pa se barvno poenoti s krovno plastjo. Na različnih globinah vsebuje popolnoma preperel grušč. Je prva plast v profilu, ki ne vsebuje agregatov v velikosti drobnega grušča. Značilni so redki drobci sige. Barva osnove: 10YR 7/2 (svetlo siva, *light gray*).

- Plast 17/18 je druga in zadnja plast v profilu, ki ne vsebuje agregatov v velikosti drobnega grušča. Prisotnih pa je kar nekaj drobcev sige in s sigo obdanih klastov enake velikosti. V peščeni frakciji nastopajo številne kalcitne konkrecije, ki so domnevno nastale *in situ*. Zelo markantna vodoravna plast je debela samo 10 cm. Tik pod njo in delno na njej so nastali lokalno manjši sprimki sige, podobnih struktur in oblik, kot jih ima stalagmitna skorja na površini v notranjosti jame. Barva osnove: bela.

- Plast 18 je plast, za katero so značilni popolnoma preperel ('fantomski') grušč, sledovi t. i. drobtinčaste sige, mešane s fosfati, in lokalno omejeni *in situ* nastali sigasti sprimki, mešani s fosfati. Barva osnove: 10YR 5/6 (rumenkasto rjava, *yellowish brown*).

- Plast 18a je delno cementirana plast. Barva necementirane osnove: 10YR 6/4 (svetlo rumenkasto rjava, *light yellowish brown*).

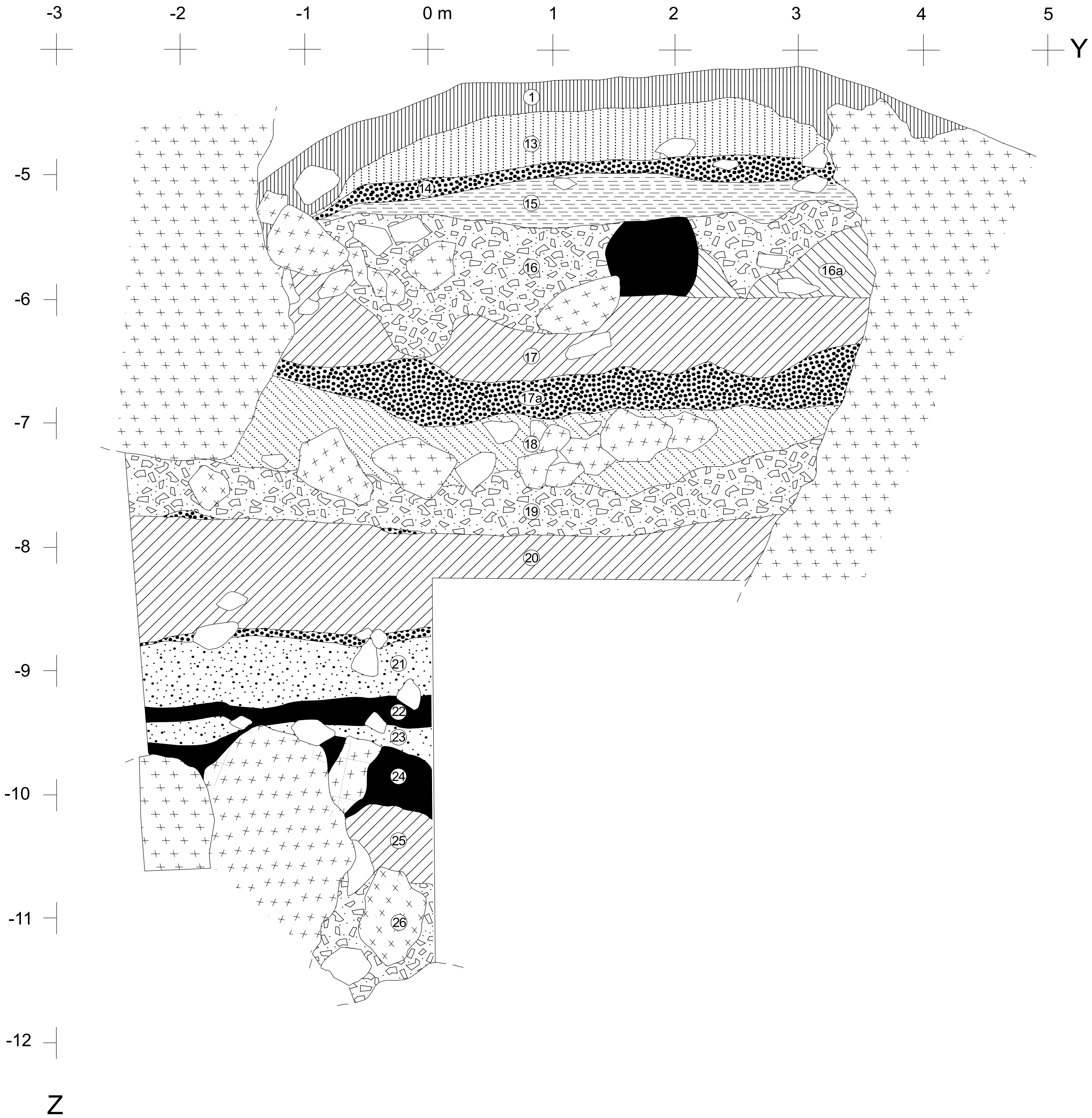
- Plast 19 je močno cementirana plast. Breča nastopa v pasovih. Vmes so deli nesprijetih sedimentov, sestavljeni iz grušča in peščeno-meljaste osnove. Značilni so večji podorni bloki. Plast 19 ima od vseh plasti spodnjega dela profila (plasti 16–23) največji grušč in bloke (glej poglavje 5.1 v tem zborniku: *sl. 5.1.9*). Barva necementirane osnove: 10YR 6/6 (rjavkasto rumena, *brownish yellow*).

- Plast 19/20 je podobna plasti 20, samo da ni cementirana. Debelozrnat grušč je zelo podoben debelozrnatemu grušču v plasti 6. Spodnji del plasti je zaradi ognjišča sive barve. Barva osnove nad ognjiščem: 2.5Y 6/4 (svetlo rumenkasto rjava, *light yellowish brown*).

- Plast 20 je v zgornjem delu močno cementirana, v spodnjem pa ne. V plasti so bili prvič najdeni večji dislocirani kosi skorij krhke sige. Siga bi se morda dala radiometrično datirati. Barva osnove: 10YR 6/3 (svetlo rjava, *pale brown*).

- Plast 21 je temneje obarvana plast in barvno odstopa od krovnine in talnine. Barva osnove: 10YR 4/3 (rjava, *brown*).

- Plast 22 je svetlejša plast med plastema 21 in 23

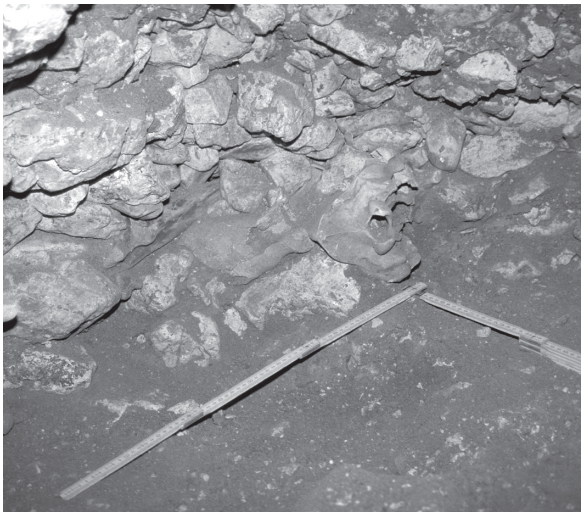


Sl. 4.4: Profil x = –2 m. I. Turk (svinčnik) in D. Knific Lunder (tuš). Legenda v s*l. 4.1a*.
Fig. 4.4: Profile x = –2 m. Drawing I. Turk (pencil) and D. Knific Lunder (ink). Legend in *Fig. 4.1a*.

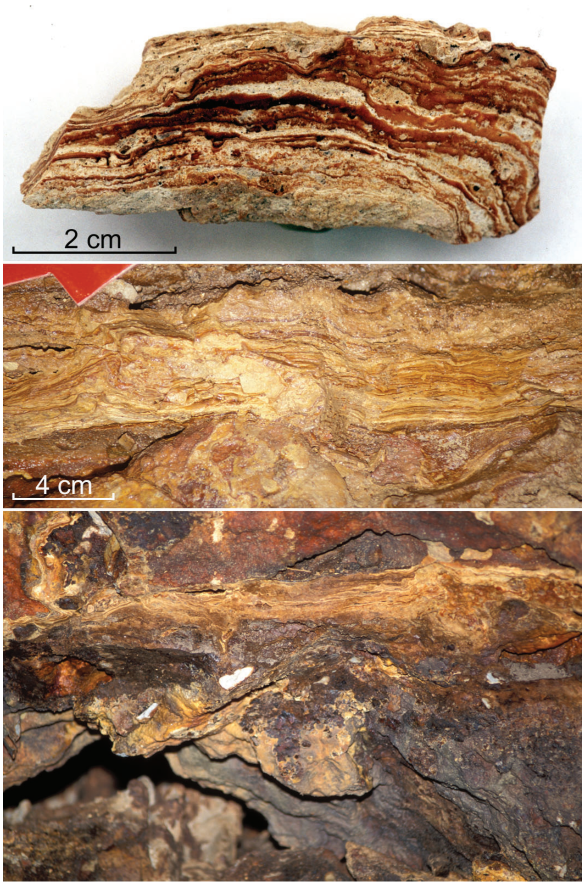
in je delno cementirana. Barva necementirane osnove: 10YR 4/2 (temno sivkasto rjava, *dark grayish brown*).

- Plast 23 je sivo obarvana, delno cementirana plast. Barva breče: 10YR 3/2 (zelo temno sivkasto rjava, *very dark grayish brown*).

Od plasti 23 navzdol smo na omejenem prostoru odkopali 2 m debelo serijo plasti (*sl. 4.4*), ki močno spominja na kompleks plasti 8. Plasti te serije so ostale sedimentološko, arheološko in paleontološko neraziskane. Popolnoma nenačeti so ostali še starejši sedimenti, ki lahko segajo do največje možne globine 50 m pod naj-mlajšo plast 2 (glej uvodno poglavje v tem zborniku: *sl. 2-3*). Stratigrafski in posledično kronološki potencial najdišča je izziv, ki mu nikakor nisem kos. Zato sem se mu zavestno opovedal in se raje posvetil obdelavi skromnih 9 metrov mlajšepleistocenskega profila, kar je povzročilo nestrinjanje prvotnega vodje izkopavanj M. Brodarja (1999, 51) in je sčasoma privedlo do popolnega razhajanja stališč, povezanih z obdelavo in razlago najdišča.



Sl. 4.5: Zelo zaobljeni bloki v plasti 8c. Fotografija I. Turk.
Fig. 4.5: Very rounded blocks in Layer 8c. Photograph I. Turk.



Sl. 4.6: Laminirana kalcitno-fosfatna skorja v plasti 10 in *in situ* v nivoju plasti 8. Fotografija I. Turk.
Fig. 4.6: Laminated calcite-phosphate crust in the Layer 10 and *in situ* at level of the Layer 8. Photograph I. Turk.

Za konec še nekaj besed o upadu plasti in njihovi debelini. Plasti zgornjega in srednjega dela profila se znižujejo v smeri jug–sever oz. iz jame, približno 4 cm na en dolžinski meter. Upad plasti v smeri vzod–zahod je zanemarljiv. Zato lahko rečem, da so plasti subhorizontalne, če zanemarimo gube, ki so izrazitejše v notranjosti jame. Debelina plasti zgornjega dela profila narašča od jamskega vhoda v notranjost, kar je neobičajno in težko razložljivo[2]. Stratigrafija se na celotnem odkopanem območju ne spreminja. Večje spremembe v stratigrafiji nastopijo šele za profilom x = 21 m..

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[2] Podoben primer je v Potočki zijalki, kjer sem ga poskusil razložiti s snežnim talusom in z njim povezanimi protalusnimi sedimenti (Turk, neobjavljeno).

4. STRATIGRAPHY OF THE DIVJE BABE I SITE

IVAN TURK

Divje babe I is a site with an extremely thick sedimentary package. Because of the almost exclusively natural sediments, the stratigraphy is fairly simple. The profile is composed of numerous more or less horizontally deposited geological layers, which may have experienced post-sedimentary deformation.

During excavations, I used colour as the main criterion for determining layers. It must be stressed here that the colour is mainly a result of the chemical process of oxidation. It was thus possible to follow individual layers more or less successfully from the slope in front of the cave far into the interior (see Turk *et al.* 1989, annexes 1–2; Brodar 1999, Fig. 1). I determined all colours in daylight with the aid of the *Munsel soil color charts* scale, on more or less moist samples of the fine sedimentary fraction in the layers. As with everything else, the colour of layers also varied, but not so much that there could be serious doubt about the accuracy of defining layers by this criterion. Other criteria for the concurrent on-site determination of layers were unsuitable for visual classification because of the excessive variability of the sediments. I several times used them for on-site descriptions, but I will not take them into account here because they are incomparably less reliable than laboratory data obtained later on the basis of studying sediment samples and the variability of databases that such studies enable. So with the description of layers I will state mainly laboratory results and very general on-site findings.

I divided the entire profile shown by drawings and photographs of one longitudinal profile (Fig. *4.1a, b*) and three transverse profiles (*Fig. 4.2a, b; 4.3a, b* and *4.4*) into three parts on the basis of visible and analytically established textural characteristics: upper, medium and lower. The upper part covers layers 2–6, the middle layers 7–15 and the lower layers 16a–23[1]. The upper and middle parts of the profile are characterised by a larger number of blocks, sand, silt and clay (fractions >65 mm and < 0.5 mm) and smaller quantities of coarse to medium granular rubble (fractions <40>10 mm) and medium to finely granular rubble (fraction <10>3 mm). In the remaining fractions (<65>40 mm and <3>0.5 mm) there are no essential differences in the profile (see sub-chapter 5.1 in this volume: *Fig. 5.1.1a, b*). The upper part of the profile contains the most silt and clay (fractions <0.5 mm), and the middle the most blocks (fraction >65 mm).

Layers 2–8 have already been described in the publication *Moustérien »bone flute« and other finds from Divje babe I in Slovenia* (Turk 1997a). So except for the complex Layer 8, I will not repeat the description. Short descriptions of all layers have also already twice been published (Turk *et al.* 1989; Brodar 1999). Since there have meanwhile, mainly in the lower part of the profile, been some essential stratigraphic and chronological changes, I will repeat the descriptions that refer mainly to the sampled profile, dated by the ESR method, from Layer 8a inclusive. The layers follow from top downwards (*Fig. 4.1–4.4*):

- Layer 8a together with other variants (8c and 8b) is part of the complex Layer 8, characterised among other things by large rockfall blocks, which extend from the slope in front of the cave all the way to the last major profile in the cave (x=21 m). After Layers 2 and 7, Layer 8a is the third cemented layer from the top down. For details see Turk and Bastiani 2000. Rubble of all sizes is cemented in the hard breccia, as well as individual blocks. All the dolomite clasts are strongly weathered, cracked and coated with a phosphate crust or coating. Individual dolomite clasts are very rounded. Where there is no crust, the surface is *coarse* and »floury«. In some spots phosphate coatings are covered by thin layer of flowstone. Colour of breccia and crusts: 10 R 3/4 (dusky red).

- Layer 8c is the only layer in the profile which in the central part of the cave is composed mainly of strongly rounded blocks with a minimum amount of rubble, sand and silt (see sub-chapter 5.1 in this volume: *Fig.*

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[1] Such a division of the profile later appeared inappropriate. The boundary between the upper and middle parts of the profile was properly set, but the division between the middle and lower parts was incorrect because the boundary runs between Layers 12 and 13. I called the new parts of the profile facies A, B and C.

5.1). Despite the pores and vacuoles between the blocks (open work) these are firmly aranged and only with difficulty peeled off. The same applies to bones, of which there are a large number in the layer. The layer is best preserved beneath the shelves (*Fig. 4.5*). It is not normally cemented and contains a lot of cavernously corroded clasts. The majority of clasts have a phosphate coating and a compact, smooth surface. Colour of breccia and coating: 10 R 3/4 (dusky red).

- Layer 8b. I thus labeled the greatly variable, uncemented part of the complex Layer 8. In the central part of the cave, Layer 8b contains the most aggregates in the sand fraction of all layers except Layer 8b-10. Thin horizontal layers of dolomite rubble alternate with horizontal layers of aggregates of the size of sand. The characteristics of the dolomite clasts are similar to those in Layer 8a. They are joined by completely weathered ('phantom') clasts *(»fantôme« d'éboulis* according to Laville 1975, 32), which in some places post-sedimentarily disintegrated in the thin layer of sand and silt (Turk, Bastiani 2000). There are also a large number of cavernously corroded clasts. Stratigraphic series containing few fragmented bones are characteristic of the layer. We did not detect anything similar in any other layer. The best preserved hearths were also in it. Exceptionally, local crusts of alternating laminate red phosphate and yellowish calcite appear (*Fig. 4.6*). Colour of matrix: 7.5YR 4/6 (strong brown).

- Layer 8b-10 is the only layer in the profile in which a sandy silt matrix (fraction <3>0.5 mm) predominates over medium and finely grained rubble (fraction<10>3 mm) (see sub-chapter 5.1 in this volume: *Fig. 5.1.1b*). The matrix consists almost exclusively of aggregates. The layer contains a large amount of corroded clasts. A clay coating to the clasts is very characteristic. Colour of matrix: 10YR 5/4 (yellowish brown). The colour is unique in the entire profile.

- Layer 10 is second in line of the cemented layers with large rockfall blocks. The breccia is laterally several times interrupted by uncemented sediments, which are a characteristic grey colour. The admixture of mud is a special characteristic. Exceptionally, local crusts of alternating laminate red phosphate and yellowish calcite appear (*Fig. 4.6*). A lot is coarse rubble, greatly rounded by corrosion, with a smooth surface. There is most such rubble and blocks below the shelves. Layer 10 has the most rubble of all layers in the profile. Medium coarse rubble predominates. Colour of matrix: 10YR 6/3 (pale brown).

- Layer 11 differs from the upper layers mainly in terms of the clearly less grey colour matrix. From Layer 11 to Layer 15 inclusive, distinguishing layers was very difficult, and sometimes unreliable because of the fairly uniform colour and texture. Colour shades were seen better on colour photographs than by the naked eye. I often solved difficulties associated with differentiating layers on site by combining layers in pairs. At least one layer, if not both, reliably appeared in the pair.

- Layer 12 is a layer with a visibly greyer colour matrix, which is similar to that in Layer 10 (10YR 6/3–pale brown). It is marked by stronger textural changes towards a reduced size of grain of the rubble and blocks (*Fig. 4.7*; see also sub-chapter 5.1 in this volume: *Fig. 5.1.9*).

- Layer 13 has similar textural qualities to Layer 12 but a darker (visibly less grey) colour of matrix (10YR 4/4–dark yellowish brown).

- Layer 14 is similar to the upper layers, but sandier and recognisably lighter (visibly greyer). The rubble is essentially less rounded than in the layer above. Colour of matrix: 10YR 6/3 (pale brown).

- Layer 15 has more cryoclastic rubble, the majority of grains are larger than in Layers 13 and 14 (see sub-chapter 5.1 in this volume: *Fig. 5.1.9*), the colour is lighter than in the layer above. Colour of matrix: 10YR 7/2 (light gray).

- Layer 16 is one of the few layers in the profile that contains exclusively cryoclastic rubble. It is therefore easily identifiable. The rubble is almost without matrix (*»éboulis secs«* of French authors) and for the most part cemented into the breccia. Part of the rubble has a pronounced phosphate coating. Very large rockfall blocks are also typical of the layer, in both the entrance and central part of the cave. Colour of breccia: 5YR 3/4 (dark reddish brown) and 2.5YR 3/4 (dark reddish brown). Colour of coating: 10R 3/4 (dusky red).

- Layer 16a is a lateral variant of Layer 16. It contains more matrix, clasts are again more rounded and are mostly not cemented. Only here and there are they cemented with a presumably calcite binding. There are traces of cryoturbation in the layer. Colour of matrix: 10YR 6/3 (pale brown). In terms of its properties and stratigraphic relation to Layer 16, the layer is reminiscent of Layer 2c and its stratigraphic equivalent Layer 2.

- Layer 17a_1 has a similar texture and morphology of clasts as the layer above, but is simply saturated with tiny particles of presumably secondary calcites, which give a white discharge when the sediment is washed. There are traces of cryoturbation in the layer. The matrix is a light grey colour, which may mean more organic admixture and a reduction environment. Colour of matrix: 2.5Y (light grey).

- Layer 17 is a yellowy brown layer between grey layers above and below. Colour of matrix: 10YR 5/4 (yellowish brown).

- Layer 17a_2 is similar in almost all respects to Layer 17a_1. It is significant that we first, from top down, found in it in the profile isolated fragment of flowstone crust. Because of impurity, the flowstone could not unfortunately be radiometrically dated. The layer contains in the lower part completely weathered ('phantom') rubble, which crumbles at a touch into sand and silt

(*»fantôme« d'éboulis* according to Laville 1975, 32). The admixture of silt is also characteristic. Colour of matrix: 10YR 7/2 (light grey).

- Layer $17a_3$ is lighter in the upper part and in the lower part the colour is uniform with the layer above. It contains completely weathered rubble at various depths. It is the first layer in the profile that does not contain aggregates of a size of fine gravel. Occasional fragments of flowstone are characteristic. Colour of matrix: 10YR 7/2 (light grey).

- Layer 17/18 is the second and last layer in the profile that does not contain aggregates of a size of fine gravel. A fair number of small fragments of flowstone are present and clasts of the same size coated by flowstone. Numerous calcite concretions appear in the sand fraction, which were presumably created *in situ*. The very markedly horizontal level is only 10 cm thick. Immediately below it and partially in it, local small conglomerates of flowstone have been created, of similar structure and form as the stalagmite crust has on the surface in the interior of the cave. Colour of matrix: white.

- Layer 18 is characterised by completely weathered ('phantom') rubble, traces of so-called crumbled flowstone, mixed with phosphates and locally limited flowstone conglomerates mixed with phosphates created *in situ*. Colour of matrix: 10YR 5/6 (yellowish brown).

- Layer 18a is a partially cemented layer. Colour of the uncemented matrix: 10YR 6/4 (light yellowish brown).

- Layer 19 is a strongly cemented layer. Breccia appears in bands. In between are parts with uncemented sediments consisting of rubble and sandy-silty matrix. Larger rockfall blocks are characteristic. Of all the layers in the lower part of the profile (Layers 16–23) Layer 19 has the most rubble and blocks (see sub-chapter 5.1 in this volume: *Fig. 5.1.9*). Colour of uncemented matrix: 10YR 6/6 (brownish yellow).

- Layer 19/20 is similar to Layer 20, except that it is not cemented. The coarse rubble is very similar to the coarse rubble in Layer 6. The lower part of the layer, because of a hearth, is grey. Colour of matrix above the hearth: 2.5Y 6/4 (light yellowish brown).

- Layer 20 is strongly cemented in the upper part but not in the lower. Larger dislocated pieces of crust of fragile flowstone were first found in the layer. The flowstone could perhaps be radiometrically dated. Colour of matrix: 10YR 6/3 (pale brown).

- Layer 21 is a darker coloured layer, whose colour deviates from the layer above and the one below. Colour of matrix: 10YR 4/3 (brown).

- Layer 22 is a lighter layer between Layers 21 and 23 and is partly cemented. Colour of uncemented matrix: 10YR 4/2 (dark greyish brown).

- Layer 23 is a grey, partly cemented layer. Colour of breccia: 10YR 3/2 (very dark greyish brown).

From Layer 23 downwards, we excavated a 2 m series of layers in a limited space (*Fig. 4.4*), which is greatly reminiscent of the complex Layer 8. The layers of this series have remained sedimentologically, archaeologically and palaeontologically unstudied. The still older sediments remained completely untouched, which may extend to a maximum possible depth of 50 m below the most recent level 2 (see introductory chapter in this volume: *Fig. 2-3*). The stratigraphic and, consequently, the chronological potential of the site is a challenge to which I am certainly not equal. I therefore deliberately renounced it and preferred to concentrate on processing the modest nine metres of the Upper Pleistocene profile, whereby I was confronted with disagreement with the original leader of the excavations, M. Brodar (1999, 51). And this resulted in totally different processing of data and their interpretation between two leaders.

Finally, a few words on the dip of the layers and their thickness. The layers of the upper and middle parts of the profile dip in a south-north direction, or away from the cave, by approximately 4 cm per metre of length. The dip of layers in an east-west direction is negligible. I can therefore say that the layers are sub-horizontal, if we ignore the folds, which are more pronounced in the interior of the cave. The thickness of the layers of the upper part of the profile increases from the cave entrance towards the interior, which is unusual and difficult to explain[2]. The stratigraphy does not change over the entire excavated area. Major changes in the stratigraphy only appear beyond the profile x=21 m.

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[2] Comparable anomaly is known from Potočka zijalka cave (cf. S. Brodar and M. Brodar 1983), which I explained with the presence of snow talus and resulting accumulation of pro-talus clastic sediments behind it (unpublished).

5. SEDIMENTI V NAJDIŠČU DIVJE BABE I

IVAN TURK, DRAGOMIR SKABERNE, BORIS OREL, JANEZ TURK,
ANDREJ KRANJC, LIDIJA SLEMENIK-PERŠE in ANTON MEDEN

Podrobnejša raziskava sedimentov ni sodila v delovno področje terenske ekipe, odgovorne za izkopavanja, niti niso bili njeni člani usposobljeni zanjo. Edina izjema je bil prvotni vodja izkopavanj M. Brodar, ki pa je imel glede narave sedimentov odklonilno stališče do uporabe tradicionalne sedimentološke metode (M. Brodar 1999). Ker ni bilo nadomestila za rešitev problema, sedimentom nismo posvečali posebne pozornosti vse do konca druge faze izkopavanj. Vendar smo kljub vsemu zbirali konvencionalne teksturne podatke v upanju, da se bodo dali klimatostratigrafsko in pozneje kronoklimatsko interpretirati (glej Laville 1975). Do preboja v iskanju alternativnih rešitev je prišlo šele ob koncu druge faze izkopavanj, ko je bilo, žal, prepozno za preverjanje zanesljivosti vseh izsledkov, ki so ključni za klimatostratigrafsko interpretacijo profila.

Preučevanje sedimentov ima določene cilje, kot je npr. ugotavljanje izvora sedimentov, načina sedimentacije, poteka diageneze itd. Za arheologijo vse to običajno nima uporabne vrednosti in samo obremenjuje že tako prenatrpano podatkovno bazo. So pa zato izjemno pomembna preučevanja, ki omogočajo slediti spremembam v nekdanjem okolju oz. klimi. Govorimo o klimatostratigrafiji v povezavi s sedimentologijo. Klimatostratigrafija je možna tudi v povezavi s paleontologijo, če sedimenti vsebujejo dovolj primernih fosilnih ostankov. Eno z drugim omogoča zanesljivejše ocene preteklih klimatskih dogodkov na podlagi navzkrižnega preverjanja rezultatov posameznih raziskav.

Sedimenti predstavljajo, zaradi več sto kubičnih metrov skrbno pregledanega materiala, največjo zakladnico podatkov in informacij. Pri tem je treba poudariti, da gre za zvezne stratigrafske podatke, česar za skoraj vse druge ne moremo trditi. Glede na to je pričakovati, da bo večina teksta posvečena prav njim in da bodo sedimentološko-stratigrafski izsledki vodilo za načrtovanje drugih, v prvi vrsti paleontoloških raziskav. Tako razmišljanje narekuje tudi vrstni red, po katerem naj bi potekale posamezne raziskave. Skratka, za uspešno delo je potreben skupni imenovalec vseh raziskav, ki ga v našem primeru predstavljajo sedimentološko-stratigrafski izsledki.

Na tem mestu predstavljamo samo manjši del zbranih podatkov iz bogate zakladnice sedimentov[1], o katerih menimo, da so ključni za interpretacijo najdišča kot sistema. Veliko podatkov nam ni uspelo ustrezno dokumentirati in so začasno izgubljeni za analizo in interpretacijo. Veliko jih še vedno čaka, da jih nekdo med izkopavanji "odkrije" in izkoristi v interpretativne namene.

5.1. SPLOŠNO O SEDIMENTIH

Izvleček

Večina tem, ki jih obravnava to podpoglavje, je bila že opisana in prevedena v angleščino v Turk, Bastiani 2000 in Turk *et al.* 2005a. Podpoglavje 5.1 je v bistvu povzetek stanja splošnih raziskav in metodologije dela na področju sedimentologije. V naslednjih podpoglavjih pa so obdelane nekatere posebne teme, ki prinašajo tudi nekaj novosti na tem področju.

Osnovne značilnosti sedimentov v plasteh 2–23 so teksturne, morfološke, barvne, kemične, biogene in diagenetske. Nekatere od naštetih značilnosti smo na podlagi določenih parametrov po potrebi preučili podrobneje, druge manj.

V teksturi igrata vodilno vlogo najdebelejša frakcija in najdrobnejša (*sl. 5.1.1a, b*; *tab. 5.1.1*). Debelejše frakcije, predvsem bloki, so nastale sinsedimento s preperevanjem jamskega svoda (Turk *et al.* 2005a). Drobnejše frakcije so nastale pretežno postsedimentno s preperevanjem v jamskih tleh (*sl. 5.1.2*).

V vseh plasteh zelo prevladujejo bloki. V plasteh 6–16 (globina −261 cm do −465 cm) v centralnem delu

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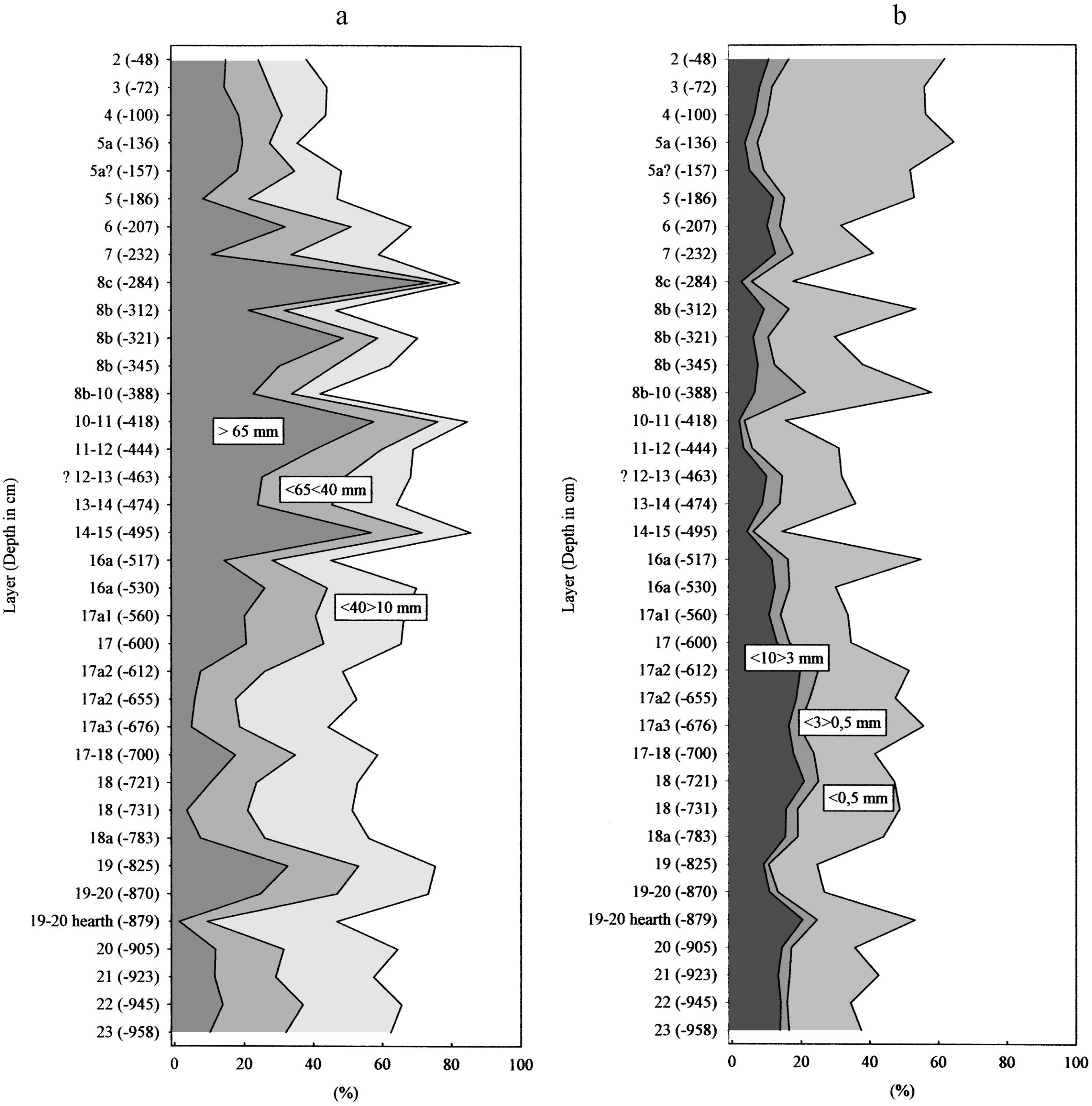
[1] Več o sedimentih je v neobjavljenem delu TURK, I. in sodelavci 2002, *Elaborat Divje babe I, izkopavanja 1989-1999, 1. Tekst,* 142 str., 130 slik, 37 tabel, *2. Osnovni stratigrafski in sedimentološki podatki,* 139 str. Prilog, *3. Osnovna stratigrafska in sedimentološka dokumentacija*, 103 fotografije, 13 risb, ki ga hrani arhiv Inštituta za arheologijo ZRC SAZU. Glej tudi TURK, J. 2004, *Odsev klime s klastov pleistocenskih sedimentov v paleolitskem nahajališču Divje babe I.* Diplomsko delo, Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo.

jame je bilo tako 51 m^3 sedimenta, od skupno 86 m^3, sestavljenega pretežno iz blokov, večjih od 100 mm. Delež blokov se je gibal od 51 % do skoraj 100 % na prostorninsko enoto. Preostalih 35 m^3 sedimenta je imelo blokov manj kot 50 % na prostorninsko enoto (*sl. 5.1.3*). Blokov, večjih od 100 mm je bilo povprečno 75 %, kar kaže, da gre za sediment z izrazito grobo skeletno zgradbo.

Delež blokov narašča od vhoda proti notranjosti jame in od vzhodne jamske stene proti zahodni. Prostorska razporeditev blokov se dobro ujema z dokumentiranjem blokov v profilih (*sl. 5.1.4; tab. 5.1.2*).

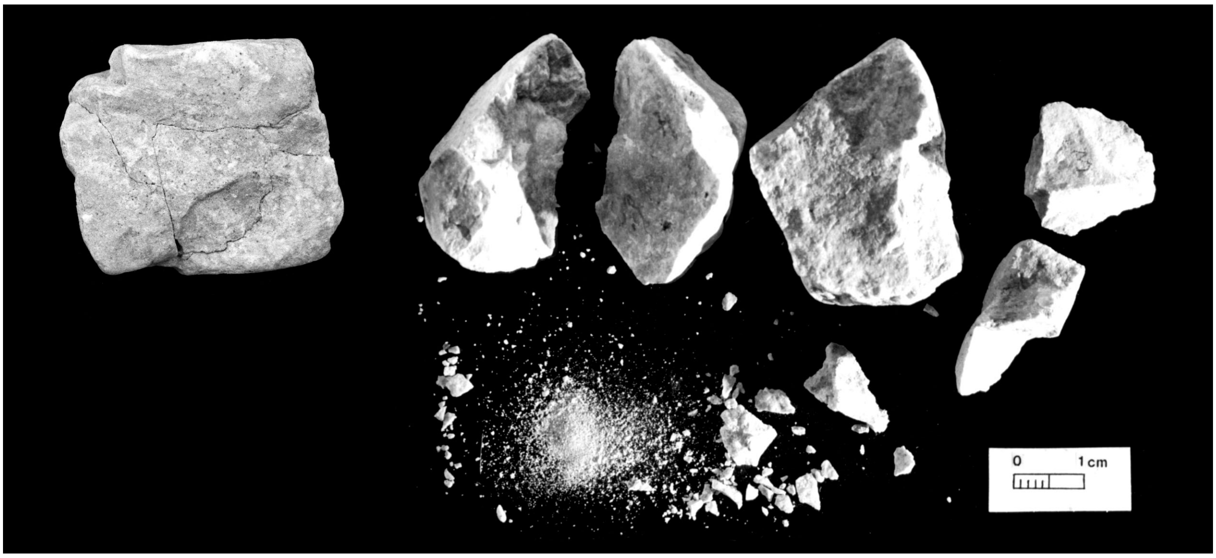
Veliki bloki so posledica stropnih podorov, ki so še vedno vidni v obliki stropnih vdolbin na mestih nad koncentracijami sedimentiranih blokov. Bloki, predvsem manjši, so postsedimentno preperevali, in sicer bolj pri vhodu kot v notranjosti jame. Dokaz za to so številni zmrzlinski klasti različnih velikosti (Turk *et al.* 2001a) in izrazit prostorski gradient zastopanosti blokov ter zmr-zlinskih klastov. Delež blokov v sedimentu se povečuje od vhoda proti notranjosti jame, medtem ko se delež zmrzlinskih klastov zmanjšuje.

V osrednjem delu jame imamo ostanke več zaporednih podorov, ki so se v tisočletjih odložili drug na drugega in dajejo danes v profilih vtis enega samega ali kvečjemu dveh velikih podorov. Nekateri podori, zlasti v plasti 8, so močno prepereli, tako da večjih blokov ni ostalo



Sl. 5.1.1a, b: Diagram odstotnih deležev analiziranih frakcij v sestavljenem profilu. Posebej za debelejše (a) in drobnejše frakcije (b). Podatki so preračunani iz *tab. 5.1.1*.

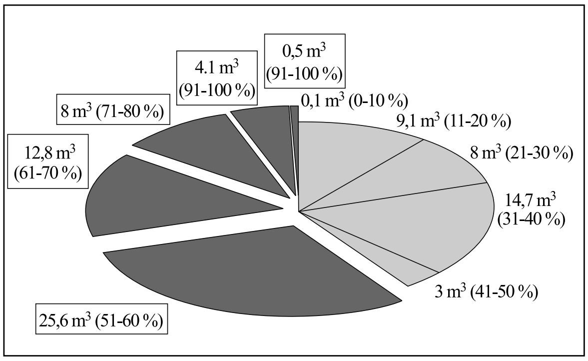
Fig. 5.1.1a, b: Diagram of percentage shares of analysed fractions in the composite profile; individually for the coarser (a) and finer fraction (b). Data are calculated from *Tab. 5.1.1*.



Sl. 5.1.2: Napokan zaobljen klast iz plasti 13–14 (gl. –463 do –474 cm), ki smo ga 22-krat zamrznili in odmrznili, potopljenega v vodo, pri čemer je razpadel najprej na majhne drobce in po 14.–22. zamrznitvah-odmrznitvah na pet večjih fragmentov (zmrzlinskih klastov). Fotografije I. Lapajne in M. Zaplatil.
Fig. 5.1.2: Cracked, rounded clast from Layer 13–14 (depth below datum –463 to –474 cm), which was frozen and thawed 22 times, submerged in water, whereby it first disintegrated into small fragments and after 14–22 freezing-thawing cycles into five larger fragments (congelifracts). Photographs I. Lapajne and M. Zaplatil.

veliko. Posamezni podori so med seboj ločeni z diskretnimi, genetsko nepojasnjenimi “medpodornimi” horizonti, kakršni so npr. v plasteh 17a$_1$, 14, 10, 8 (več nivojev) in 6. Morda ni naključje, da se doline na krivulji blokov stratigrafsko ujamejo s temi horizonti (*sl. 5.1.4*), dokumentiranimi v številnih profilih. Z medpodornimi horizonti so povezani zastoji v odlaganju blokov, saj so spodnje (stropne) strani blokov v teh plasteh močno reliefno korodirane (*sl. 5.1.5*). Do izdatnejše korozije jamskega svoda je namreč prišlo vsakokrat, ko je bil jamski obok dalj časa stabilen. To pa pomeni zanesljivo sedimentacijsko vrzel z vsemi možnimi posledicami za sedimente in njihovo vsebino, kot je npr. stratigrafska sočasnost najdb iz različnih kronoloških obdobij. Sedimentacijske vrzeli bomo obravnavali v drugih poglavjih tega zbornika.

Posebno vprašanje so podorni bloki pred jamo, ki so nastali z rušenjem navpične dolomitne stene, v kateri se odpira vhod v jamo. Da je blokov tu manj, kot bi jih pričakovali, zaradi preperevanja kamnine, lahko razložimo s strmim pobočjem pod jamo, po katerem so se bloki lahko kotalili v dolino. Če drži podmena M. Brodarja (1999), da je prišlo na prehodu iz pleistocena v holocen do silnih podorov, ki so pomaknili prvotni jamski vhod več metrov nazaj, moramo imeti ostanke teh podorov na bregu reke Idrijce, in to samo v ozkem pasu pod jamo. Dejansko je tako, vendar je tam le nekaj manjših skal, ki predstavljajo prej skromen ostanek veliko starejših pleistocenskih podorov kot pa pričevanje o polpreteklih katastrofah, katerih sledovi so drugje običajno odlično ohranjeni in naredijo na opazovalca močan vtis. To potrjujejo številni postglacialni podori v bližnjih gorah, kjer so se starim na istih mestih pridružili novi med potresi VII.–VIII. stopnje po EMS lestvici v Posočju leta 1998 in 2004 (Vidrih, Ribičič 1998; 2004; Vidrih *et al.* 2001). V Divjih babah I, ki ležijo zunaj epicentra, ti potresi niso odluščili niti najmanjšega kosa



Sl. 5.1.3: Minimalni odstotni deleži blokov na prostorninsko enoto 0,12 m^3 sedimenta v plasteh 6–16 (gl. –261 do –465 cm) s skupno prostornino 86 m^3. V analizirani prostornini sedimenta je bil samo en blok velik 0,5 m^3. Količina sedimentov, ki so imeli manj kot 10 % blokov, je izredno majhna (0,1 m^3), pač pa je zelo velika količina sedimentov (25,6 m^3), ki so imeli 51–60 % blokov.
Fig. 5.1.3: Minimum percentage share of blocks and boulders per volumetric uinit of 0.12 m^3 of sediment in layers 6–16 (depth below datum –261 to –465 cm) with total volume of 86 m^3. In the analysed volume of sediments there was only one boulder of 0.5 m^3 size. The amount of sediments which had less than 10% of blocks and boulders is extremely small (0.1 m^3), but a very large quantity of sediments (25.6 m^3) had 51–60 % of blocks and boulders.

Tab. 5.1.1: Masni deleži frakcij v vzorcih iz sestavljenega profila.
Tab. 5.1.1: Weight share of fractions in samples from the composite profile.

Layer (Depth in cm)	Profile (x)	> 65 mm (kg)	< 65 > 40 mm (kg)	< 40 > 10 mm (kg)	< 10 > 3 mm (kg)	< 3 > 0.5 mm (kg)	< 0.5 mm (kg)	Sum (kg)
2 (-48)	17	4.2	2.7	4.0	3.0	1.7	12.9	*28.4*
3 (-72)	17	4.1	3.8	4.7	2.3	1.0	12.7	*28.6*
4 (-100)	17	4.7	3.2	3.2	1.7	0.9	11.7	*25.4*
5a (-136)	17	4.5	1.8	1.8	0.9	0.8	13.1	*22.9*
5a? (-157)	17	4.5	4.1	3.4	1.3	1.0	10.6	*24.9*
5 (-186)	17	2.2	3.6	6.9	3.2	0.9	10.1	*26.8*
6 (-207)	17	10.4	6.3	5.7	3.3	1.2	5.8	*32.6*
7 (-232)	17	3.1	6.7	7.4	3.7	1.5	6.8	*29.2*
8c (-284)	17	23.4	1.6	1.2	0.9	0.9	3.8	*31.8*
8b (-312)	17	5.6	2.8	4.0	2.5	1.9	9.8	*26.4*
8b (-321)	17	15.4	3.1	3.7	1.9	1.4	6.1	*31.6*
8b (-345)	12	10.3	5.5	5.5	2.6	1.6	8.8	*34.2*
8b-10 (-388)	12	5.5	2.7	2.0	1.6	3.6	8.9	*24.3*
10-11 (-418)	12	20.4	6.6	3.0	0.8	0.5	4.2	*35.5*
11-12 (-444)	12	14.6	7.0	3.3	1.2	0.9	9.1	*36.1*
? 12-13 (-463)	12	7.6	7.2	5.8	3.0	1.4	5.2	*30.2*
13-14 (-474)	12	7.8	7.0	6.1	2.9	1.7	7.2	*32.6*
14-15 (-495)	12	20.6	5.4	5.1	1.6	0.7	3.0	*36.2*
16a (-517)	12	4.6	4.5	5.5	3.7	1.5	12.6	*32.4*
16a (-530)	6	7.4	5.2	7.4	3.6	1.2	3.9	*28.6*
17a1 (-560)	6	5.9	6.0	7.6	3.2	1.0	5.8	*29.4*
17 (-600)	6	6.8	7.4	7.4	4.3	1.2	5.9	*33.0*
17a2 (-612)	6	2.3	5.6	7.0	6.1	1.6	8.1	*30.7*
17a2 (-655)	6	1.8	3.7	11.0	5.8	1.2	7.8	*31.2*
17a3 (-676)	5	1.4	4.0	7.4	4.7	0.9	10.5	*28.9*
17-18 (-700)	5	6.1	6.1	8.4	6.2	2.1	6.2	*35.0*
18 (-721)	5	3.4	4.3	9.7	6.9	1.4	7.3	*33.0*
18 (-731)	5	1.1	5.5	9.5	4.9	1.1	9.4	*31.4*
18a (-783)	4	2.2	5.4	8.8	4.5	1.1	7.3	*29.3*
19 (-825)	4	11.1	7.0	7.6	3.1	0.5	4.8	*34.1*
19-20 (-870)	4	8.3	7.5	8.9	3.6	0.8	4.5	*33.7*
19-20 hearth (-879)	4	0.5	3.0	14.0	7.6	1.6	10.7	*37.4*
20 (-905)	4	3.1	5.2	8.7	3.8	0.7	4.9	*26.4*
21 (-923)	4	4.1	6.3	10.1	4.8	1.2	9.3	*35.7*
22 (-945)	4	4.7	7.9	9.7	4.8	0.6	6.3	*34.0*
23 (-958)	4	3.6	7.7	10.8	4.9	0.9	7.5	*35.4*
SUM		*247.3*	*183.1*	*235.8*	*124.55*	*44.01*	*282.45*	*1117.2*
MEDIAN		*4.7*	*5.4*	*6.9*	*3.3*	*1.1*	*7.4*	
25th%		*3.3*	*3.6*	*4.0*	*2.1*	*0.9*	*5.8*	
75th%		*8.1*	*6.6*	*8.8*	*4.7*	*1.5*	*9.9*	

kamnine s približno 100 m^2 velike, opazovane površine jamskega oboka, kaj šele da bi sprožili podor. Pogostnost skalnih podorov se povečuje z jakostjo potresov VI. stopnje in več (Vidrih, Ribičič 1998, preglednica 11, 391 ss).

Drobnejše frakcije (<4 mm) predstavljajo neznaten masni delež sedimenta. Vendar igrajo pomembno vlogo, saj so zaradi svoje mobilnosti zapolnile vse pore v skeletu večjih klastov. Medzrnska poroznost je pomembna last-

Depth (cm)	Quadrat 68	Quadrat 61	Quadrat 54	Quadrat 47	Quadrat 40	Quadrat 31	Quadrat 32	Quadrat 33	*Total*	*Average*
-225			20	20	40				*80*	*27*
-237			20	60	20				*100*	*33*
-249			60	20	20				*100*	*33*
-261		20	50	60	30	50	60	70	*340*	*49*
-273		20	30	20	40	60	50	70	*290*	*41*
-285		30	40	40	30	30	60	70	*300*	*43*
-297	52	60	40	32	40	64	56	72	*416*	*52*
-309	72	48	60	60	52		56	68	*416*	*59*
-321	60	60		68	60	64	60	84	*456*	*65*
-333				68	56	64	76	84	*348*	*70*
-345				72	64	68	88	92	*384*	*77*
-357				64	64	76	76	88	*368*	*74*
-369				52	56	68	68		*244*	*61*
-381				60	68	84	68		*280*	*70*
-393				48	64	84	84		*280*	*70*
-405				60	60	60	60		*240*	*60*
-417				60	60	60	68		*248*	*62*
-429				60	56	60	60		*236*	*59*
-441				60	60	60	60		*240*	*60*
-453				64	64	68	60		*256*	*64*
-465				56	56	24			*136*	*45*
Total	*184*	*238*	*320*	*1104*	*1060*	*1044*	*1110*	*698*		
Average	*61*	*40*	*40*	*53*	*50*	*61*	*65*	*78*		

Tab. 5.1.2: Odstotni deleži blokov v sedimentacijskih nivojih kvadratov 33–68 pred profilom x = 21 m.

Tab. 5.1.2: Percentage share of blocks and boulders in sedimentation levels of quadrats 33–38 in front of profile x = 21 m.

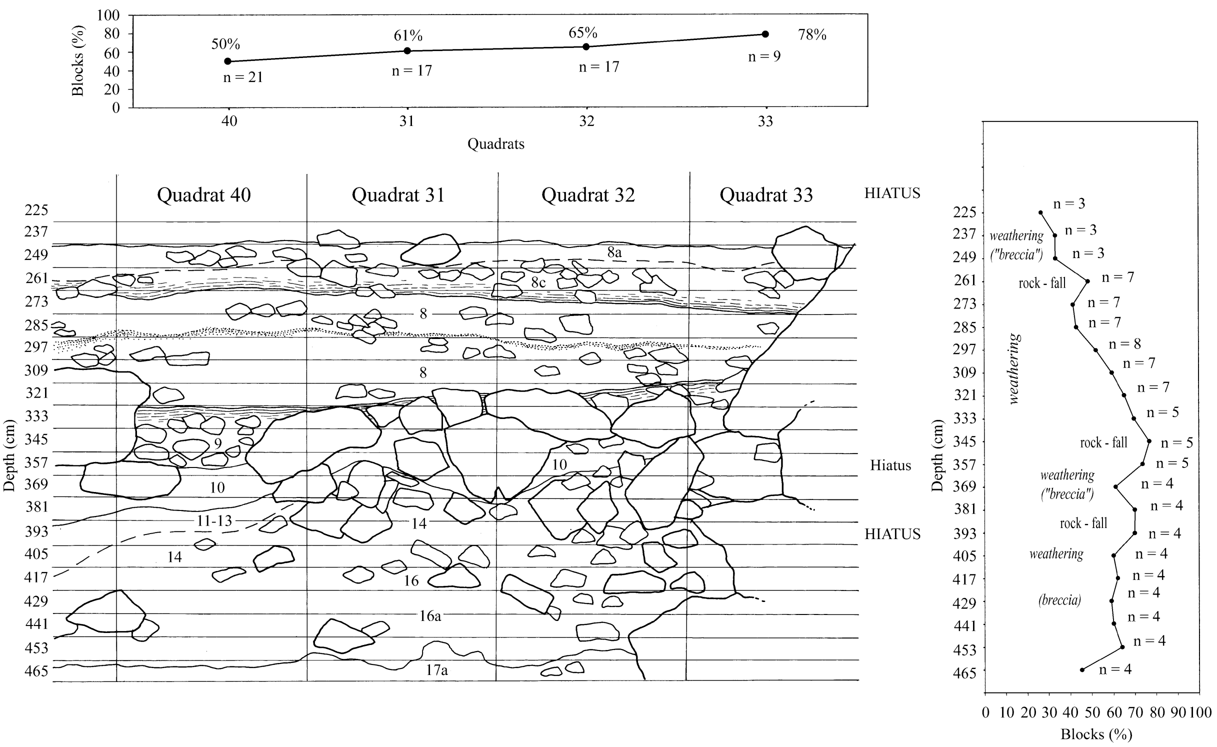
nost jamskih klastičnih sedimentov, zlasti v povezavi s stalnim pronicanjem podzemne vode, ki prenaša drobna zrna in tako zapira pore v sedimentu. V zelo poroznem sedimentu se večina vode in zrn premika navzdol. Dolgoročno je bil pretok vode, ocenjen na podlagi enoletnih meritev na tlorisni površini 91 m^2 v Divjih babah I, neznansko velik (minimalno 192,7 litra $^{-m2/leto}$, povprečno 756,9 litra $^{-m2/leto}$). Zato tudi vertikalni prenos v tleh ni bil zanemarljiv. Pomembno je vedeti, koliko vode sediment lahko sprejme in koliko je lahko zadrži v obliki vezane (retencijske) vode, katere plasti so bolj in katere manj prepustne, ali so bile katere plasti občasno lahko vodonosne in kolikšen je bil kapilarni dvig vode v različnih plasteh. Te lastnosti sedimentov, v našem primeru, niso stalne, ampak so se sčasoma spreminjale, zaradi infiltracije osnove v pore med klasti in zaradi diagenetskih procesov. Zato je nemogoče podati zanesljivo razlago o zapletenem, preteklem doganju, povezanem z delovanjem vode v sedimentih.

Naši poskusi so potrdili, da peščen sediment z veliko količino fosfatnih agregatov lahko sprejme tudi nekoliko več kot 50 % vode na prostorninsko enoto sedimenta. Večina te vode se veže v pore agregatov in se težko odcedi. Če z vodo nasičen sediment zamrznemo se volumen ne poveča, ker se povečani volumen ledu (približno 9 %) domnevno kompenzira v porah agregatov. Pri tem se manjši del agregatov zdrobi. Po zamrzovanju in odmrzovanju se sediment razrahlja. Nasprotno temu sprejme peščen sediment brez agregatov in s preperelimi klasti samo 40 % vode na volumsko enoto sedimenta. Večji del te vode ni vezan in se zlahka odcedi. Po zamrzovanju in odmrzovanju se tak sediment bolj konsolidira in se mu prostornina zmanjša za približno 5 %.

Zaradi zgoraj navedenih lastnosti sedimentov lahko iščemo odgovor na vprašanje, zakaj so znaki krioturbacije vidni samo v plasteh, ki imajo malo agregatov in zakaj jih ni v nobeni od številnih plasti, ki jih imajo veliko, čeprav tudi v teh plasteh več parametrov govori, da so bile občasno izpostavljene ekstremno mrzli klimi (npr. v plasti 8b–10). Prav tako lahko v opisani lastnosti sedimentov iščemo odgovor na to, zakaj so vse plasti z agregati bolj rahle (manj konsolidirane) in nekatere plasti brez agregatov zbite (bolje konsolidirane), kar smo opazili pri izkopavanju.

Z vodo nasičen peščen in/ali meljast sediment z veliko agregati postane bolj neprepusten kot sediment z malo agregati in melja. Če je nad njim porozen in prepusten sediment, se v njem lahko nabere prosta voda. Takšen primer je npr. lokalno omejena plast 16 v vhodnem predelu jame. Klasti v plasti so cementirani, rdečkasta barva fosfatnih oblog na njih pa kaže na oksidacijsko okolje.

Zrnavost sedimentov vpliva tudi na dvig kapilarne vode, ki je bistveno višji v drobno kot v debelo zrnatih sedimentih.

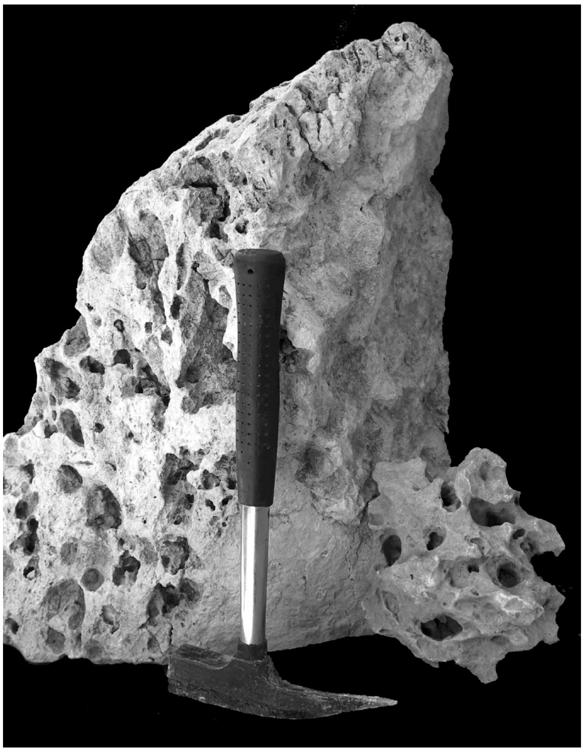


Sl. 5.1.4: Bloki, dokumetnirani v profilu x = 21 m, in lateralna ter vertikalna zastopanost blokov, večjih od 100 mm, v prostoru pred profilom. Podatki so vzeti iz *tab. 5.1.2.*
Fig. 5.1.4: Blocks and boulders documented in profile x = 21 m, and lateral and vertical representation of blocks and boulders larger than 100 mm in the space in front of the profile. Data are taken from *Tab. 5.1.2.*

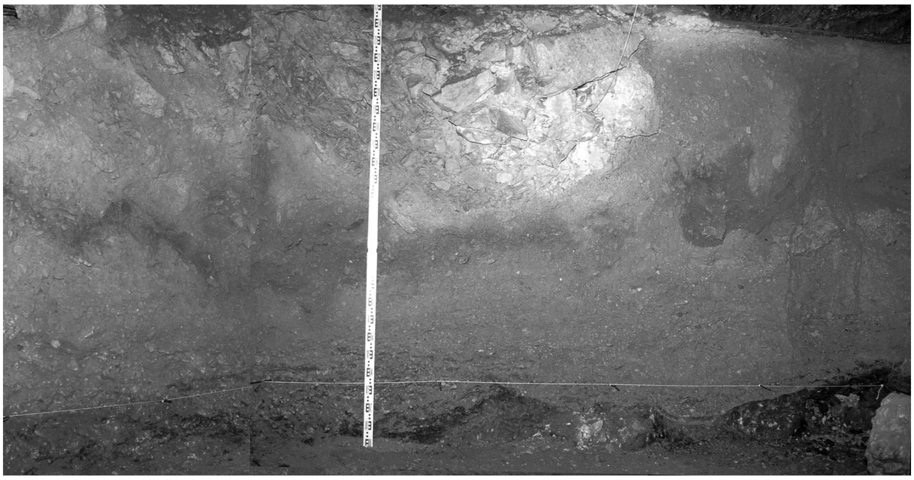
Večje razlike v zrnavosti so med spodnjim in združenim srednjim ter zgornjim delom profila, oz. med plastmi 2–15 in 16–23. Spodnji del profila je prepustnejši od srednjega in zgornjega dela, saj vsebuje več srednjega in drobnega grušča in predvsem manj melja in agregatov (*sl. 5.1.1a, b*). Temu primerno je lahko vseboval tudi več proste vode, ki se kapilarno ni toliko dvigala kot v srednjem in zlasti zgornjem delu profila. Zaradi večjega pretoka vode je lahko nastalo v spodnjem delu profila tudi več cementa, ki je klaste povezal v breče.

Zrnavost sedimenta je vplivala na redukcijsko-oksidacijske procese v sedimentih, ki se odslikavajo v različno obarvanih plasteh.

Na več mestih v jami smo naleteli na leče izrazito debelozrnatega, poroznega in prepustnega sedimenta s posameznimi podornimi bloki, obdanega z bolj drobnozrnatim, manj prepustnim sedimentom (*sl. 5.1.6*). Debelozrnat sediment, ki je skoraj brez osnove in brez



Sl. 5.1.5: Reliefno korodirana spodnja stran bloka iz plasti 6. Blok kaže na zastoj v sedimentaciji in na močno korozijo stropa pred odložitvijo plasti 6. Desno spodaj je reliefno popolnoma korodiran blok, najden v (ilovnatih) tleh pod vrhom Viševice (1428 m) v Gorskem Kotarju na Hrvaškem. Fotografiji I. Turk.
Fig. 5.1.5: Cavernously corroded lower side of boulder from Layer 6. The boulder indicates a halt in sedimentation and a strong corrosion of roof prior to the deposition of Layer 6. In the lower right is a completely cavernously corroded block found in (clayey) soil below the peak of Viševica (1428 m) in Gorski Kotar in Croatia. Photographs I. Turk.



Sl.5.1.6: Leča debelozrnatega sedimenta v profilu y = -6 m. Levo je profil x = 11 m. Fotografija I. Turk.
Fig. 5.1.6: Lenth of coarse grained sediments in profile y = -6 m. To the left is profile x = 11 m. Photograph I.Turk.

najdb, je vključen med bolj drobnozrnate sedimente z bogatimi najdbami. Litološki odnosi kažejo, da so te leče povezane z zadnjim večjim podorom, katerega bloki so delno zasuti in delno vidni na sedanjem površju. Ena od možnih razlag za nastanek leč bi bila njihova povezava s termokarstom (glej Williams, Smith 1989, 141 ss). V poznem glacialnem vrhuncu bi lahko nastala blizu vhoda posamezna večja jedra talnega ledu. Ko bi se led v

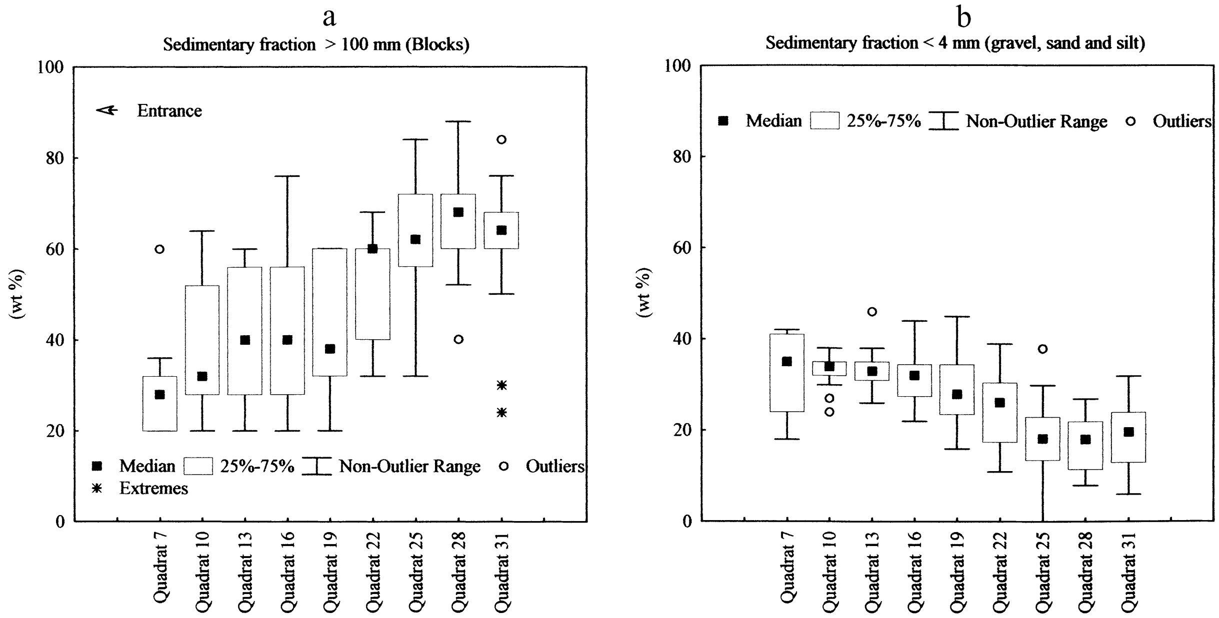
Tab. 5.1.3a, b: Masni odstotni deleži blokov večjih od 100 mm (a), in sedimentne frakcije, manjše od 4 mm, v sedimentacijskih nivojih kvadratov 7–31 (b).
Tab. 5.1.3a, b: Weight percentage shares of blocks greater than 100 mm (a) and sedimentary fractions smaller than 4 mm in the sedimentation levels of quadrats 7–31 (b).

a

Depth (cm)	Quadrat 7	Quadrat 10	Quadrat 13	Quadrat 16	Quadrat 19	Quadrat 22	Quadrat 25	Quadrat 28	Quadrat 31
-261	20								
-267	30	20	40	40					
-273	20	40	60	60	60	40	60		
-279	28	20	40	40	60	60	60	40	50
-291	32	28	28	28	60	60	70	40	60
-303	36	32	56	56	60	60	80	60	30
-315	32	52	60	56	60	36	36	68	64
-327	24	56	44	60	40	40	56	68	
-339	28	28	44	48	36	40	56	72	64
-351	60	44	60	76	52	60	40	56	64
-363	60	64	60	32	36	68	84	68	68
-375	20	28	44	52	32	68	76	88	76
-387	20	56	40	40	56	60	64	64	68
-399	24	28	28	28	36	64	32	88	84
-411	28	28	20	24	32		60	84	84
-423	20	24	36	20	60	32	68	64	60
-435	24	32	28	20	20	40	60	72	60
-447	28	60	28	28	20	32	72	68	60
-459		36	20	28	20	36	64	80	60
-459					36	60	80	64	68
-465								52	24
MEDIAN	*28*	*32*	*40*	*40*	*38*	*60*	*62*	*68*	*64*
25th%	*20*	*28*	*28*	*28*	*32*	*40*	*56*	*60*	*60*
75th%	*32*	*52*	*56*	*56*	*60*	*60*	*72*	*72*	*68*

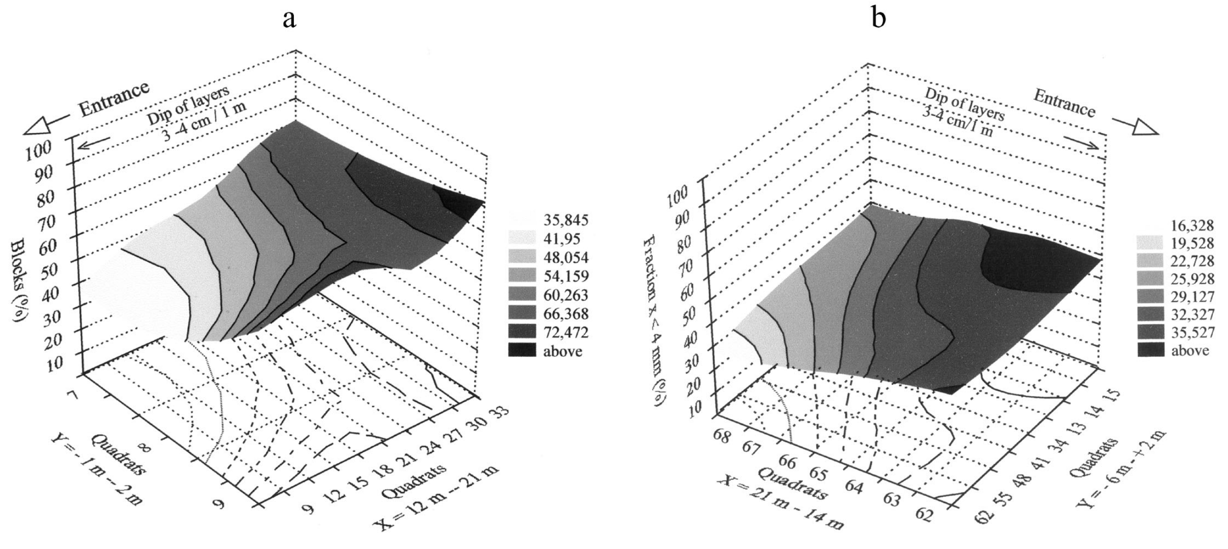
b

Depth (cm)	Quadrat 7	Quadrat 10	Quadrat 13	Quadrat 16	Quadrat 19	Quadrat 22	Quadrat 25	Quadrat 28	Quadrat 31
-54									
-60									
-68						28	20		
-74				22		16	12	25	18
-87				32	24	21		8	17
-100			30	33	16	31	30	15	21
-112		32	33	32	18	19	15	13	31
-123		27	46	27	23	30	25	19	20
-135		30	36	44	38	39	38	21	32
-147	41	35	29	34	45	29	27	21	24
-159	35	34	31	42	34	31	19	22	28
-171	42	24	38	34	37	32	14	27	21
-183	41	38	31	40	28	29	21	22	19
-195	24	32	26	28	28		18	25	12
-207	35	37		26	21	18	14	13	8
-219	18	35	32	35	25			9	13
-231	19	37	35	30	31	14	13	10	6
-243		35	33	23	35	11	0	9	22
-255					24	17	11		13
-267									26
MEDIAN	*35*	*34.5*	*32.5*	*32*	*28*	*28*	*18*	*19*	*20*
25th%	*21.5*	*31*	*30.5*	*27*	*23*	*17*	*13*	*10*	*13*
75th%	*41*	*36*	*35.5*	*35*	*35*	*31*	*25*	*22*	*24*



Sl. 5.1.7a, b: Mediana in kvartili masnih deležev (težni %): bloki, večjih od 100 mm (a), in sedimentna frakcija, manjša od 4 mm (b), za sedimentacijske nivoje vzdolžnega niza kvadratov 7–31. Podatki v *tab. 5.1.3a, b*. Kvadrat 7 je najbližje vhodu, kvadrat 31 pa je od njega najbolj oddaljen. Glej različen gradient pri blokih in frakciji, manjši od 4 mm.

Fig. 5.1.7a, b: Median and quartile mass shares (% weight): blocks and boulders larger than 100 mm (a), and the sedimentary fraction smaller than 4 mm (b) for sedimentation levels along the series of quadrats 7–31. Data in *Tab. 5.1.3a, b*. Quadrat 7 is closest to the entrance, quadrat 31 is most distant from it. See different gradients with blocks and boulders and fractions smaller than 4 mm.



Sl. 5.1.8a, b: Minimalni masni deleži blokov, večjih od 100 mm, v 49 m^3 sedimentov (a), in sedimentne frakcije, manjše od 4 mm v 40 m^3 sedimentov (b). Prikazano je povprečje masnih deležev blokov na podlagi 409. podatkov v 18. sedimentacijskih nivojih (od –261 cm do –465 cm) in drobnejša frakcije na podlagi 660. podatkov v 6. sedimentacijskih nivojih (od –105 cm do –177 cm).

Fig. 5.1.8a, b: Minimum mass shares of blocks and boulders larger than 100 mm in 49 m^3 of sediments (a), and. sedimentary fraction smaller than 4 mm in 40 m^3 of sediment (b). Average mass shares of blocks and boulders on the basis of 409 data in 18 sedimentation levels (from –261 cm to –465 cm) and finer sedimentary fraction on the basis of 660 data in 6 sedimentation levels (from–105 cm to –177 cm) are shown.

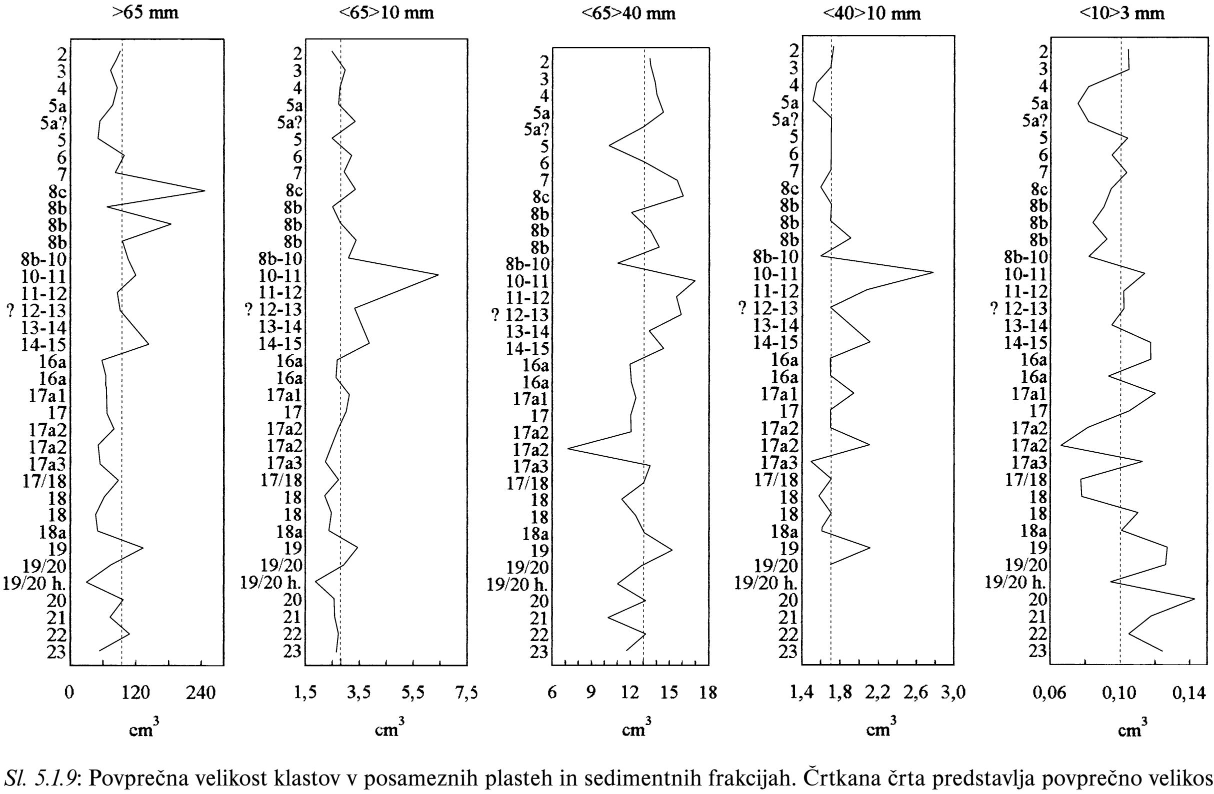
poznem glacialu ali pozneje stopil, bi nastale na površju vdolbine, ki bi jih zapolnili najmlajši krioklastični sedimenti, kakršne imamo ponekod v plasti 2.

Masni delež drobnejše sedimentne frakcije je v osrednjem delu jame obratno sorazmeren z bloki zaradi učinka skupne vsote (*sl. 5.1.1a, b; tab. 5.1.1*). Njen delež se zmanjšuje od vhoda proti notranjosti jame, medtem ko delež blokov narašča (*sl. 5.1.7a, b; tab. 5.1.3a, b*). Pojav smo lahko sledili tudi v večjem volumnu sedimentov (*sl. 5.1.8a, b*). To lahko pomeni, da so drobne sedimentne frakcije, kot rečeno, nastale predvsem s preperevanjem blokov, tj. postsedimentno. Tako pri blokih kot pri drobnejših sedimentnih frakcijah smo s prostorsko analizo ugotovili, da variabilnost med plastmi ni večja od variabilnosti znotraj plasti. Zato se variabilnosti med plastmi ne da interpretirati.

Povprečna velikost zrn posameznih sedimentnih frakcij dopolnjuje in v določenih pogledih tudi dobro nadomešča podatke o masnih deležih sedimentnih frakcij. Velikosti klastov smo ocenili na podlagi povprečne prostornine zrn, ki smo jo dobili tako, da smo težo vseh zrn delili z njihovim številom in nato na podlagi specifične mase dolomita, ki je povprečno 2,9 g/cm^3, izračunali povprečno prostornino zrn kot mero velikosti, ki je neodvisna od oblike zrn. Računali smo po naslednjem obrazcu: $v = m / (n * 2,9)$, pri čemer je m masa in n število zrn. Zanesljivost podatka je odvisna od stopnje preperelosti zrn in njihovega števila. Število zrn se je gibalo po plasteh odvisno od frakcije. Pri blokih (>65 mm): 9–59 zrn, pri debelem grušču (<65>40 mm): 42–230 zrn, pri srednjem grušču (<40>10 mm): 383–2184 zrn, in pri drobnem grušču (<10>3 mm): 324–848 zrn. Zrna smo vzorčili v sestavljenem profilu in jih nismo četrtinili, razen pri drobnem grušču, kjer smo v ta namen uporabili Jonsonov razdelilnik, vendar samo pri plasteh iz zgornjega in srednjega dela profila.

Povprečna velikost zrn v frakcijah v profilu je prikazana na *sl. 5.1.9*. Kot posebnost se je izkazala plast 10-11, ki je sestavljena iz nadpovprečno velikih klastov v vseh frakcijah. Plast 10-11 ima tudi podpovprečno malo frakcij manjših od 10 mm. To lahko kaže na močno primarno preperevanje (podor?) in šibko sekundarno dezintegracijo klastov, kar bi lahko povezali z relativno hitro sedimentacijo v tem delu profila.

Med povprečno velikostjo klastov, večjih od 40 mm, in povprečno velikostjo klastov, manjših od 40 mm, so določene razlike med plastmi zgornjega dela profila (plasti 2–12) in spodnjega (plasti 13–23), če upoštevamo kronoklimatsko razmejitev (glej podpoglavje 5.2 in 5.3 ter poglavje 6 v tem zborniku). Te razlike se dajo smiselno razložiti s primarnim in sekundarnim preperevanjem (Turk *et al.* 2005a). Primarni ali sinsedimentni so predvsem klasti večji od 40 mm, sekundarni ali postse-



Sl. 5.1.9: Povprečna velikost klastov v posameznih plasteh in sedimentnih frakcijah. Črtkana črta predstavlja povprečno velikost posamezne sedimentne frakcije v celotnem profilu.

Fig. 5.1.9: Average size of clasts in individual layers and sedimentary fractions. Dashed line is the average size of individual sedimentary fraction in the profile.

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dimentni pa so predvsem klasti, manjši od 40 mm. Prvi so nastali s preperevanjem jamskega svoda, drugi pa s preperevanjem talnih sedimentov. V spodnjem, toplejšem in bolj suhem delu profila prevladujejo med klasti, manjšimi od 40 mm, povprečno večji klasti kot v zgornjem, hladnejšem in vlažnejšem delu, kar povezujemo z večjim talnim preperevanjem v zgornjem delu profila. Pri klastih, večjih od 40 mm, je ravno obratno. Ti so povprečno večji v zgornjem delu profila.

Naravo klastov smo preučili skupaj s teksturo tako, da smo opran grušč v vzorcih vseh plasti razprostrli in ga med seboj neposredno primerjali. Ugotovili smo naslednje: kasti so v skoraj vseh plasteh bolj ali manj zaobljeni (toda glej Brodar 1999, 39, ki navaja drugačne podatke). Površina zaobljenih klastov je lahko 1.) gladka, tj. zdrava, 2.) minimalno preperela ali hrapava, tj. mokasta, in 3.) zelo preperela. V celotnem profilu je v plasti 5a in 5a? debel grušč najbolj preperel. Zelo preperele površine debelega grušča in blokov ima več plasti zgornjega in srednjega dela profila: 8b–10, 8b, 5a, 5a? in 4, in samo dve plasti v spodnjem delu profila, in sicer plast $17a_3$ in 18. Vse naštete plasti vsebujejo tudi popolnoma preperel t. i. 'fantomski' grušč, ki ga poznamo tudi iz številnih drugih mlajšepleistocenskih jamskih najdiščih. Za njegov nastanek ni zanesljive razlage[2]. Površina zelo zaobljenih klastov v plasti 8c in 10–12 je 'zdrava', nedrobljiva.

Zanimivo pri preperelosti klastov je to, da debel grušč v površinski plasti 2 ni zelo preperel, kar pa morda ne velja za grušč, ki leži na površini. Stopnja preperelosti se v tem primeru ni dala ugotoviti, zaradi debelih oblog mulja in sige, ki smo jih morali odstraniti s kislino, ki je načela tudi površino klastov.

Na preperelost lahko vpliva kamnina, ki ni homogena. V plasteh sta prisotni dve barvni različici dolomita: temno siv gost zelo drobno zrnat dolomit in bel zrnat dolomit (glej poglavje 2 v tem zborniku).

Med izkopavanji in vzorčevanjem profilov smo ugotovili različne oblike grušča: od redkih zelo ploščatih kosov (*plaquettes*), pogostih podolgovatih kosov (*prismatiques*?), skoraj kroglastih kosov, do kockastih in raznih poliedričnih kosov (Miskovsky 1974, fig. 133 idr., Laville 1975: pl. 37 idr.). Vendar vseh oblik nismo kvantificirali. Prav tako nismo kvantificirali zaobljenega grušča ter površinsko in globinsko preperelega grušča in različnih oblog na njem (prim. Campy 1989, 41ss), kar vse nastopa v številnih različicah v sedimentih Divjih bab I.

Zaobljenost grušča smo nekoliko podrobneje preučili v 7 vzorcih iz profila x = -1m (*tab. 5.1.4*). Uporabili smo metodologijo za morfometrijsko preučevanje proda. Za boljšo predstavo in primerjavo smo dodatno obdelali tudi dva vzorca recentnega grušča iz bližnje jame Divje babe II (glej poglavje 2 v tem zborniku, *sl. 2.2a, b*).

Tab. 5.1.4: Morfometrične značilnosti dolomitnega grušča v profilu x = -1 m. Legenda: PV = povprečna velikost v mm (po Cailleuxu 1947, 1959), (a+b+c)/3. Za = indeks zaobljenosti (po Cailleuxu ibid.), (2r/a) x 1000. Sp = indeks sploščenosti (po Cailleuxu ibid.), [(a+b)/2c]x100. Sf = indeks sferičnosti (po Krumbeinu), (bc/a^2)x1000. N vzorca posamezne plasti je bil ~ 100 klastov.

Tab. 5.1.4: Morphometric characteristics of dolomite rubble in profile x = - 1 m. Legend: PV = average size in mm (after Cailleux 1947, 1959), (a+b+c)/3. Za = index of roundness (after Cailleux ibid.), (2r/a) x 1000. Sp = index of flatness (after Cailleux ibid.), [(a+b)/2c]x100. Sf = index of spheroidicity (after Krumbein), (bc/a^2)x1000. Each layer was represented by a sample of ~ 100 clasts.

Sample - Layer	PV	Za	Sp	Sf
Holocene rubble 1	25.1	45	242	639
Holocene rubble 2	30.8	34	219	653
7	15.8	284	192	702
8	16.0	239	181	705
9	17.6	171	207	676
12a	17.5	263	180	719
13	17.9	165	180	712
16	19.3	45	270	609
17	19.3	75	201	688

Starost grušča sama po sebi ne pogojuje zaobljenosti ali zrnatosti grušča. Tako je v spodnjih dveh plasteh (16 in 17) grušč največji, najmanj zaobljen in obenem najbolj sploščen, torej najbolj podoben recentnemu grušču. Ni natančno znano, zakaj je grušč v nekaterih više ležečih plasteh tako dobro zaobljen, kot kak prod. Vsekakor pa je iz profila razvidno, da ni nujno, da se grušč spreminja s starostjo, da postaja bolj zaobljen in bolj ploščat (glej M. Brodar 1959, 425). Na to je lahko med drugim vplivala različna zgradba in pretrtost matične kamnine, ki je pogojevala tudi hitrost sedimentacije in odločala o količini in sestavi osnove. V nobenem primeru pa površina posameznih kosov ne kaže na delovanje tekoče vode, saj nikjer ni opaziti sledov polirane površine, ki je najbolj značilna za prave prodnike.

Podatke morfometričnih analiz podrobneje prikazuje *tabela 5.1.4*. Pri tem naj opozorimo, da sta sploščenost in sferičnost dejansko dva različna kazalca istih procesov in sta zato obratno sorazmerna: čim večji je indeks sploščenosti, tem manjši je indeks sferičnosti, čeprav to razmerje ni matematično natančno oz. izračunljivo.

Največji indeks sploščenosti imajo recentni grušč in vzorca iz plasti 16 in 17 ter vzorec iz plasti 9 (za plast 16 glej poglavje 4 v tem zborniku, *sl. 4.7*). To govori v prid trditvi, da močnejša sploščenost ni rezultat poznejših sprememb, ampak je prvotna, najverjetneje odvisna od strukture diskontinuitet (razpok, plastnosti itd.) v kamnini. To potrjuje tudi indeks zaobljenosti, ki je ravno pri teh vzorcih tudi najmanjši.

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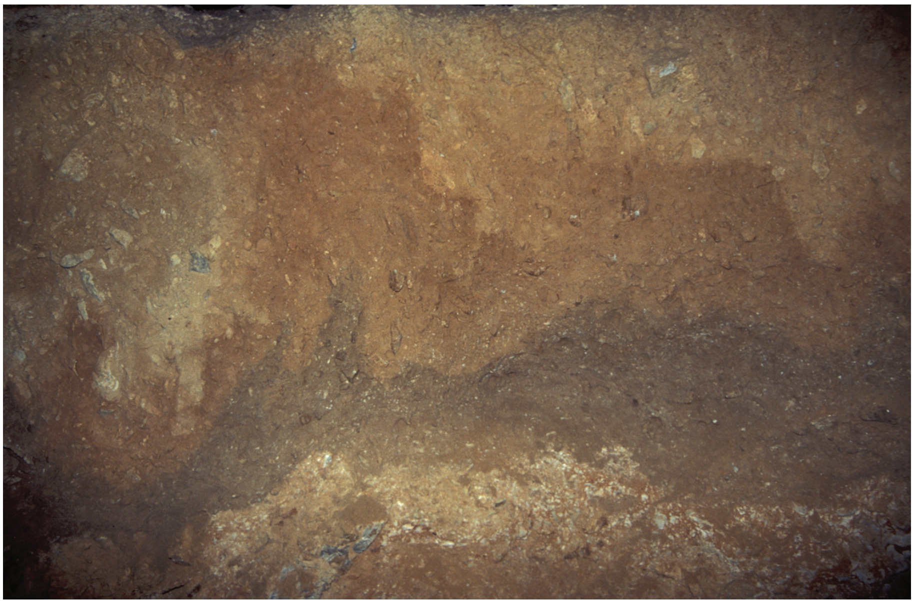
[2] Popolnoma preperele klaste, ki jih lahko zdrobimo z rokami, opažamo v alpskem visokogorju, 25–50 cm nad stalno zmrznjenimi tlemi (Retzer 1974, 777).



Sl. 5.1.10: Gube v profilu y = –6 m. Fotografija I. Turk.
Fig. 5.1.10: Folds in profile y = –6 m. Photograph I. Turk.

V zvezi z indeksom zaobljenosti naj povemo, da fluvialni sediment, ki ima indeks zaobljenosti več kot 100, uvrščamo med prod, drugače pa med grušč, čeprav "meja" nikakor ne more biti ostra, ampak gre za relativno širok prehodni pas. V našem primeru ne gre za prod (glej poglavje 4 v tem zborniku, *sl. 4.5*), ampak za grušč, čeprav z visokim indeksom zaobljenosti. Indeksi kažejo, da je bil grušč v nekaterih plasteh (7, 12a, 8) res močno preoblikovan. Zgolj za ilustracijo navajamo rezultate 33 meritev karbonatnega proda iz nekaterih slovenskih jam (Kranjc 1986): srednja vrednost indeksa zaobljenosti teh meritev je 250, v razponu od 117 do 551. Indeks zaobljenosti iz plasti 7, ki znaša 284, je torej res visok. Na močno zaobljen grušč s kompaktno gladko površino in fosfatnimi oblogami, ki so nastale, ko je bil grušč že okrogel, smo naleteli še na več mestih, npr. na dnu plasti 8 in na enem mestu na dnu plasti 5, kar se ujema s porastom padavin (glej podpoglavji 5.3 in 5.5 v tem zborniku, *sl. 5.3.6* in *5.5.1a*).

Primerjava povprečne velikosti grušča in indeksa zaobljenosti s pomočjo Spearmanovega koeficienta korelacije ranga in verjetnostnega testa Student-t (Briggs 1977) kaže, da je manj kot 5 % verjetnosti, da sta povprečna velikost (PV) in zaobljenost (Za) le naključno odvisni. Razmerje med obema parametroma je obratno sorazmerno – čim manjša je povprečna velikost, tem večji je indeks zaobljenosti. To potrjuje domnevo, da gre za naraščanje indeksa zaobljenosti zaradi postdepozicijskih procesov oz. za postopno zaporedno preperevanje in odstranjevanje preperinskih oblog. Končni produkt je lahko t. i. fantomski grušč. Dejansko smo pri kopanju pogosto naleteli na grušč z nekaj milimetrsko slabo vezano oblogo preperine, ki se mehansko zlahka odstrani, nato pa se proces preperevanja lahko nadaljuje v globino.

Več pozornosti smo posvetili posebnim oblikam klastov, ki jih razlagamo kot talne zmrzlinske klaste (kongelifrakte) in talne oz. stropno-stenske korozijske tvorbe (glej podpoglavje 5.2 v tem zborniku).

V barvi sedimentov prevladujejo rjavkasti toni s svetlejšimi in temnejšimi odtenki, kar se povezuje z njihovim redoks (redukcijsko-oksidacijskim) potencialom. Osnovna bela do zelo svetlo siva barva dolomitne kamnine je v večini plasti bolj ali manj spremenjena zaradi postsedimentacijskih procesov. Na barvo sedimentov vplivajo predvsem prevleke (tanek sloj) in obloge (debel sloj) na klastih, ki vsebujejo sekundarne železove minerale (hematit, goetit, lepidokrokit). Močneje obarvani so zlasti fosfatni cementi. Barva sedimentov je odvisna od geokemijske sestave in kemijskih procesov, predvsem stopnje oksidacije[3].

Kemijske in biogene lastnosti sedimentov smo zasilno obdelali v podpoglavju 5.4 tega zbornika, avtigene novotvorbe (agregate) in diagenezo pa v podpoglavju 5.3. Zato na tem mestu samo na kratko o prevlekah oz. oblogah in brečah.

Prevleke na klastih so v vseh plasteh, obloge pa samo v nekaterih plasteh. Največ oblog je v kompleksu plasti 8. Posebnost plasti 2, 5, 8b-10 in 11 so glinene prevleke na drobnem grušču in pesku (Turk, Dirjec 1997a, sl. 3.1: 2). V plasti 8b–10 je takšnih prevlek največ (30 %). Barvo oblog in prevlek smo določili na grušču

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[3] V plasti 18 smo na skali naleteli na trak rdečkaste fosfatne inkrustacije, ki se je natanko ujemal z debelino in obliko tanke sive plasti. V sivo obarvanih plasteh so inkrustacije na posameznih klastih enake barve kot v rjavo obarvanih plasteh. To dokazuje, da gre, kljub različni barvi, za podoben proces.

velikosti 40–65 mm, ker se je ta hitreje obarval kot osnova (Gale, Hoare 1991, 151). Barva prevlek v plasteh 2–5 je 10YR 7/8 (rdečkasto-rumena, *reddish yellow*), v plasteh 6–8c: 10R 3/4 (temno rdeča, *dusky red*), v plasteh 10–20: 7.5YR 4/4 (rjava, *brown*) in v plasteh 21–23: 10YR 3/2 (temnosivo rjava, *very dark grayish brown*). Glede na barve lahko sklepamo, da gre pretežno za oksidirane železove spojine.

Za grušč v plasti 2 (predvsem na površju) so značilne obloge iz mulja in sige. Takšne obloge zasledimo le redko, in še to ločeno, bodisi iz mulja bodisi iz sige (npr. v plasti 4, 6, 10 in 17a$_2$), ne pa skupaj kot v plasti 2.

Breče se nahajajo v več plasteh. Dolomitne klaste veže v brečo večinoma fosfatno vezivo. Barva breče je po plasteh naslednja: plast 8a (10R 3/4 – temno rdeča, *dusky red*), plast 10 (5YR 4/4 – rdečkasto rjava, *reddish brown*), plast 16 (breča brez osnove: 10R 3/4 – temno rdeča, *dusky redish*, breča z osnovo: 2.5YR 3/4 – temno rdečkasto rjava, *dark reddish brown*), plasti 18a, 19 in 20 (7.5YR 4/4 – rjava, *brown*), plasti 22 in 23 (10YR 3/2 – temnosivo rjava, *very dark grayish brown*). Enake barve kot breče so tudi posamezni večji fosfatni agregati v plasteh 7, 8c, 8b, 8b–10, 13, 16a, 17, 18 in 19/20.

Na koncu moramo omeniti še gubanje plasti, ki se ga običjano povezuje s krioturbacijo (S. Brodar 1960; M. Brodar 1991; Osole 1961). Takšno gubanje je prizadelo predvsem plasti 2–5a, v manjši meri pa tudi nekatere druge plasti (npr. plast 16a, 17a$_1$). Z gubami so povezane navpično zasajene kosti in podolgovati kamni (glej poglavje 16 v tem zborniku, *sl. 16.1*). Gube v plasteh 2–5a smo lahko zasledovali od jamskega vhoda do profila x = 21 m (*sl. 5.1.10*). Za tem profilom omenjene plasti niso več nagubane, kar je nemara povezano do neke mere tudi s spremembo v strukturi sedimentov. Za profilom x = 21 m sivo plast 4 z majhno gostoto fosilinih ostankov, ki vsebuje malo agregatov, naenkrat zamenja rjava plast z veliko gostoto fosilnih ostankov, ki vsebuje maksimalno agregatov. Ker domnevamo, da agregati ublažijo razteznostne učinke, ki nastanejo, ko talna voda zamrzne, bi razlike v strukturi sedimentov lahko vplivale na gubanje. Gube so najizrazitejše in največje v osrednjem predelu jame, kar je lahko povezano z mikrookoljem in/ali mikroklimo. Sedimenti so bili v tem predelu, zaradi ožine, bočno in delno čelno omejeni, medtem ko so bili v vhodnem predelu omejeni samo bočno. To je vplivalo na raztezanje in nabrekanje, zaradi segregacije ledu in večanja prostornine. Temperaturni prag za nastanek permafrosta je v jamah bistveno višji kot na prostem, zaradi odsotnosti snežne odeje in vegetacijskega pokrova. Permafrost lahko nastane v tleh z drobnozrnato komponento, kot je v Divjih babah I, že pri povprečni letni jamski temperaturi zraka 2° C, na prostem s snežno odejo 25 cm in manj pa šele pri –3°C (Van Andel 2002). Izmerjena temperatura zraka v predelu za profilom x = 21 m pozimi leta 1981 je bila 8°C pri zunanji temperaturi –1°C. Vendar je treba poudariti, da v Divjih babah I ni bilo aktivnega sloja ali molisola, zaradi česar tudi ni prihajalo do geliflukcije in soliflukcije razen na pobočju pred jamo.

5.2. MORFOLOŠKE ZNAČILNOSTI KLASTOV IN KLIMATOSTRATIGRAFIJA

Izvleček

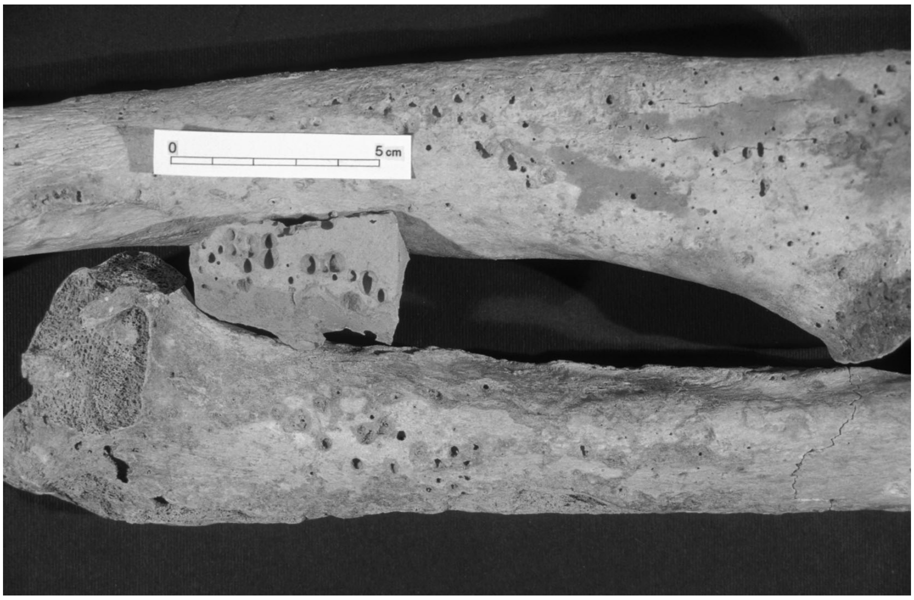
Večina tem, ki jih obravnava to podpoglavje, je bila že opisana in prevedena v angleščino v Turk, Bastiani 2000 in Turk *et al.* 2001a; 2005a. Talni zmrzlinski klasti so nam služili za približek nihanja paleotemperature (*sl. 5.2.6*), reliefno korodirani klasti pa za približek spremembe paleovlage (*sl. 5.2.4*). Preverili smo, kako se je na klimatske spremembe odzival jamski medved (*sl. 5.2.10; 5.2.11a,b*), in ugotovili, da je na dinamiko obiska jame-brloga in smrtnost jamskega medveda vplivala predvsem vlažnost, manj temperatura.

Morfologiji klastov pri raziskovanju avtohtonih jamskih sedimentih doslej niso posvečali posebne pozornosti. Na misel, da bi jo sistematično preučili, je prišel I. Turk na podlagi terenskih opažanj pri spiranju vseh sedimentov na sitih s premerom odprtin 10 mm, 3 mm in 0,5 mm. Nekatere oblike klastov, vseh velikosti, so se namreč ponavljale v različnem obsegu in številu v vseh plasteh. Pri nekaterih fragmentih je bilo jasno, da so se njihove površine preoblikovale na jamskem svodu. Spet druge oblike so lahko nastale izključno postsedimentno v tleh. Ker sta na preoblikovanje klastov in jamskega svoda vplivali predvsem vlaga in temperatura, se je ponudila enkratna priložnost za klimatostratigrafsko členitev in razlago profila. Variabilnost morfoloških oblik v profilu pripisujemo tako vplivu klime. Povezavo klimatostratigrafije in kronologije obravnavamo v poglavju 6 tega zbornika.

Rezultati morfološke analize so omogočili delitev profila na tri facije (A, B in C) ter v določenih primerih na subfacije (C-1 in C-2) (Turk 2003a). Takšna delitev se je pozneje pokazala za umestno in kronološko utemeljeno (glej Turk 2006). Zato je služila kot osnova za različne biostratigrafske študije, koristna pa bo tudi pri načrtovanju arheoloških analiz. Mejo med facijo A in B smo arbitrarno določili med plastjo 6 in 7, mejo med facijo B in C pa med plastjo 12 in 13. Mejo med subfacijo C-1 in C-2 smo postavili med plast 17a3 in 17/18.

Ko smo se lotili morfološke analize klastov, smo imeli pred očmi predvsem dvoje:

1. Vlaga, ki se kondenzira na jamskem stropu in stenah, povzroča reliefno korozijo dolomitne kamnine (prim. Slabe 1995). Zaradi delovanja zmrzali odpadejo kosi reliefno korodirane površine in se pomešajo med druge klaste (glej podpoglavje 5.1 v tem zborniku, *sl. 5.1.5*).

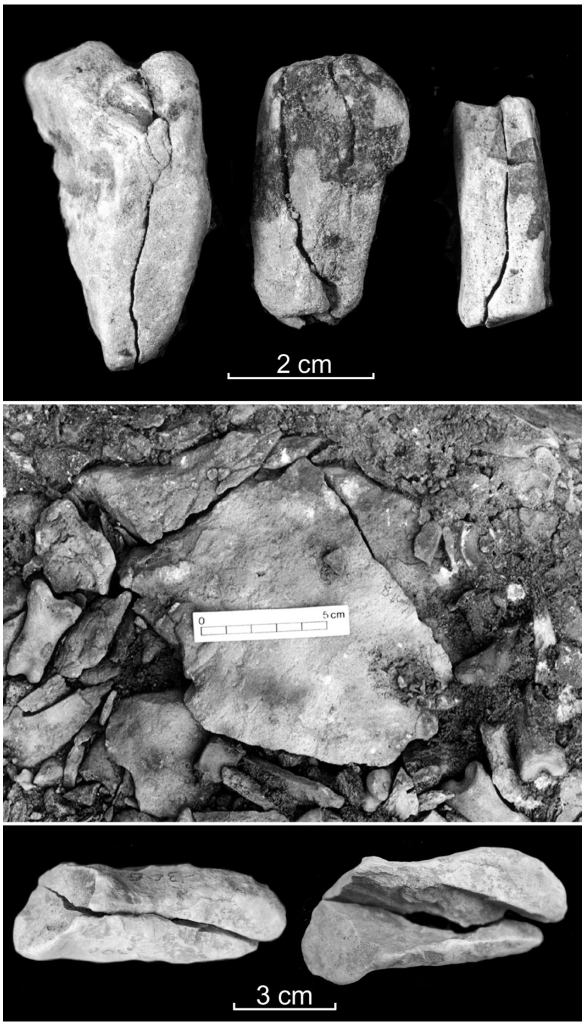


Sl. 5.2.1: Reliefno korodirana površina kosti in podobno korodiran klast iz previsa pod vrhom Briceljka (2346 m) v Loški steni. Fotografija I. Turk.
Fig. 5.2.1: Cavernously corroded surface of bones and similarly corroded clast from rockshelter below the peak of Briceljk (2346 m) in the Loška stena. Photograph I. Turk.

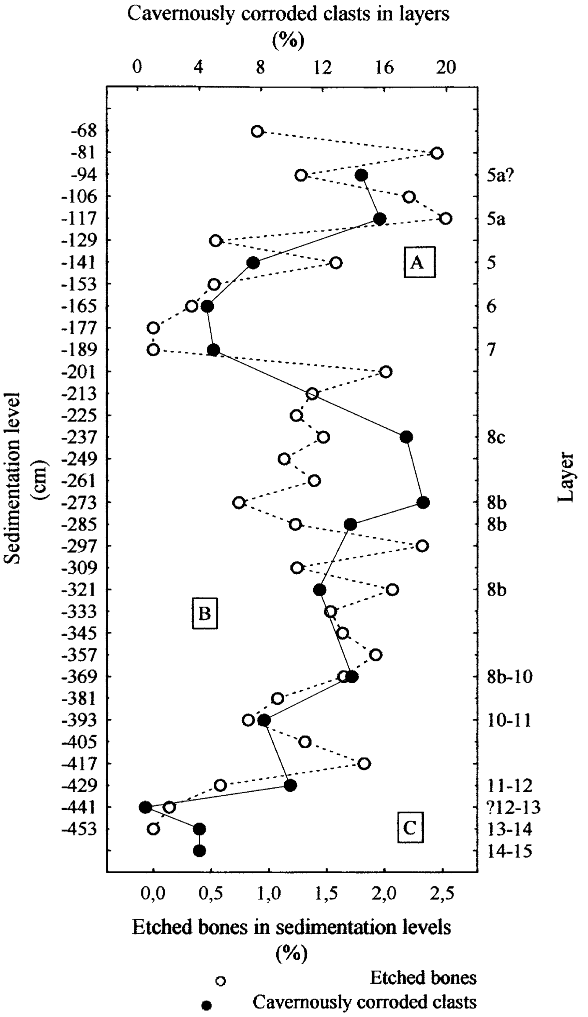
2. Podzemna voda, katere dotok je neposredno povezan s padavinami, korozijsko jedka dolomitne klaste in množične fosilne ostanke v jamskih tleh. Zato se najprej zaoblijo robovi klastov in kostnih fragmentov, nato pa postopno celoten klast. V določenih primerih pride tako na klastih kot kosteh do posebne reliefne korozije (*sl. 5.2.1*). Zaradi delovanja zmrzali na/v jamskih tleh zaobljeni in drugi klasti razpadejo na zmrzlinske klaste ali kongelifrakte (glej Ehlers 1996, sl. 60) (*sl.5.2.2*).

S tlemi poimenujemo izključno relativno tanko vrhnjo plast, v kateri potekajo ali so potekali intenzivni postsedimentacijski procesi, kot sta preperevanje in cementiranje. V globljih plasteh so ti procesi upočasnjeni ali pa niso izraženi, kar je potrjeno z nepovezanostjo diagenetskih procesov in starosti sedimentov.

Izjedkane (reliefno korodirane) površine klastov so, kot rečeno, posledica primarne stropne in stenske korozije ter sekundarne korozije v tleh. Stropno-stenska korozija, katere delež se da teoretično oceniti s pomočjo korodiranih klastov, je kazalec vlage in zastojev v avtohtoni klastični sedimentaciji (Turk *et al.* 2005a). Izjedkane kosti pa so nastale izključno v tleh in so precej redkejše od izjedkanih klastov.



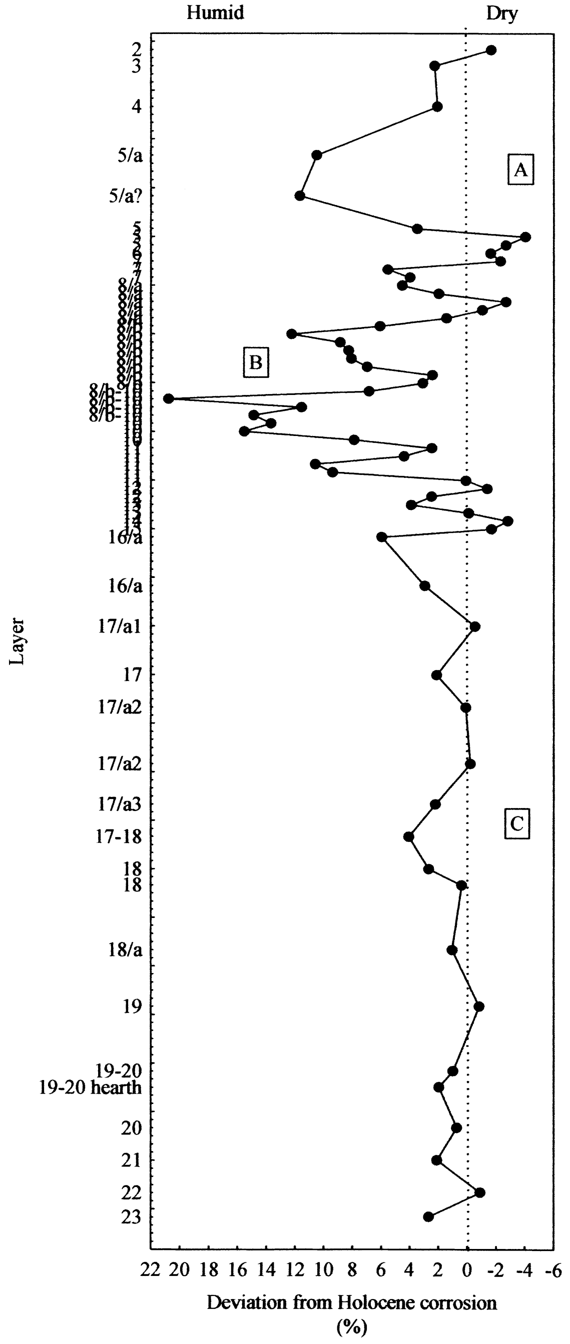
Sl. 5.2.2: Talni zmrzlinski klasti: zametki, *in situ* oblika v breči in končna oblika, sestavljena iz ločeno najdenih delov. Fotografija I. Turk in D. Valoh.
Fig. 5.2.2: Topsoil congelifracts: origins,.*in situ* formation, secondary consolidated in breccia, and final form of conjoint parts found separately. Photograph I. Turk and D. Valoh.



Sl. 5.2.3: Porazdelitev izjedkanih kosti, večjih od 50 mm, v sedimentacijskih nivojih bloka sedimentov na lokaciji B in reliefno korodiranih klastov, večjih od 40 mm, v zgornjem delu sestavljenega profila Divjih bab I. Podatki so podani kot odstotek izjedkanih kosti od vseh kostnih ostankov, večjih od 50 mm, in reliefno korodiranih klastov v frakciji x < 40 mm. Označene so glavne facije A–C.

Fig. 5.2.3: Distribution of etched bones larger than 50 mm in sedimentation levels of block of sediments at location B and cavernously corroded clasts larger than 40 mm in the upper part of the composite profile of Divje babe I. Data are given as a percentage of etched bones of all bone remains larger than 50 mm and cavernously corroded clasts in the fraction x < 40 mm. Main facies A–C are marked.

Zmrzlinski klasti vseh vrst so povezani z vlago in temperaturo, vendar so izključno posledica negativnih temperatur. Za interpretacijo zmrzlinskih klastov je zelo pomemben način vzorčevanja. Med zmrzlinskimi klasti smo izbrali tiste, ki so nastali na/v tleh s sekundarnim preperevanjem, tj. postsedimento, zaradi česar imajo z izjemo najmlajših robov ostale robove zaobljene. Za razliko od drugih zmrzlinskih klastov, smo jih poimenovali talni. Vpliv hitrosti sedimentacije na količino talnih zmrzlinskih klastov smo zmanjšali z izborom klastov zadnje



Sl. 5.2.4: Na podlagi zastopanosti reliefno korodiranih klastov ocenjena krivulja kondenzne (in talne) vlage v sestavljenem profilu Divjih bab I. Prikazano je odstopanje od holocenske vrednosti (= 0). Označene so glavne facije A–C. Podatki so zbrani v *tab. 5.2.1*, vključno s holocensko vrednostjo v plasti 1. Neenakomerni presledki na ordinati označujejo nezvezno vzorčene plasti, enakomerni pa zvezno vzorčene.

Fig. 5.2.4: On the basis of share of cavernously corroded clasts, an assessment of the curves of condensation (and soil) moisture in the composite profile of Divje babe I was done. The deviation from Holocene value 0 is shown. Main facies A–C are marked. Data are collected in *Tab. 5.2.1*, including Holocene values in Layer 1. Uneven steps on the ordinate mark discontinuously sampled layers, and even steps continuously distributed samples by layers.

Tab. 5.2.1: Delež reliefno korodiranih klastov in talnih zmrzlinskih klastov ter vsebnost fosilnih ostankov in agregatov, izražena z gostoto na prostorninsko enoto v sestavljenem profilu. Kongelifrakti v plasti 6 predstavljajo povprečje dveh vzorcev z zelo različnimi vrednostmi.
Tab. 5.2.1: Share of cavernously corroded clasts and topsoil congelifracts and content of fossil remains and aggregates expressed by the density per volume unit in the composite profile. Congelifracts in Layer 6 are the average of two samples with very different values.

Layer (Depth in cm)	Profile (x)	Facies	Congelifracts <40>10 mm (%)	Corroded >40 mm (%)	Density <3>0.5 mm (g/vol.)	Bone fragments >3 mm (g/vol.)
1 (-20)	-	-	10.9	4.0	1.09	-
2 (-43)	17	A	16.6	2.4	1.27	66
3 (-68)	17	A	13.5	6.3	1.38	65
4 (-96)	17	A	24.5	6.1	1.22	49
5a (-131)	17	A	37.2	14.5	1.08	90
5a? (-152)	17	A	17.2	15.7	1.05	20
5 (-182)	17	A	14.4	7.5	1.24	110
5 (-204)	10.5	A	13.1	0.0	1.07	127
5 (-211)	10.5	A	10.4	1.4	1.01	96
6 (-219)	10.5	A	22.3**	2.4	0.92	74
7 (-228)	10.5	B	7.4	1.7	0.95	91
7 (-236)	10.5	B	8.0	9.6	0.94	111
7 (-245)	10.5	B	8.5	8.0	0.97	176
8a (-254)	10.5	B	10.0	8.6	1.01	272
8a (-261)	10.5	B	9.3	6.0	0.92	432
8a (-269)	10.5	B	14.0	1.4	0.88	494
8c (-277)	10.5	B	30.6	3.0	0.82	152
8c (-284)	10.5	B	20.9	5.5	0.82	82
8b (-294)	12	B	32.1	10.1	0.85	217
8b (-303)	12	B	54.9	16.3	0.85	99
8b (-310)	12	B	61.2	12.9	0.9	117
8b (-317)	12	B	63.6	12.3	0.82	910
8b (-324)	12	B	58.9	11.8	0.83	795
8b (-336)	14	B	49.0	16.5	0.78	1077
8b (-340)	14	B	33.2	6.5	0.92	305
8b (-346)	14	B	34.4	7.1	0.86	262
8b-10 (-353)	14	B	48.6	10.9	0.8	174
8b-10 (-360)	14	B	56.3	24.8	0.92	290
8b-10 (-366)	14	B	53.8	15.6	0.88	380
8b-10 (-372)	14	B	53.7	18.9	0.82	176
10 (-379)	14	B	49.6	17.7	0.88	216
10 (-387)	14	B	30.2	19.6	0.9	497
10 (-394)	14	B	29.4	11.9	1.05	561
11 (-401)	14	B	40.3	6.5	1.08	568
11 (-408)	14	B	31.0	8.4	1.1	383
11 (-413)	14	B	31.4	14.6	1.11	448
11 (-422)	14	B	27.3	13.4	1.02	459
11 (-431)	14	B	20.8	4.1	1.08	326
12 (-439)	14	B	23.6	2.7	1.23	420
12 (-446)	14	B	10.6	6.5	1.33	619

continued....

Tab. 5.2.1 (nadaljevanje / cont.)

Layer (Depth in cm)	Profile (x)	Facies	Congelifracts <40>10 mm (%)	Corroded >40 mm (%)	Density <3>0.5 mm (g/vol.)	Bone fragments >3 mm (g/vol.)
13 (-454)	14	C	11.9	7.9	1.39	337
13 (-461)	14	C	16.3	4.0	1.52	142
13 (-468)	14	C	11.6	1.2	1.54	44
13 (-477)	14	C	6.3	2.4	1.53	12
16a (-512)	12	C	12.1	10.0	1.45	38
16a (-525)	6	C	9.3	7.0	1.25	53
17a1 (-555)	6	C	13.8	3.5	1.37	32
17 (-588)	6	C	14.7	6.2	1.39	45
17a2 (-607)	6	C	11.3	4.1	1.47	71
17a2 (-650)	6	C	6.6	3.8	1.47	51
17a3 (-671)	5	C	5.5	6.3	1.40	74
17-18 (-680)	5	C	14.0	8.1	1.31	27
18 (-717)	5	C	6.3	6.7	1.41	49
18 (-726)	5	C	6.5	4.4	1.38	105
18a (-777)	4	C	10.2	5.1	1.20	26
19 (-823)	4	C	7.3	3.2	1.50	154
19-20 (-865)	4	C	12.9	5	1.24	82
19-20 hearth (-875)	4	C	14.2	6.0	1.38	176
20 (-900)	4	C	3.3	4.8	1.16	58
21 (-918)	4	C	7.2	6.1	1.31	55
22 (-940)	4	C	9.0	3.1	1.43	66
23 (-952)	4	C	8.4	6.7	1.38	80
MEDIAN			*14.3*	*6.5*	*1.09*	*114*
25th%			*10.0*	*4.0*	*0.92*	*66*
75th%			*32.1*	*10.9*	*1.38*	*326*

generacije, ki so nastali tik pred odložitvijo novih sedimentov zaradi primarnega preperevanja (Turk *et al.* 2001a). Na ta način smo izenačili tudi časovne intervale, v katerih so nastali talni zmrzlinski klasti v posameznih nivojih. Nismo pa mogli odpraviti učinkov neenakomerne sedimentacije, zaradi katere so nastale časovne vrzeli med posameznimi nivoji talnih zmrzlinskih klastov. Enake težave smo imeli tudi pri izjedkanih klastih in kosteh.

Reliefno korodirane klaste in talne zmrzlinske klaste smo preučili v različnih profilih, od katerih se nekateri podvajajo v daljši seriji plasti, tako da je bilo mogoče primerjati rezultate iz različnih profilov. Žal nam ni uspelo sistematično zbrati podatkov, ki bi se nanašali na večjo prostornino sedimentov oz. na sedimentacijske nivoje, kot nam je to uspelo pri kostnih ostankih in agregatih (Turk 2003a).

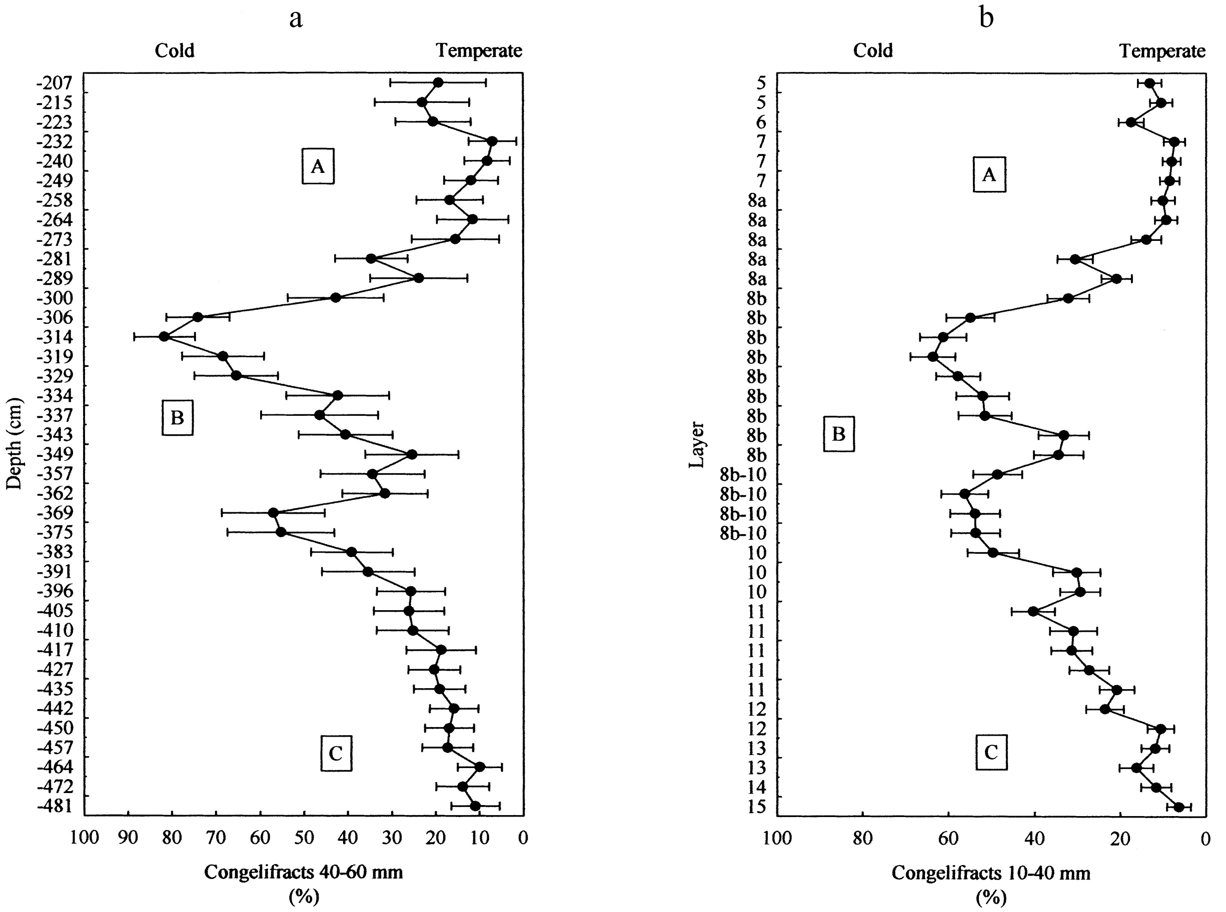
Reliefno korozijo klastov smo preučili na podlagi vzorcev, ki so vsebovali 62–253 klastov, večjih od 40 mm. Rezultate, dobljene po profilih, smo preverili z reliefno korozijo kosti v sedimentacijskih nivojih, ki smo jih primerjali s plastmi, kakor smo jih določili v profilih. Zaradi majhne pojavnosti reliefne korozije na kosteh so bili vzorci kosti bistveno večji od vzorcev klastov in so šteli od 3.132 do 24.212 kosti. Ujemanje med reliefno korodiranimi klasti in izjedkanimi kostmi je tako veliko (*sl. 5.2.3*), da lahko zaupamo rezultatom, dobljenim samo na podlagi klastov. Ti so prikazani na *sl. 5.2.4* in v *tab. 5.2.1.*

Reliefno korozijo smo prikazali kot odstopanje od holocenskega povprečja za Divje babe I, ki znaša 4 % ± 2,8 % (= 2 SE). Večja odstopanja so značilna za zgornji del profila (facies A–B), ki pripada izotopski stopnji 3 (MIS 3) (glej poglavje 6 v tem zborniku). To pomeni, da je bilo tedaj več večjih zastojev v sedimentaciji in da je bila klima vlažnejša kot v spodnjem delu profila (facies C), ki pripada izotopski stopnji 5 (MIS 5).

Tab. 5.2.2: Delež talnih zmrzlinskih klastov ter vsebnost agregatov in fosilnih ostankov, izražena z gostoto na prostorsko enoto v sestavljenem profilu.
t = toplo, c = mrzlo, a = suho, h = vlažno

Tab. 5.2.2: Share of topsoil congelifracts and content of aggregates and fossil remains expressed as the density per volume unit in the composite profile.
t = temperate, c = cold, a = "arid", h = humid

Layer (composite profile)	Depth (cm)	Facies	OIS (MIS)	Temperature as to congelifracts	Humidity as to aggregates	Congelifracts <40>10 mm (%)	Aggregates = Density <0.5 mm (g/vol.)	Aggregates = Density <3 >0.5 mm (g/vol.)	Bone fragments >3 mm (g/vol.)
2	-9	A	3	t	a	16.6	1.08	1.27	66
3	-16	A	3	t	a	13.5	1.12	1.38	65
4	-44	A	3	c	a	24.5	1.15	1.22	49
5a upper	-79	A	3	c	h	37.2	1.08	1.08	90
5a lower	-100	A	3	t	h	17.2	1.06	1.05	20
5	-130	A	3	t	a	14.4	1.11	1.24	110
6	-150	A	3	c	a	27.1	1.19	1.36	127
7	-176	B	3	t	h	6.6	1.08	1.01	536
8c	-227	B	3	c	h	26.8	1.04	0.94	269
8b upper	-256	B	3	t	h	18.5	0.95	0.87	308
8b middle	-265	B	3	t	h	13.8	1.00	0.96	346
8b lower	-309	B	3	c	h	22.6	1.00	0.90	208
8b-10	-350	B	3	c	h	27.7	0.85	0.80	255
10-11	-381	B	3	t	h	18.0	0.91	0.89	347
11-12	-406	B	3	t	h	17.2	0.99	1.01	522
?12-13	-427	C-1	5	t	a	6.9	0.95	1.14	395
13-14	-437	C-1	5	t	a	8.2	1.00	1.29	43
14-15	-458	C-1	5	t	a	12.9	1.00	1.32	8
16a upper	-480	C-1	5	t	a	12.1	1.02	1.45	38
16a lower	-517	C-1	5	t	a	9.3	1.02	1.25	53
17a1	-547	C-1	5	t	a	13.8	1.02	1.37	32
17	-580	C-1	5	t	a	14.7	1.08	1.39	45
17a2 upper	-599	C-1	5	t	a	11.3	1.12	1.47	71
17a2 lower	-642	C-1	5	t	a	6.6	1.10	1.47	51
17a3	-667	C-1	5	t	a	5.5	1.13	1.40	74
17/18	-691	C-2	5	t	a	14.0	1.21	1.31	27
18 upper	-713	C-2	5	t	a	6.3	1.20	1.41	49
18 lower	-722	C-2	5	t	a	6.5	1.13	1.38	105
18a	-773	C-2	5	t	a	10.2	1.17	1.20	26
19	-815	C-2	5	t	a	7.3	1.16	1.50	154
19/20	-865	C-2	5	t	a	12.9	1.15	1.24	82
20	-900	C-2	5	t	a	3.3	1.10	1.16	58
21	-918	C-2	5	t	a	7.2	1.15	1.31	55
22	-940	C-2	5	t	a	9.0	1.09	1.43	66
23	-952	C-2	5	t	a	8.4	1.09	1.38	80
MEDIAN						*12.9*	*1.08*	*16.1*	*71*
25th%						*7.3*	*1.00*	*9.8*	*49*
75th%						*17.2*	*1.13*	*24.4*	*208*



Sl. 5.2.5a, b: Delež kongelifraktov v frakcijah 40–60 mm (a) in 10–40 mm (b) v profilu y = -2 m. Interval zaupanja je 95 % (2 SE). Globine se nanašajo na plasti, iz katerih so bili odvzeti vzorci. Označene so glavne facije A–C.
Fig. 5.2.5: Share of congelifracts in the fractions 40–60 mm (a) and 10–40 mm (b) in profile y = -2 m. Interval of confidence is 95 % (2 SE). Depths refer to layers from which samples were taken. Main facies A–C are marked.

Krivulja reliefne korozije klastov se zelo dobro ujema s krivuljo porazdelitve agregatov, ki ju vzporejamo s spremembo vlage in deležem zmrzlinskih klastov, ki nakazuje spreminjanje temperature (glej *sl. 5.2.7a, b* in podpoglavje 5.3 v tem zborniku, *sl. 5.3.3a*). O tem več v nadaljevanju.

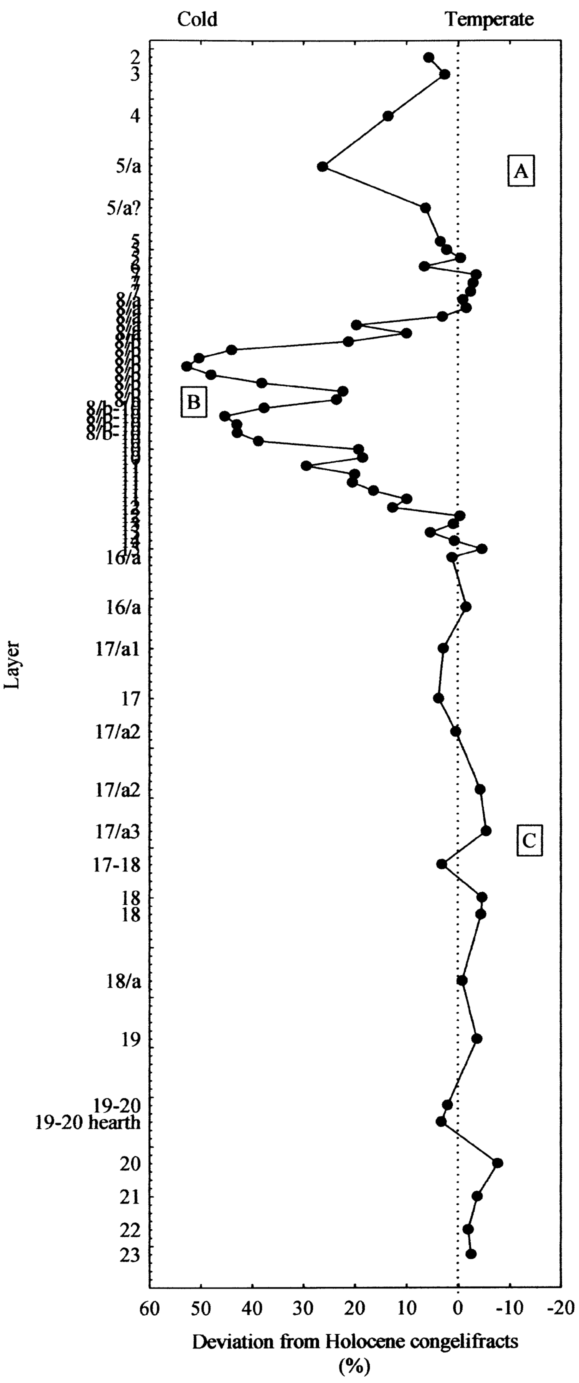
Postsedimentno ali talno preperevanje smo ocenili na podlagi deleža talnih zmrzlinskih klastov srednje debelega grušča (<40>10 mm) od skupnega števila zaobljenih kosov grušča v vzorcu. Pri vzorcih, ki so vsebovali povprečno 1.300 celih kosov z zaobljenimi robovi in zmrzlinskih klastov skupaj, smo se odločili za podvzorčenje s četrtinjenjem. Deleži zmrzlinskih klastov so prikazani v *tab. 5.2.1* in *5.2.2.*

Kriterij za opredeljevanje zmrzlinskih klastov smo poenotili tako, da smo vse vzorce in podvzorce pregledali vsaj desetkrat. Zmrzlinske klaste smo izločili tako, da smo vse prvotne vzorce in podvzorce pregledali dvakrat zapored v dveh dneh. Med prvim in drugim izborom zmrzlinskih klastov ni bilo bistvenih razlik kljub enoletnemu odmiku. Med zmrzlinskimi klasti smo izbirali kose s prelomi, ki so bili čim bolj svežega videza, kar se je najlepše videlo po ostrini robov in reliefa na prelomih ter različni preperelosti starih prelomnih ploskev in nove prelomne ploskve. Relativno starejši prelomi imajo vsi bolj ali manj zaobljene robove in preperelo površino. Če se je le dalo, jih nismo mešali z najmlajšimi prelomi. Manjše težave s klasifikacijo prelomov smo imeli pri ekstremno preperelih klastih v plasteh 4, 5a, 7 in 8b. V cementiranih sedimentih klasifikacija prelomov ni bila izvedljiva.

Metodo smo preverili na dveh frakcijah z zmrzlinskimi klasti dveh podobnih profilov. Frakciji sta v obeh primerih dali podoben rezultat, od katerih je eden prikazan na *sl. 5.2.5.* Zato mislimo, da lahko metodi popolnoma zaupamo. Vendar bi bilo v bodoče smiselno pojav spremljati tudi prostorsko v najdišču, podobno kot smo to storili z agregati in kostmi (Turk 2003a).

Zmrzlinski klasti nastajajo povsod, kjer zmrzuje. Zlasti pogosti so v periglacialnih področjih.

Čeprav jih imamo v skoraj vseh pleistocenskih in holocenskih jamskih najdiščih v Sloveniji, jih ni nihče sistematično preučil. V bodoče bi vsekakor priporočali, da se upoštevajo.



Sl. 5.2.6: Na podlagi deleža talnih zmrzlinskih klastov ocenjena paleotemperatura. Prikazano je odstopanje od holocenske vrednosti (= 0). Označene so glavne facije A–C. Podatki so zbrani v *tab. 5.2.1*, vključno s holocensko vrednostjo v plasti 1.Neenakomerni presledki na ordinati označujejo nezvezno vzorčene plasti, enakomerni pa zvezno vzorčene.
Fig. 5.2.6: Estimate of palaeotemperature on the basis of share of topsoil congelifracts. The deviation from Holocene value 0 is shown. Main facies A–C are marked. Data are collected in *Tab. 5.2.1*, including Holocene value in Layer 1. Uneven steps on the ordinate mark discontinuously sampled layers, and even steps continuously distributed samples by layers.

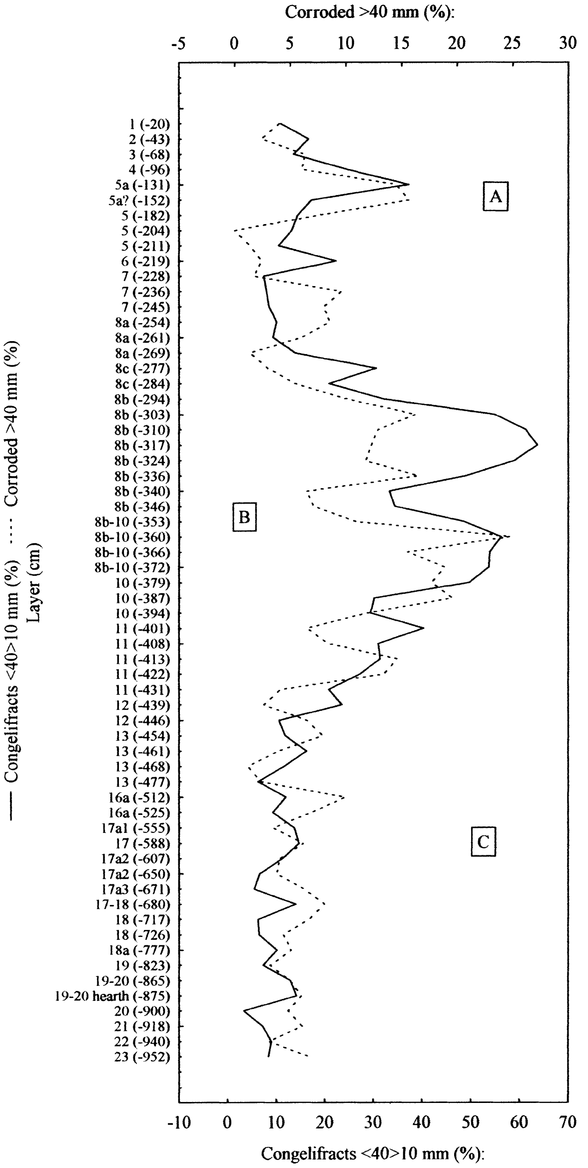
Rezultate, dobljene na podlagi analize zmrzlinskih klastov, prikazuje *sl. 5.2.6*.

Delovanje zmrzali na/v tleh smo prikazali kot odstopanje deleža zmrzlinskih klastov od holocenske vrednosti, ki je 4,4 % ±3,2 % (= 3 SE) oz. 6,5 % ±2,6 % (= 3 SE). Vrednost se nanaša na delovanje zmrzali pred več kot štirimi tisočletji. To smo ugotovili na podlagi primerjave debeline sigastih oblog na prazgodovinski keramiki in zmrzlinskih klastih.

Za zgornji del profila (facies A–B) je značilen večji delež zmrzlinskih klastov kot za spodnji (facies C). To pomeni hladnejšo oz. toplejšo klimo, kar se popolnoma ujema z datiranjem plasti v obeh delih profila v izotopsko stopnjo MIS 3 in 5 (glej poglavje 6 v tem zborniku).

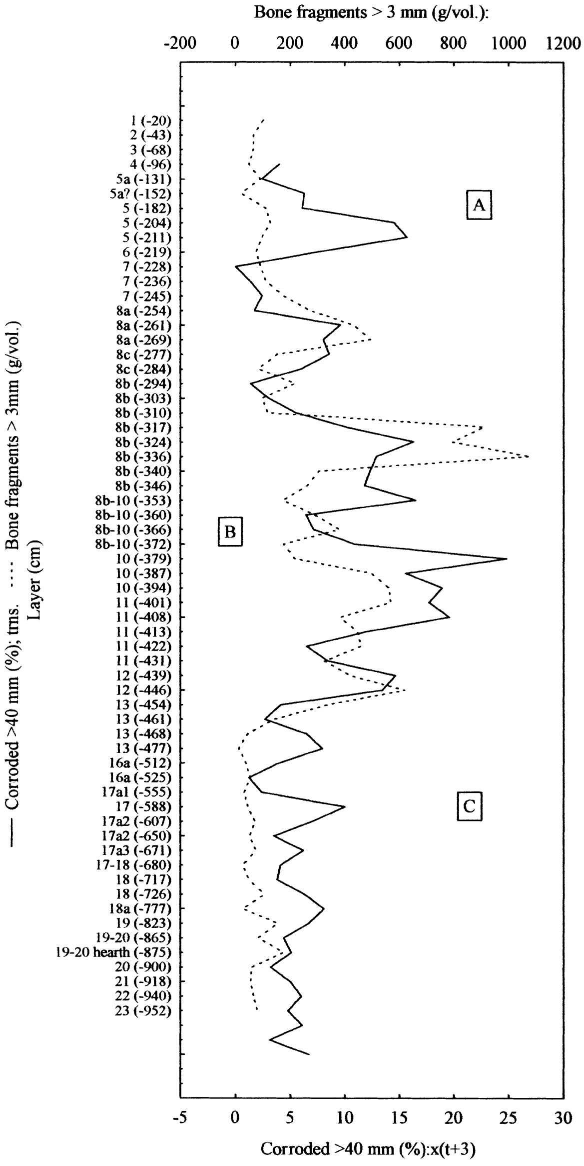
Porazdelitev zmrzlinskih klastov v profilu se zelo dobro dopolnjuje s porazdelitvijo reliefno korodiranih klastov (*sl. 5.2.7*). To je razumljivo, saj je za nastanek enih in drugih potrebna vlaga. Razen tega je pri nižjih temperaturah več kondenza kot pri višjih. Reliefno korodiranih in zmrzlinskih klastov je malo v faciji C in veliko v facijah A–B (*sl. 5.2.7*). Ker je do korozije jamskega stropa prišlo med zastojem klastične sedimentacije, je del reliefno korodiranih klastov lahko starejši od pripadajočih zmrzlinskih klastov. Del reliefno korodiranih klastov pa je verjetno posledica korozije na/v tleh. To dokazuje sorazmerno dobra korelacija med zastopanostjo najedkanih kosti in reliefno korodiranih klastov (*sl. 5.2.3*). Če je tako, obstaja resna nevarnost, da se pri razlagi reliefno korodiranih klastov vrtimo v krogu reliefno korodirani klasti – fosilni ostanki oz. da so reliefno korodirani klasti neposredno posledica kopičenja fosilnih ostankov jamskega medveda, namesto da bi bili neposredno posledica bolj vlažne klime. Ker je med reliefno korozijo klastov in fosilnimi ostanki lahko stratigrafski odmik, povezan s procesi v tleh, smo premaknili krivuljo reliefno korodiranih klastov nazaj za tri stratigrafske enote (*sl. 5.2.8*). Ujemanje obeh krivulj dopušča možnost vzročno-posledične povezave med fosilnimi ostanki (beri jamskim medvedom) in talno korozijo, ki jo lahko razlagamo na dva načina: 1.) Jamski medved je prispeval organske snovi, ki so skupaj s povečano vlažnostjo povzročile korozijo nižje ležečih klastov. Glavni vzrok za korozijo so bile organske snovi. 2.) Jamski medved je iskal zavetje v jami predvsem v dolgih obdobjih povečane vlažnosti. Glavni vzrok za korozijo je bila povečana vlažnost. Povečanje vlažnosti je nesporno dokazljivo na podlagi stropne korozije in izločanja sekundarnega kalcita v obliki tankih skorij na kosteh (*sl. 5.2.9*), klastih in reliefno korodiranih površinah, ki so bile predhodno inkrustrirane s fosfati. Slednje govori za daljša obdobja s povečano vlago oz. povečanimi padavinami, ki so se odrazila tako na stropu kot v tleh v naslednjem zaporedju procesov: reliefna korozija, fosfatna inkrustacija, siga.

Nobeneda dvoma ni, da je prisotnost jamskega medveda v najdišču povezana s klimo. Prav tako ni dvo-



Sl. 5.2.7: Primerjava med krivuljo talnih zmrzlinskih klastov in reliefno korodiranih klastov. Označene so glavne facije A–C. Podatki so zbrani v *tab. 5.2.1*, vključno s holocensko vrednostjo v plasti 1.

Fig. 5.2.: Comparison between the curves of topsoil congelifracts and cavernously corroded clasts. Main facies A–C are marked. Data are collected in *Tab. 5.2.1*, including Holocene value in Layer 1.

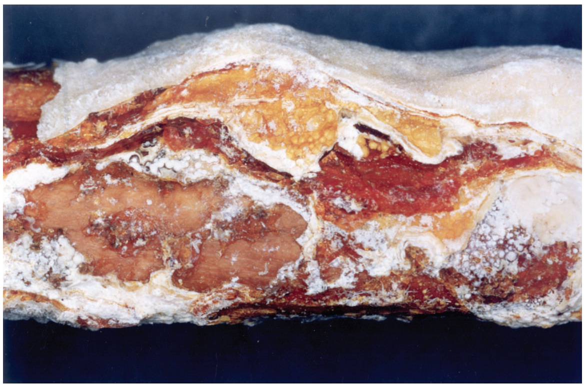


Sl. 5.2.8: Primerjava med krivuljo fosilnih ostankov in reliefno korodiranih klastov, ki je odmaknjen za 3 plasti. Označene so glavne facije A–C. Podatki so zbrani v *tab. 5.2.1*, vključno s holocensko vrednostjo v plasti 1.

Fig. 5.2.8: Comparison of curves of fossil remains and cavernously corroded clasts laged by 3 layers. Main facies A–C are marked. Data are collected in *Tab. 5.2.1*, including Holocene value in Layer 1.

ma, da so ostanki jamskega medveda povratno vplivali na sedimente, kar zlasti velja za reliefno korodirane klaste in avtigene fosfatne agregate oz. talne novotvorbe. Zato je poučna primerjava med opredelitvijo klime na podlagi agregatov in zmrzlinskih klastov na eni strani ter fosilnimi ostanki in zmrzlinskimi klasti na drugi strani (*sl. 5.2.10*).

Če izhajamo iz talnih zmrzlinskih klasov oz. približkov za paleotemperaturo, v domnevno suhi in zmerno topli klimi izotopske stopnje MIS 5 med temperaturo in jamskim medvedom ni povezave. Zmerna temperaturna nihanja niso bistveno vplivala na prisotnost in umrljivost jamskega medveda. V domnevno vlažni ali suhi in hladni ali zmerno topli klimi izotopske stopnje MIS 3 je med temperaturo in jamskim medvedom izrazita pozitivna korelacija. Edina izjema je plast 5a. Prisotnost in umrljivost jamskega medveda je absolutno bistveno večja v toplih obdobjih kot v hladnih. Plasti facije A in B kažejo, da je kostnih ostankov več v toplih obdobjih in manj v hladnih. Izjema je plast 5a.

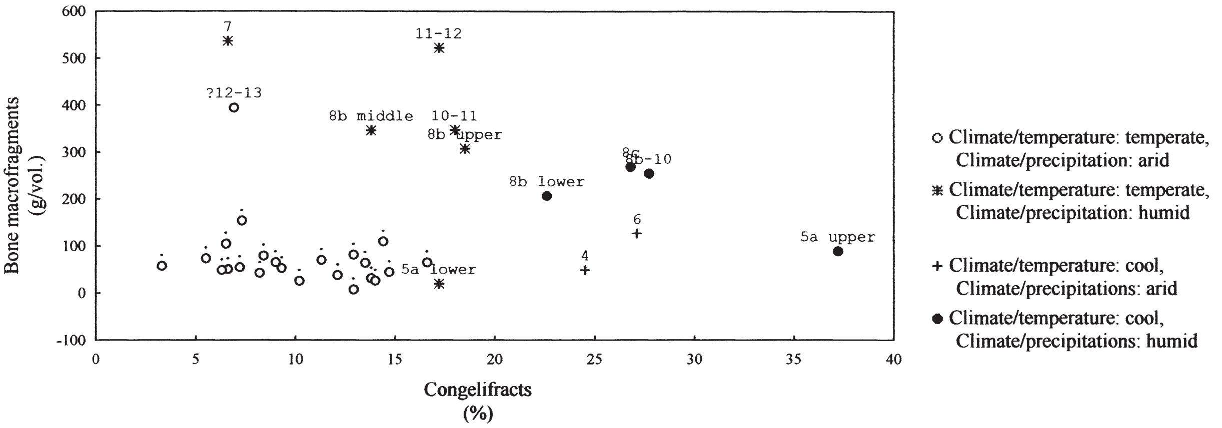


Sl. 5.2.9: Rebro jamskega medveda iz plasti 8b (kvadrat 21, reženj -309 cm) z menjajočimi se rdečkastimi fosfatnimi in belimi kalcitnimi oblogami. Fosfatne obloge imajo želatinast videz. Fotografija I. Turk.
Fig. 5.2.9: Rib of cave bear from Layer 8b (quadrat 21, cut -309 cm) with alternating reddish phosphate and white calcite encrustation. The phosphate coatings have gelatinous appearance. Photograph I. Turk.

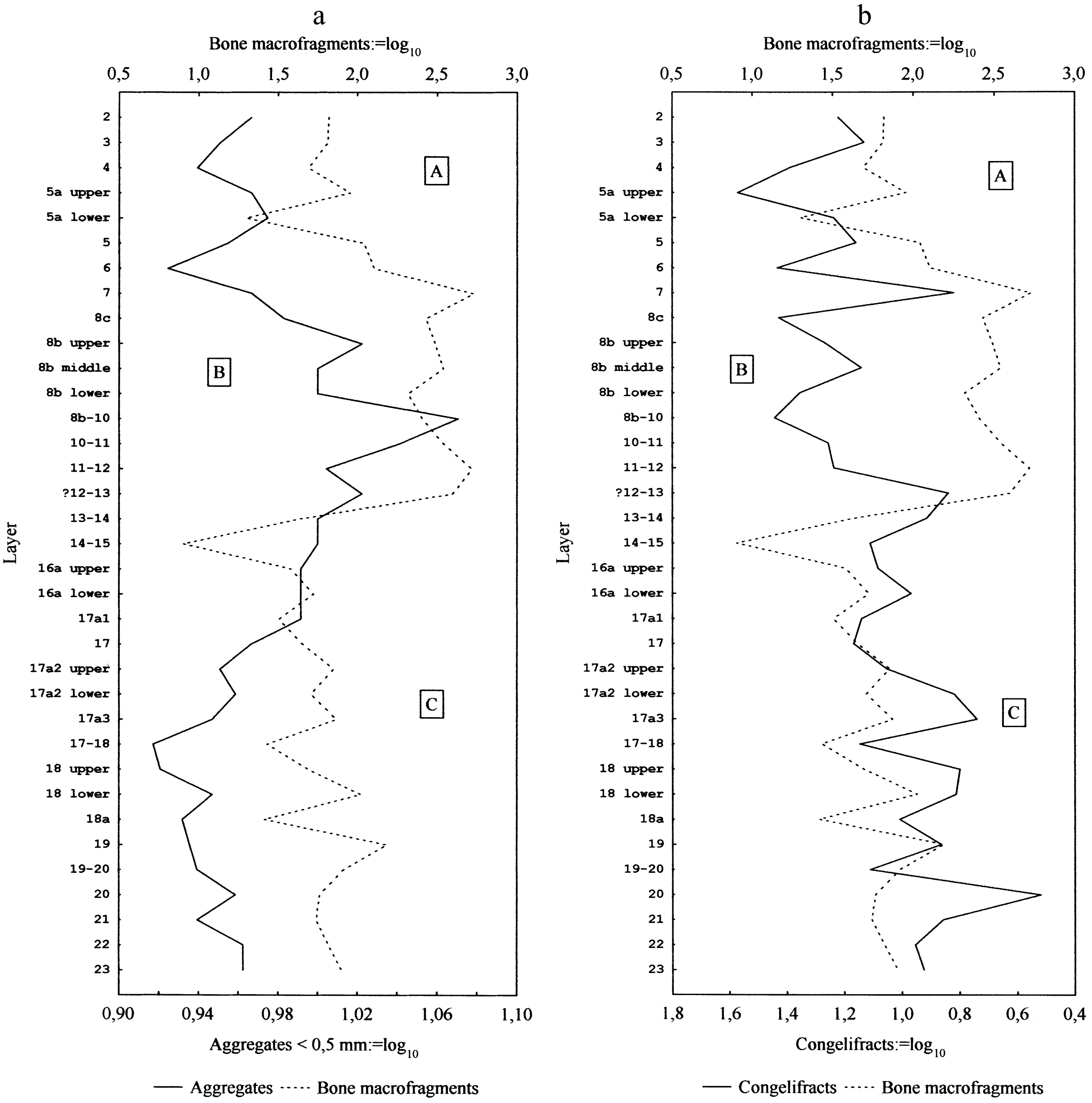
V hladnih in vlažnih obdobjih je ostankov manj kot v toplih in vlažnih.

Če približke paleotemperature zamenjamo s približki paleovlage (glej podpoglavje 5.3 v tem zborniku), velja, da je kostnih ostankov več v vlažnih fazah in manj v suhih. V tistih plasteh facije B, ki pripadajo topli in vlažni klimi, je med približki paleotemperature in kostnimi ostanki pozitivna povezava (*sl. 5.2.10* in *5.2.11a*), med približki paleovlage in kostnimi ostanki pa izrazita negativna povezava (*sl. 5.2.11b*). V preostalih plasteh MIS 3 ni posebnega odnosa med klimo in jamskim medvedom.

V krioturbatno nagubanih plasteh 2–5a je delež postsedimentnih zmrzlinskih klastov takšen kot v vseh drugih plasteh zgornjega dela profila. Proti pričakovanju se njihov delež ni povečal. Zato sklepamo, da je v plasteh 2–5a nastal permaforst brez aktivnega sloja, ki bi se poleti odtajal in pozimi ponovno zamrznil. V jamskem okolju in zaradi senčne lege jamskega vhoda je bilo to mogoče. Krioturbacija bi v takšnih pogojih nastopila pri postopni zamrznitvi in postopni odmrznitvi sedimentov vseh prizadetih plasti. To se je sicer lahko nekajkrat ponovilo, vendar vedno brez pravega aktivnega sloja, v katerem bi bilo bistveno več postsedimentnih zmrzlinskih klastov, kot smo jih dejansko ugotovili v nagubanih plasteh 2–5a. Če je bilo tako, so neutemeljena razmišljanja o izdatnejšem polzenju (geliflukciji) sedimentov, ki tvorijo plasti 2–5a.



Sl. 5.2.10: Grafični prikaz odnosa med talnimi zmrzlinskimi klasti, kostnimi ostanki jamskega medveda in domnevnimi tipi klime na podlagi zmrzlinskih klastov in agregatov, večjih od 0,5 mm in manjših od 3 mm. Vsi podatki so zbrani v *tab. 5.2.2*.
Fig. 5.2.10: Graphic presentation of the relations among topsoil congelifracts, bone remains of cave bear and presumed climate types on the basis of topsoil congelifracts and aggregates larger than 0.5 mm and smaller than 3 mm. All data are collected in *Tab. 5.2.2*.



Sl. 5.2.11a, b: Primerjava med krivuljama fosilnih ostankov in talnih zmrzlinskih klastov (a) ter agregatov v frakciji, manjši od 0,5 mm (b). Označene so glavne facije A–C. Podatki, ki so prikazani kot časovna vrsta, tako da iz njih odsevata trend in cikličnost, so preračunani iz *tab. 5.2.2.*

Fig. 5.2.11a, b: Comparison between the curves of fossil remains and topsoil congelifracts (a) and aggregates in the fraction smaller than 0.5 mm (b). Main facies A–C are marked. Data, which are shown in a time series graph so that cyclical and trend data pattern are reflected in them, are calculated from *Tab. 5.2.2.*

5.3. AGREGATI, BREČE IN KLIMATOSTRATIGRAFIJA

Izvleček

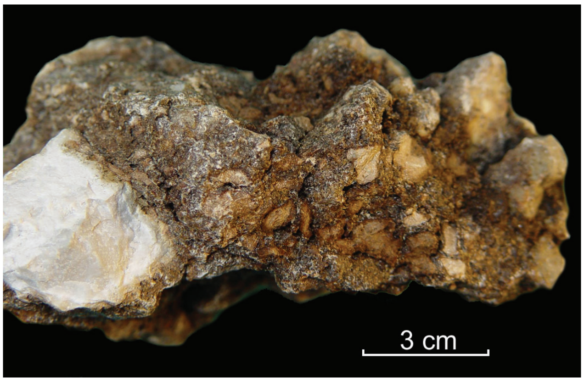
Nekatere teme, ki jih obravnava to podpoglavje, so bile že opisane in prevedene v angleščino v Turk et al. 2005a in Turk 2003a; 2006. Avtigeni talni agregati so nam služili kot približek paleovlažnosti, pri čemer se rezultati dobro ujemajo s približki paleovlažnosti na podlagi reliefno korodiranih klastov (*sl. 5.3.4a*). Tako pri nastanku agregatov kot reliefno korodiranih klastov je odigral določeno vlogo jamski medved, ki je prispeval fosfatno vezivo in organske kisline (*sl. 5.3.4b, 5.3.5a,b*). Na podlagi talnih zmrzlinskih klastov in agregatov smo dobili klimatogram najdišča (*sl. 5.3.6*). Klimatska približka za paleotemperaturo in paleovlažnost kažeta, da so bila hladnejša obdobja praviloma vlažnejša, kar pomeni, da je bilo tudi več padavin. To se ne ujema z večino dosedanjih razlag klime v mlajšem pleistocenu na podlagi jamskih sedimentov in s simulacijo klime v izotopski stopnji MIS 3 za Sredozemlje in jugovzhodno Evropo na podlagi heterogenih podatkov iz 380 paleolitskih najdišč (Barron *et al.* 2003).

Posebnost v sedimentih so breče v plasteh 6, 7, 8, 10, 16, 16a, 18, 18a, 19, 20, 22–24 in 26. Breče v plasteh 6/7, 8a, 8c/8b in 8b–10 vsebujejo več fosforja, ki izvira pretežno iz bioapatita. Vsebnost fosforja v breči ni vezana na določen tip klime. Razen tega se sporadično pojavljanje breč v profilu najdišča ne ujema z ocenami paleovlažnosti.

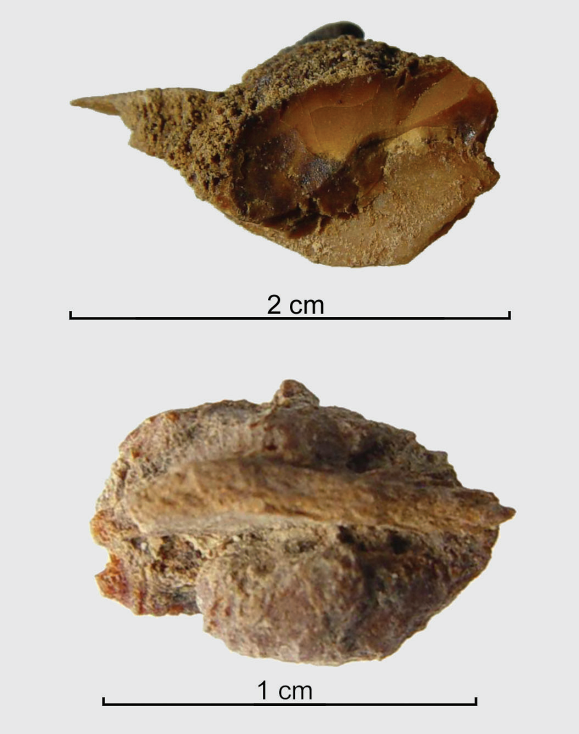
Avtigeni agregati, ki so nastali z diagenetskimi procesi v jamskih tleh s sodelovanjem vode in cementa, so značilne talne novotvorbe. Čeprav predstavljajo samo neznaten delež klastičnih sedimentov, so lahko zelo pomembni za ugotavljanje paleovlažnosti oz. paleopadavin. Agregati nastopajo v vseh drobnejših frakcijah in so tudi sestavni del breč (*sl. 5.3.1*). Zgrajeni so iz drobnih klastov, mikroskopskih drobcev kosti in cementa. Pogoste so novotvorbe iz čistega fosfatnega cementa. V slednjih so v določenih primerih cementirani večji kostni in dolomitni fragmenti (*sl. 5.3.2*), pa tudi dlake (glej poglavje 13 v tem zborniku).

Delež agregatov smo določili s pomočjo prostorninske mase (gostote) v frakciji 0,5–3 mm, pri čemer je gostota obratno sorazmerna s količino agregatov. Izbor frakcije je bil izključno praktične narave, saj smo to frakcijo dobili pri spiranju sedimentov na sitih. Razen tega smo lahko uspešno vizualno nadzorovali vsebnost agregatov in njeno prostorsko variabilnost. Ta frakcija ima najmanjše masne deleže med vsemi frakcijami. Gibljejo se od najmanj 1,4 % v plasti 10–11 do največ 14,8 % v krovni plasti 8b–10.

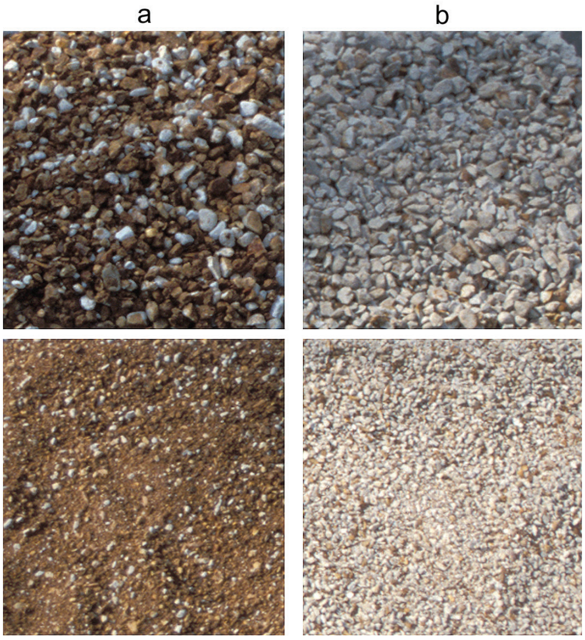
Agregati kot približek paleovlažnosti so bili določeni v premešanem sedimentu vzorca, tako da predstavljajo povprečje vzorca (*sl. 5.3.3a, b*). Gostota frakcije 0,5–3 mm je največ 1,54 g/cm^3 (dolomitni klasti brez agregatov) in najmanj 0,82 g/cm^3 (agregati brez dolomitnih klastov). Napaka pri določevanju gostote je znašala največ ± 0,05 g/cm^3 ali 3,2 % do 6 % glede na razpon volumenske mase. Vzorčevanje je potekalo tako v profilih kot sedimentacijskih nivojih, kar je omogočilo dober vpogled v variabilnost, povezano s časom in prostorom (Turk 2003a). Podobno kot pri talnih zmrz-



Sl. 5.3.1: Breča iz plasti 8a, ki vključuje agregate (sedimentne novotvorbe) do velikosti 10 mm in več. Fotografija i. Turk.
Fig. 5.3.1: Breccia from Layer 8a, which includes aggregates (diageneticaly formed particles) up to 10 mm and more. Photograph I. Turk.



Sl. 5.3.2: Kostni drobci v fosfatnem cementu želatinastega izgleda. Fotografija I. Turk.
Fig. 5.3.2: Bone fragments in the phosphate cement of gelatinous appearance. Photograph I. Turk.

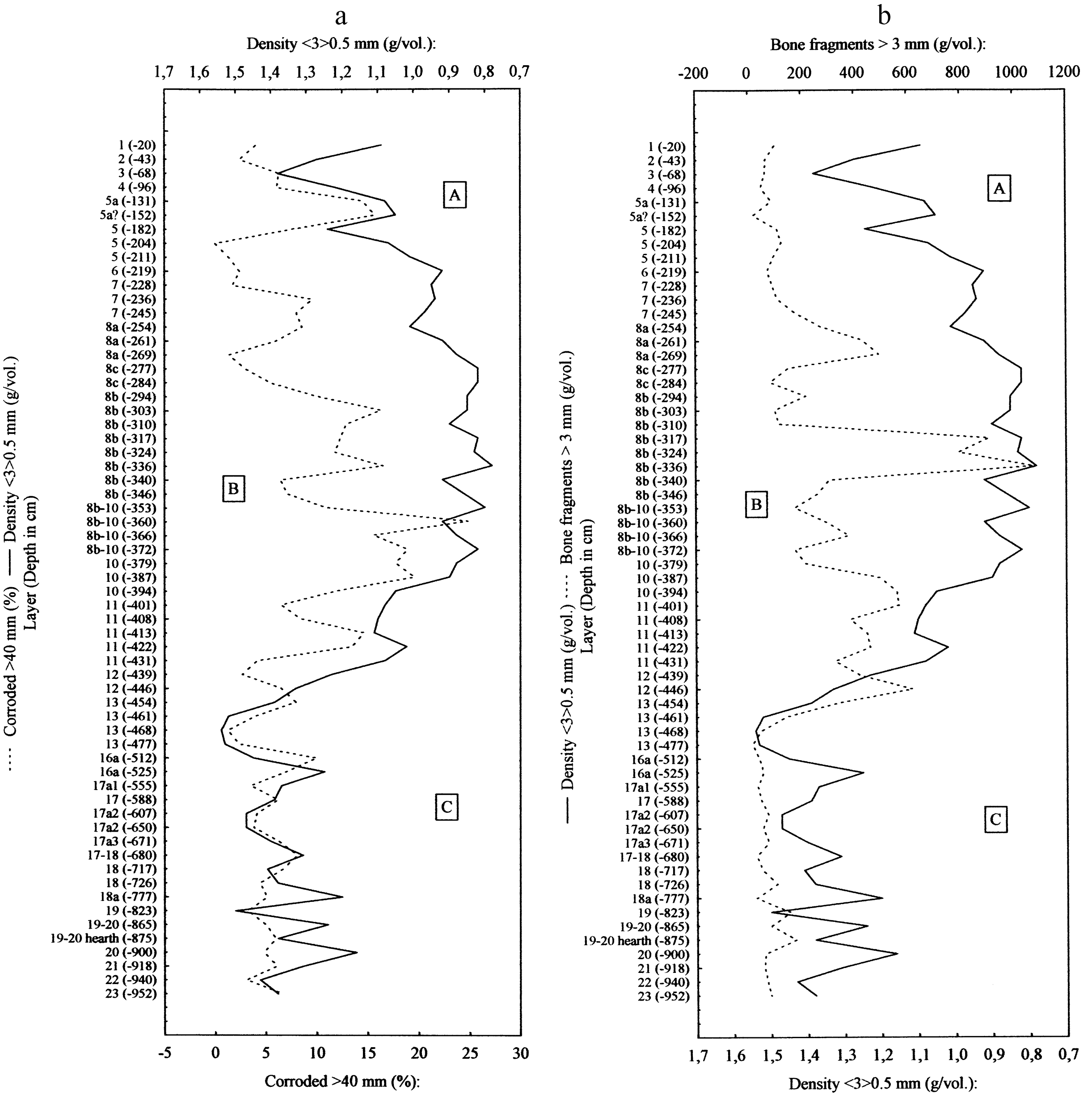


Sl. 5.3.3a, b: Sedimentni frakciji 0,5–3 mm in 3–10 mm, v kateri prevladujejo bodisi agregati, plast 7 (a) bodisi dolomitni klasti, plast 6 (b). Fotografija I. Turk.
Fig. 5.3.3a, b: Sedimentary fraction 0.5–3 mm and 3–10 mm, in which either aggregates, Layer 7 (a) or dolostone clasts, Layer 6 (b) predominate. Photograph I. Turk.

linskih klastih tudi pri agregatih nismo mogli odpraviti učinka neenakomerne sedimentacije, zaradi katerega je lahko v posameznih nivojih več agregatov kot v drugih.

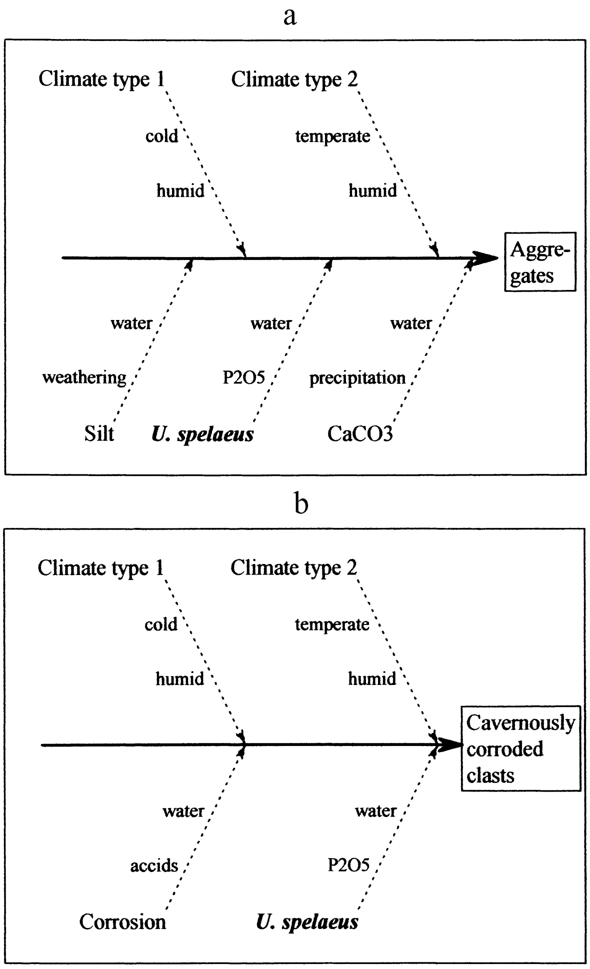
Pri agregatih, ki vsebujejo pretežno fosfatne cemente, je vprašljiv njihov nastanek in posledično uporaba zastopanosti agregatov kot približka za paleovlažnost. Ni namreč jasno, ali so agregati, avtocikliči in vzročno povezani z življenjem in smrtjo jamskega medveda, ki je prispeval fosfor, ali alociklični in vzročno povezani s klimo ali gre za kombinacijo obojega, kar bi bilo še najverjetneje (prim. tudi Turk 2003a, 2006).

Krivulji agregatov in reliefno korodiranih klastov sta podobni. Obe kažeta močno povečano vlažnost v faciji B in podoben trend vrednosti v večjem delu profila (*sl. 5.3.4a*). Krivulja fosilnih ostankov jamskega medveda ne kaže trenda v odnosu z agregati in reliefno korodiranimi klasti (*sl. 5.3.4b*), pač pa se vrhunci v faciji B ujemajo s povečano vlažnostjo, izraženo z agregati in reliefno korodiranimi klasti. Bočno preverjanje vsebnosti agregatov in fosilnih ostankov jamskega medveda po sedimentacijskih nivojih je odkrilo še večjo podobnost, pa tudi sinhronost med krivuljo agregatov in fosilnih

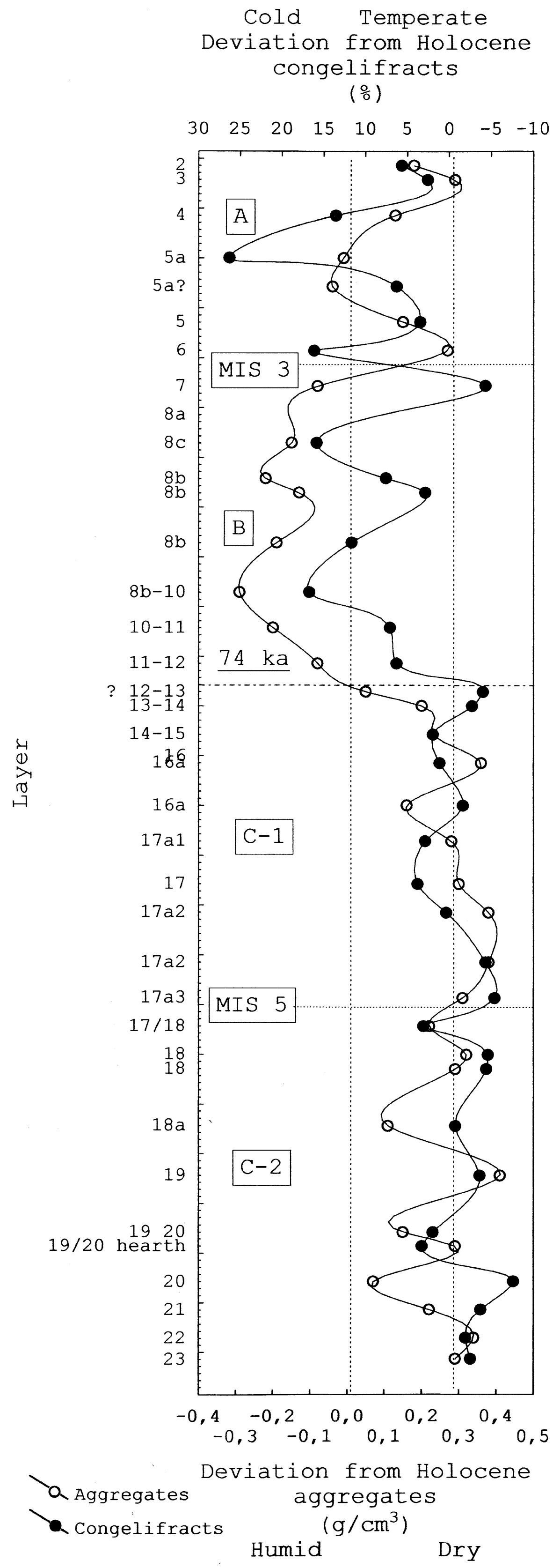


Sl. 5.3.4a, b: Primerjava med krivuljama zastopanosti reliefno korodiranih klastov in agregatov (a) ter med krivuljo fosilnih ostankov in agregatov (b). Označene so glavne facije A–C. Podatki so zbrani v *tab. 5.2.1*, vključno s holocensko vrednostjo v plasti 1.

Fig.5.3.4a, b: Comparison between curves of shares of cavernously corroded clasts and aggregates (a) and between the curves of fossil remains and aggregates (b). Main facies A–C are marked. Data are collected in *Tab. 5.2.1*, including Holocene value in Layer 1.



Sl. 5.3.5a, b: Diagram, ki prikazuje možne vzroke za nastanek agregatov (a) in reliefno korodiranih klastov (b) v jamskih tleh.
Fig. 5.3.5a, b: Cause and effect diagram showing possible causes of the formation of aggregates (a) and cavernously corroded clasts (b) in the cave topsoil.



▷▷
Sl. 5.3.6: Potek domnevnih sprememb paleotemperature na podlagi zastopanosti talnih zmrzlinskih klastov in paleovlage na podlagi zastopanosti avtigenih agregatov v plasteh sestavljenega profila in njihovo odstopanje od holocenske vrednosti. Označene so facije (A, B) in subfacije (C-1, C-2). Podatki so zbrani v *tab. 5.2.2.* Holocenski vrednosti sta podani v *tab. 5.2.1.* Neenakomerni presledki na ordinati označujejo nezvezno vzorčene plasti.
Fig. 5.3.6: Course of presumed changes in palaeotemperature on the basis of portion of topsoil congelifracts and palaeohumidity on the basis of portion of authigenic aggregates in layers of the composite profile and their deviation from Holocene value. Facies (A, B) and sub-facies (C-1, C-2) are marked. Data are collected in *Tab. 5.2.2.* Holocene values are given in *Tab. 5.2.1.* Uneven steps on the ordinate mark discontinuously sampled layers.

ostankov (Turk 2003a, sl. 6). Pojav agregatov in reliefno korodiranih klastov lahko razložimo z interakcijo sediment, jamski medved, klima (*sl. 5.3.5a, b*). Vsekakor gre bolj za alociklične kot avtociklične spremembe, na katere je vplivala klima, natančneje vlažnost oz. padavine. Kot je razvidno s *sl. 5.3.5a* in *b* imajo isti vzroki lahko različne posledice, da en vzrok sproži posledico, pa je včasih potreben medsebojni vpliv več vzrokov.

Klimatska približka za paleotemperaturo in paleovlažnost kažeta, da so bila hladnejša obdobja praviloma vlažnejša, kar pomeni, da je bilo tudi več padavin (*sl. 5.3.6*). To se ne ujema z večino dosedanjih razlag klime v mlajšem pleistocenu na podlagi jamskih sedimentov in s simulacijo klime v izotopski stopnji MIS 3 za Sredozemlje in jugovzhodno Evropo na podlagi heterogenih podatkov iz 380 paleolitskih najdišč (Barron *et al.* 2003). Po drugi strani je naš rezultat skladen s predvidenimi spremembami v klimatskem minimumu oz. poznem ali zadnjem glacialnem vrhuncu (LGM – *Late* ali *Last Glacial Maximum*) na podlagi drugačnega (meteorološkega?) modela. Klima v zmernem pasu (med 35° in 50° zemljepisne širine) bi bila tedaj vlažnejša kot današnja zaradi spremembe v kroženju zračnih mas in prerazporeditve klimatskih pasov (Reading, Levell 1996, 10, sl. 2.1b).

S fosfatnimi agregati so genetsko povezane breče oz. cementiranje klastičnih sedimentov v plasteh 6, 7, 8, 10, 16, 16a, 18, 18a, 19, 20, 22–24 in 26 s pretežno fosfatnim cementom. V vhodnem predelu jame so bili cementirani samo manjši deli posameznih plasti predvsem v plasti 8, v osrednjem predelu pa je breča v plasti 8 obsegala skoraj vso odkopano površino. Ta breča s karbonatno-fosfatnim vezivom pripada dvema glavnima fazama cementiranja, ki ju prekinja nesprijeta mešanica dolomitnega grušča, peska in melja. Starejša faza je obsegla plasti 8 in 10 (plast 9 je lokalnega značaja), mlajša pa plasti 6 do 8. Vsaka posamezna faza ni nujno enotna, saj pripadajoče breče ponekod prekinjajo manjši vložki nesprijetih usedlin, ki jih ne moremo istovetiti z glavnim medfaznim paketom nekonsolidiranih sedimentov. Ta se razteza nad/pod 46 % cementirane površine. Na 27 % te površine je ekstremno preperel grušč (t. i. fantomski grušč). Med obe glavni fazi cementiranja se verjetno vriva še tretja, manj izražena faza, ki obsega približno 10 %, vse odkopane površine (Turk, Bastiani 2000). Tri faze cementiranja se dobro ujemajo s tremi fazami stropno-talne korozije, izražene z reliefno korodiranimi klasti v plasteh 7–10, ki predstavljajo količino padavin (glej *sl. 5.2.7*). Po vseh znakih sodeč, je šlo v faciji B za ekstremno vlažno klimo.

Plasti nad zgornjo brečo v plasti 8 niso nikjer več cementirane. Izjema so sedanja jamska tla, ki so ponekod zasigana. Pod območjem holocenske sige nismo do vključno plasti 16 nikjer naleteli na starejšo zasigano površino, ki bi jo lahko povezali s kakim izrazito vlažnim obdobjem zadnjega glaciala ali z zadnjim, pravilneje predzadnjim interglacialom (OIS/MIS 5e). Prve skromne sige se pojavijo šele v plasti 17/18, ki je v bistvu sestavljena iz nekonsolidiranih drobnih skupkov sige oz. t. i. drobtinčaste sige ali kalcitnih agregatov.

Breče v različnih plasteh profila Divjih bab I je težko povezati v smiselno celoto z drugimi klimatskimi in okoljskimi kazalci. Klasifikacija cementiranih plasti po vzoru klasifikacije na podlagi analize približkov klime, podane s talnimi zmrzlinskimi klasti in fosfatnimi agregati, je pokazala, da breče nimajo povezave z oceno klime kot celote, sestavljene iz temperature in padavin (Turk 2006). V primerih, kjer pride do delnega sovpadanja, kot npr. v plasti 8, v kateri tako agregati kot breča in reliefno korodirani klasti ter izjedkane kosti govorijo za ekstremno vlažno klimo, je to zgolj naključje. Zato se nagibamo k mnenju, da je bila klima v času nastajanja plasti facije C bolj suha kot v času nastajanja facij A in B, kljub pogostejši cementaciji sedimentov, do katere je verjetno prišlo naknadno in s precejšnim časovnim odmikom od nastanka plasti.

Cementiranje je proces, ki praviloma poteka postopno od cementiranja najmanjših delcev (nastanek agregatov) do največjih (breč). Največ fosfatnega cementa, ki je hkrati najčistejši, je v brečah. Kemijsko sestavo cementov v različnih plasteh profila Divjih bab I prikazuje *tab. 5.3.1.* V analizo, ki so jo naredili v laboratorijih ACME *Analytical laboratories LTD* v Kanadi z metodo ICP (*inductively coupled plasma emission spectrometry*), je bilo dano čim čistejše vezivo (cement) breč, po možnosti brez klastične dolomitne komponente. Kljub pazljivemu vzorčevanju pa se v nekaterih primerih nismo mogli izogniti dolomitnim klastom, ki so fosfatni cement kontaminirali.

V prvi vrstici *tab. 5.3.1* so vrednosti, ki bi se glede na naše meritve v samem najdišču nabrale v tisoč letih na enem kvadratnem metru v usedlini, izločeni iz skozi strop jame pronicajoče vode[4]. Označili smo jih kot moderni standard. Vse vrednosti elementov modernega standarda so bolj ali manj primerljive z vrednostmi v sedimentnem profilu. Edina izjema je baker. V modernem standardu je velika tudi žaroizguba, predvsem zaradi vsebnosti organskih snovi, ki jih ponazarja ogljik, količina katerega znaša kar 30,6 %.

Plast 1 je kalcitna siga, ki se še vedno tvori v jami. Značilne zanjo so velika vsebnost CaO, velika žaroizguba in majhne vrednosti vseh elementov, predvsem stroncija.

Za poznavanje diageneze breč so pomembne tudi frakcije sipkega sedimenta, ki vsebujejo agregate, ki predstavljajo zgodnjo fazo cementiranja. Zato smo analizirali cemente breč in frakcije v istih plasteh, tako da frakcije pripadajo približno enakim stratigrafskim nivojem kot cement breč (*tab. 5.3.2*).

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[4] Frakcijo manjšo od 0,5 mm, ki jo danes prinaša skozi strop pronicajoča voda, smo vzorčili v razdobju 7 let v osrednjem predelu jame na površini veliki 150 m^2. Na podlagi prvin v usedlini, ki se je nabrala v pretočni akumulacijski posodi, velikosti 1x1x1 m, smo izračunali vnos eksogenih prvin na kvadratni meter površine v tisoč letih.

Tab. 5.3.1: Kemijska sestava cementov v brečah iz različnih plasti. Oksidi in žaroizgube so v %, sledni elementi v ppm.
Tab. 5.3.1: Chemical composition of cements in breccia from various layers. Oxides and loss on ignition (LOI) are in %, trace elements in ppm.

	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	P_2O_5	LOI	Cd	Co	Rb	Sr	Th	U	Zr	Cu
Modern sample	**1**	**0.5**	**3.9**	**14.7**	**0.17**	**0.95**	**70.5**	**2.4**	**0.6**	**7.6**	**25.6**	**0.6**	**0.8**	**11.2**	**2207.1**
Layer 1 (dripstone)	0.22	0.1	2.71	51.47	0.06	1.2	43.5	0.8	0.6	2.9	36.1	< 0.1	0.2	4	4.7
Layer 6	1.24	0.48	5.92	41.78	0.23	21.3	26.2	1.7	2.4	9.9	119	1.4	1.2	13.4	95.1
Layer 6/7	1.17	0.44	1.75	49.15	0.2	29.1	16.2	1.5	2.2	7.6	145.8	1.2	1.2	11.7	132.3
Layer 8a	1.12	0.45	1.99	46.24	0.25	26.97	19.6	1.5	2.4	8.5	133.9	1	2.6	12.7	138.4
Layer 8a	1.02	0.57	1.76	48.93	0.16	29.22	16.8	1.2	3.4	6.8	157.2	0.9	1.4	11.3	165.6
Layer 8a	1.33	0.48	1.6	46.78	0.24	28.82	16.8	1	2.3	9.2	145	1.7	1.3	13.9	142.5
Layer 8c/8b*	1.55	0.63	1.53	47.2	0.27	27.56	17.5	0.9	2.6	10.6	147.4	1.2	3.2	18.4	145.1
Layer 8c/8b*	1.61	0.71	1.91	45.13	0.27	29.89	17.3	2.5	2.4	11.6	159	1.5	2.5	17.8	172.3
Layer 8c/8b*RE	1.58	0.72	1.86	45.25	0.26	29.65	17.5	2.1	2.6	10.8	161.7	1.4	2.2	16.6	158.4
Layer 8c/8b*	1.45	0.58	1.51	45.78	0.25	28.12	17.9	0.8	2	10.6	147.1	1.5	1.2	18	164.3
Layer 8b-10	1.02	0.38	1.53	47.2	0.18	23.39	23	0.7	2.8	7.2	119.9	0.9	1	12.2	66.2
Layer 10-12	1.31	0.45	7.1	40.9	0.22	17.89	28.8	1	2.1	9.3	93	1.6	1.2	15.6	46.3
Layer 13	1.45	0.52	4.84	42.82	0.27	20.41	25.9	0.8	1.5	10.8	104.3	1.6	0.9	18.5	51.4
Layer 13 RE	1.52	0.55	5	42.02	0.25	20.8	25.8	0.8	1.4	8.9	107.4	1.6	1.1	17.6	54.8
Layer 18	1.32	0.47	7.69	39.83	0.28	17.82	29.5	1.5	3.9	11.3	108.4	1.3	5.5	18.9	61.3
Layer 18a/19	1.31	0.45	6.24	41.56	0.28	20.23	26.7	2.2	2.4	9.9	103.9	1.7	3.2	14.7	102.5
Layer 25	1.5	0.33	7.69	39.83	0.28	17.39	28.7	1	1.2	9.4	92.2	1	2.6	13.7	45.8

* Isti sedimentacijski nivo.
RE = Ponovljena meritev na istem vzorcu.
* The same sedimentation level.
RE = Repeat measurement on the same sample.

Tab. 5.3.2: Geokemijska sestava frakcije, manjše od 0,5 mm, frakcije 0,5–3 mm in cementa v breči. Vrednosti za okside in žaroizgube so podane v utežnih %, preostale pa v ppm. Legenda: **0,5** je frakcija, manjša od 0,5 mm. **3** je frakcija 0,5–3 mm. **Br.** je breča.
Tab. 5.3.2: Geochemical composition of the fraction smaller than 0.5 mm, the fraction 0.5–3 mm and cement in breccia. Values for oxides and loss on ignition are given in weight %, the remainder in ppm. Legend: **0.5** is the fraction smaller than 0.5 mm, **3** is the fraction 0.5–3 mm. **Br** is breccia.

	0.5: MgO	3: MgO	Br.: MgO	0.5: CaO	3: CaO	Br.: CaO	0.5: P_2O_5	3: P_2O_5	Br.: P_2O_5
Modern standard	**3.9**			**14.7**			**0.95**		
Layer 6	2.85	18.36	5.92	47.03	33.33	41.78	28.87	3.88	21.3
Layer 7	8.16	10.76	1.75	35.15	34.89	49.15	17.67	15.55	29.1
Layer 8c	9.43	7.26	1.53	37.9	40.85	47.2	15.12	19.74	27.56
Layer 8b upper	12.42	5.7	1.91	33.1	41.21	45.13	9.97	20.67	29.89
Layer 8b-10*	8.84	6.49	1.53	37.21	40.24	47.2	16.34	19.01	23.39
Layer 8b-10*	9.4	3.86	1.53	37.44	43.39	47.2	15.45	22.45	23.39
Layer 11-12	10.35	7.88	7.1	34.99	38.75	40.9	12.71	17.98	17.89
Layer 12-13	10.63	10.67	4.84	34.71	37.6	42.82	12.33	14.05	20.41
Layer 18 upper	16.43	18.97	7.69	31.89	32.72	39.83	4.64	1.82	17.82
Layer 19	15.28	15.36	6.24	32.86	35.19	41.56	6.01	6.2	20.23

* Različna vzorca iste plasti.
* Two various samples of the same layer.

Za pravilno razumevanje geokemije frakcij in breč je treba poznati sestav in lastnosti analiziranih frakcij.

Frakcija 0,5–3 mm je sestavljena iz agregatov, dolomitnih klastov in kostnih drobcev. Agregati so avtigene novotvorbe, ki so nastale *in situ* v zgodnji diagenezi jamskih sedimentov. Sestavljajo jih jamski sedimenti, povezani s fosfatnim cementom. Jamski sediment je pretežno iz dolomitnih klastov in različnih alohtonih primesi. Deleži prvin v frakciji variirajo predvsem zaradi različnih razmerij komponent, ki sestavljajo frakcijo 0,5–3 mm.

Frakcija, manjša od 0,5 mm, je sestavljena podobno kot frakcija 0,5–3 mm, vendar z možnim dodatkom eksogenih novotvorb in razpadlih avtigenih agregatov. Deleži prvin v frakciji variirajo iz podobnih razlogov kot pri debelejši frakciji.

V vseh frakcijah in v breči je bistveno manj Al_2O_3, Fe_2O_3, SiO_2 in drugih oksidov ter redkih zemelj, značilnih za preperine, ki sestavljajo pokarbonatna tla v bližnji okolici (glej poglavje 3 v tem zborniku, *tab. 3.1*). To nesporno dokazuje, da v času nastanka vsake posamezne plasti ni prišlo do bistvenega spiranja preperine nad jamo v jamo (glej tudi Turk 2006 in podpoglavje 5.4 v tem zborniku), in sicer zaradi specifičnega reliefa nad jamo, ki je pogojeval stalno erozijo tal. Divje babe I predstavljajo tako redek primer skoraj popolnoma avtohtone, izjemno debele jamske sedimentacije v karbonatnem okolju. To pa je lastnost, ki bi jo veljalo v prihodnje vsekakor bolje izkoristiti.

5.4. GEOKEMIJSKA ANALIZA PEŠČENO-MELJASTE FRAKCIJE SEDIMENTA

Izvleček

Tema tega podpoglavja je bila delno obravnavana in predvedena v Turk 2006. V peščeno-meljasti frakciji smo analizirali tri skupine kemičnih prvin, domnevno različnega izvora (*sl. 5.41-5.4.5*).

Razmerje med kalcijem in stroncijem (*sl. 5.4.4*) se v profilu spreminja enako kot se spreminja vsebnost fosfatnih agregatov (glej podpoglavje 5.3 v tem zborniku, *sl. 5.3.6*). Vse skupaj pa je povezano z variabilnostjo vlage oz. padavin in omogoča delitev profila na že predlagane štiri dele (facije in subfacije). Facija A in subfacija C-2 sta si podobni. Nekaj posebnega sta facija B in predvsem subfacija C-1, kar se tiče vsebnosti kalcija in stroncija ter njunega razmerja (*sl. 5.4.4*).

Med izkopavanji v letih 1990–1999 smo med drugim sistematično vzorčili frakcijo manjšo od 0,5 mm, ki smo jo geokemijsko zvezno analizirali v sestavljenem profilu (*tab. 5.4.1*)[5] in režnjih kvadrata 36 (Turk 2006). Analizirana frakcija predstavlja najgiblivejši del sedimenta, ki skupaj z nekaterimi drugimi frakcijami zapolnjuje pore med večjimi klasti in bloki.

Temeljna značilnost geokemijske sestave frakcije, manjše od 0,5 mm, je, da vsebuje absolutno največje deleže večine analiziranih prvin med vsemi frakcijami. Izjemo predstavljajo samo Zn, Cu, Cd, Ni, MgO, CaO, P_2O_5, Sr in U. Ti so bolje zastopani v večjih frakcijah, katerih sestavni del so tudi kostni drobci in agregati, ki v večji meri vsebujejo predvsem fosfatni, redkeje kalcitni cement.

V frakciji, manjši od 0,5 mm, so možne različne alohtone primesi zaradi prinosa vode, vetra, živali in ljudi.

Voda je spirala primesi iz plitkih tal in kamnine neposredno nad jamo in jih ponovno odlagala v jamskih sedimentih. Prihajalo je tudi do premeščanja primesi znotraj profila jamskih sedimentov oz. jamskih tal. Zaradi tega je nemogoče ugotoviti pravo naravo eluvialno-iluvialnih horizontov. Posledica tega je negotova kronološka razlaga tega pojava. Izdatnejše domnevne pleistocenske preperine so na več mestih ohranjene na planoti nad jamo, vendar ne neposredno nad njo (glej poglavje 3 v tem zborniku).

Veter je prinašal peščena in manjša zrna ter aerosole iz daljne in bližnje okolice. Te sestavine so se lahko odložile neposredno zaradi delovanja vetra ali pa so jih na tla sprale padavine.

Jamski medved je na kožuhu prinesel nezanemarljive količine prahu in blata iz bližnje okolice. Poginuli medvedi so prispevali glavne bioprvine (C, H, N, Ca, P, O, K, S, Cl, Na, Mg), pa tudi sledne (Fe, Zn, Cu, Mn, Ni, Mo, Cr, Se, I, Co, F, Sn, Si, V in As). Pomembno vlogo pri diagenezi sedimentov so odigrale organske kisline, ki so nastale na podlagi bioprvin.

Človek je v kuriščih in njihovi neposredni bližini s svojimi različnimi dejavnostmi, lokalno vplival na geokemijsko sestavo sedimentov, kar so pokazale primerjalne analize med kurišči in sedimenti (neobjavljeno) (glej tudi podpoglavje 5.5 v tem zborniku). Vendar ga zaradi njegove skromne prisotnosti nismo uvrstili med vplivnejše dejavnike.

Kar zadeva novotvorbe, ugotavljamo, da so nastale izključno na/v jamskih tleh ali sedimentu in so zato avtigene. Avtigene novotvorbe so bile močno odvisne od hitrosti sedimentacije. Novotvorbe so lahko nastale avtociklično, če so nanje vplivali predvsem dejavniki, povezani s sedimenti, v danem primeru ostanki jamskega medveda, ali alociklično, če je nanje vplivala predvsem klima.

Vrednosti analiziranih prvin kažejo v profilu vzorce, značilne za posamezne skupine prvin, ki smo jih lahko ugotovili tudi z analizo glavnih komponent (PCA). Vzorci se med seboj razlikujejo na podlagi številnih faznih odmikov, medtem ko so znotraj posamezne skupine ti redkejši. Da so analitski podatki zanesljivi, smo se prepričali s primerjanjem podatkov v dveh profilih in s ponovljenim vzorčenjem v istem profilu (Turk 2006).

V prvi skupini (*sl. 5.4.1*) so minerali, ki vsebujejo SiO_2, Al_2O_3, Fe_2O_3, K_2O, Na_2O, Th, Ce, Zr in druge redke zemlje. Ta skupina predstavlja v glavnem alohtono komponento sedimenta.

V drugi skupini (*sl. 5.4.2*) so paraalohtone prvine organskega izvora ali minerali, ki vsebujejo P_2O_5, Cu, Co in Ba. V to skupino sodita tudi natrij (glej Turk 2006) in kalcij saj je kalcij ena od glavnih sestavin apatita, tj. kosti in fosfatnih cementov.

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[5] Geokemijske analize so bile izdelane v laboratorijih ACME *Analytical Laboratories LTD* v Kanadi z metodo ICP (*inductively coupled plasma emission spectrometry*): *Group 4A-Whole rock ICP analysis, Group 4B* in *Group 1DX.*

Tab. 5.4.1: Izbor geokemijskih podatkov za frakcijo manjšo od 0,5 mm. V krepkem tisku so izpisane močno izstopajoče vrednosti in vrednosti približno sočasnih vzorcev v različnih profilih. Za metodo vzorčenja glej Turk (2006).

Tab. 5.4.1: Selection of geochemical data for fraction smaller than 0.5 mm. Strongly deviating values (outlayers) and values of approximately contamporaneus samples from various profiles are written in bold type. See Turk (2006) for sampling procedure.

Layer (m)	Profile (x)	Facies	"Cu" (ppm)	"Th" (ppm)	"Zr" (ppm)	"Ce" (ppm)	"Co" (ppm)	"Ba" (ppm)	"Sr" (ppm)	"SiO$_2$" (%)	"Al$_2$O$_3$" (%)	"Fe$_2$O$_3$" (%)	"K$_2$O" (%)	"CaO" (%)	"MgO" (%)	"P$_2$O$_5$" (%)
Modern sample (150 m^2/7 y)			2317.5	0.6	11.8	5.5	0.6	28.8	26.9	3.4	1.1	0.5	0.2	15.5	4.1	1.0
Modern sample (m^2/1000 y)			2207.1	0.6	11.2	5.2	0.6	27.4	25.6	3.3	1.0	0.4	0.2	14.7	3.9	1.0
1(-0.40) dripstone			5.3	< 0.2	3.8	1.7	< 0.5	22.3	39.5	0.7	0.2	0.1	0.1	51.7	2.7	0.9
2(-0.50)	17	A	26.5	2.0	17.8	10.3	0.7	47.4	82.4	3.7	1.4	0.4	0.3	31.8	16.4	6.5
3(-0.64)	17	A	35.3	1.7	17.3	10.7	0.6	53.5	84.8	3.7	1.4	0.4	0.3	32.3	15.4	8.3
3(-0.71)	17	A	44.8	1.9	20.5	12.6	1.3	63.3	94.7	4.2	1.5	0.5	0.3	32.8	14.9	9.4
4(-0.81)	17	A	47.0	1.7	18.9	11.5	1.0	61.7	94.8	4.1	1.6	0.5	0.3	32.6	14.5	10.1
4(-0.91)	17	A	42.1	1.8	19.1	11.9	1.1	58.5	95.1	3.9	1.5	0.5	0.3	32.8	15.0	9.9
4(-1.00)	17	A	45.7	1.8	20.9	12.1	1.1	66.4	100.0	3.9	1.4	0.6	0.3	32.0	13.6	10.4
4(-1.07)	17	A	31.6	1.4	11.8	9.4	0.6	44.4	86.9	2.9	1.1	0.4	0.2	32.8	17.7	6.9
5a(-1.26)	17	A	28.4	1.2	10.9	7.6	<.5	31.1	77.2	2.1	0.9	0.2	0.2	32.0	17.6	5.7
5a?(-1.46)	17	A	40.2	1.2	11.6	7.8	2.3		84.1	2.4	1.0	0.3	0.2	34.7	14.3	8.8
5a?(-1.54)	17	A	38.4	1.2	11.5	9.0	1.2	39.9	86.1	2.3	1.0	0.2	0.2	31.5	16.2	7.6
5a?/5(-1.67)	17	A	39.1	1.5	12.7	8.8	1.0	40.8	84.8	2.5	1.1	0.3	0.2	33.7	17.5	7.4
5(-1.77)	17	A	39.5	1.4	11.1	8.8	1.1	32.9	79.7	2.5	1.0	0.3	0.2	32.1	16.4	7.3
5(-1.86)	17	A	46.1	1.3	15.2	9.7	1.3	42.9	85.5	3.0	1.2	0.3	0.2	32.0	15.9	7.7
5(-1.96)	17	A	41.8	1.9	14.0	9.5	1.0	32.5	72.7	3.3	1.3	0.2	0.2	32.2	17.3	6.0
6(-2.07)	17	A	51.2	1.5	14.2	9.7	1.2	39.2	85.5	3.1	1.2	0.4	0.2	31.1	16.9	6.6
6(-2.16)	17	A	58.6	1.2	15.7	9.1	1.6	41.9	92.5	3.0	1.1	0.4	0.2	33.3	15.9	8.6
6(-2.17)	17	A	91.8	1.5	13.1	8.7	1.3	35.6	84.8	2.7	1.1	0.4	0.2	30.8	16.9	5.8
7(-2.24)	17	A	52.0	1.5	15.2	9.7	1.8	57.4	94.0	3.2	1.2	0.4	0.2	33.8	14.2	11.3
7(-2.32)	17	B	68.6	1.6	18.0	11.2	2.4	70.8	84.0	3.9	1.4	0.6	0.3	35.5	10.8	15.8
7(-2.40)	17	B	64.8	1.7	21.9	9.7	1.8	67.3	101.3	4.2	1.5	0.4	0.3	36.3	9.8	16.8
8a(-2.52)	17	B	76.0	1.7	18.1	11.4	2.0	72.5	112.1	4.6	1.6	0.6	0.3	36.7	9.3	17.8
8c(-2.74)	17	B	83.8	1.5	18.7	11.5	1.9	66.5	112.2	3.9	1.4	0.5	0.3	35.7	9.9	17.3
8b(-2.91)	17	B	68.9	1.6	22.8	12.5	1.3	48.1	91.6	4.2	1.6	0.5	0.3	33.4	13.1	11.8
8b(-3.03)	17	B	69.8	2.5	23.0	13.6	1.6	52.4	89.0	5.4	1.9	0.6	0.4	32.4	14.4	10.1
8b(-3.12)	17	B	72.0	2.6	28.6	15.6	1.7	52.5	92.5	5.7	1.9	0.7	0.4	31.5	14.3	9.4
8b(-3.21)	17	B	**71.8**	**1.7**	**15.6**	**10.7**	**1.4**	**52.4**	**99.3**	**3.4**	**1.3**	**0.5**	**0.2**	**33.5**	**12.6**	**12.8**
8b(-3.37)	12	B	**71.2**	**2.8**	**26.7**	**16.0**	**2.0**	**60.2**	**113.4**	**6.0**	**1.9**	**0.7**	**0.4**	**30.9**	**13.7**	**10.5**
8b(-3.61)	12	B	83.5	2.1	24.4	16.2	1.8	61.3	126.9	5.9	1.9	0.6	0.4	34.7	9.9	16.6
8b(-3.68)	12	B	82.8	2.0	21.5	13.9	1.4	60.3	119.7	5.5	1.8	0.6	0.4	35.2	9.9	17.3
8b-10(-3.76)	12	B	71.9	2.1	20.4	13.2	1.3		114.2	5.3	1.8	0.6	0.3	37.2	8.8	16.3
8b-10(-3.88)	12	B	73.8	2.0	18.5	12.7	1.9	52.3	119.7	4.8	1.6	0.5	0.3	35.1	9.5	17.5
8b-10(-3.98)	12	B	58.6	2.4	23.2	14.4	1.4	54.5	113.9	5.9	1.9	0.6	0.4	33.3	11.0	14.5
10-11(-4.08)	12	B	51.9	2.5	25.8	15.3	1.3	55.4	114.2	6.6	2.0	0.7	0.4	34.3	11.2	14.1
11-12(-4.31)	12	B	50.9	2.5	27.6	16.1	1.2	56.5	**180.6**	7.0	2.2	0.8	0.5	33.6	11.1	13.9
11-12(-4.44)	12	B	46.4	2.6	28.7	15.8	1.3	68.6	118.4	6.9	2.2	0.8	0.4	33.3	11.2	14.0
?12-13(-4.54)	12	B	44.4	2.3	29.3	16.1	1.7	63.1	116.1	7.4	2.2	0.7	0.4	33.2	12.2	12.4
13-14(-4.63)	12	C-1	46.2	2.1	33.4	17.7	1.2	64.4	118.1	7.9	2.5	0.9	0.5	32.8	11.2	13.4
13-14(-4.74)	12	C-1	41.2	3.8	39.8	20.7	1.1	70.7	112.9	10.2	3.3	1.0	0.6	30.2	12.4	10.4
14-15(-4.85)	12	C-1	27.9	3.4	37.5	18.8	1.3	58.0	101.1	9.0	2.9	0.8	0.5	29.2	14.5	7.3
14-15(-4.95)	12	C-1	33.8	3.2	33.2	19.5	1.1	60.1	100.6	8.5	2.8	0.9	0.5	30.0	15.1	6.9
16a(-5.06)	12	C-1	**25.0**	**1.3**	**15.4**	**10.9**	**0.7**	**36.0**	**85.3**	**4.2**	**1.5**	**0.4**	**0.3**	**31.4**	**16.7**	**6.1**
16a(-5.20)	6	C-1	**35.9**	**3.5**	**32.8**	**16.8**	**2.2**		**49.0**	**7.4**	**2.6**	**0.8**	**0.5**	**31.9**	**13.1**	**8.0**
16a(-5.29)	6	C-1	41.5	2.9	27.9	16.4	1.7	68.3	110.4	6.8	2.4	0.7	0.5	30.9	13.6	9.5
16a(-5.33)	6	C-1	43.2	3.0	30.8	17.1	2.0	69.7	106.7	7.1	2.5	0.8	0.5	30.4	13.8	9.0
16a(-5.41)	6	C-1	35.5	2.4	20.2	13.8	1.3	60.3	103.3	5.1	1.9	0.6	0.4	32.1	15.2	8.7
17a1(-5.50)	6	C-1	31.8	2.1	21.9	13.8	0.9		88.7	5.2	2.0	0.6	0.3	31.5	15.4	6.0
17(-5.76)	6	C-1	22.0	2.4	19.4	13.2	1.0	43.0	85.2	5.2	1.9	0.5	0.4	30.7	17.5	5.5
17a2(-6.02)	6	C-1	19.5	2.9	28.7	15.3	0.9	46.3	84.9	5.8	1.9	0.5	0.4	29.9	17.9	4.1
17a2(-6.27)	6	C-1	23.9	2.8	25.2	16.4	1.0	49.4	86.9	6.4	2.2	0.6	0.4	29.3	17.2	4.2
17a2(-6.44)	6	C-1	29.6	2.9	24.9	16.0	0.8	45.6	79.6	6.6	2.2	0.6	0.5	28.7	17.3	4.3
17a2(-6.56)	6	C-1	28.0	2.9	24.6	17.6	0.8	53.2	88.3	6.3	2.1	0.6	0.5	29.1	16.7	4.9
17a3(-6.66)	6	C-1	22.7	2.9	21.3	14.1	0.6	45.7	79.5	4.9	1.7	0.5	0.4	30.3	17.5	4.6
17a3(-6.76)	5	C-1	34.0	2.1	18.1	12.4	0.9	48.3	84.0	4.4	1.6	0.5	0.3	30.9	16.7	5.6
17a3(-6.83)	5	C-1	36.1	1.8	14.0	10.3	1.2	43.5	83.2	3.4	1.3	0.4	0.3	32.2	17.1	6.1
17/18(-6.90)	5	C-2	18.7	0.9	13.2	8.0	1.7		67.7	2.9	1.0	0.3	0.2	35.3	14.6	3.5
17/18(-7.06)	5	C-2	17.5	1.5	13.0	9.1	0.6	25.9	79.1	3.0	1.0	0.4	0.2	32.3	16.6	3.4

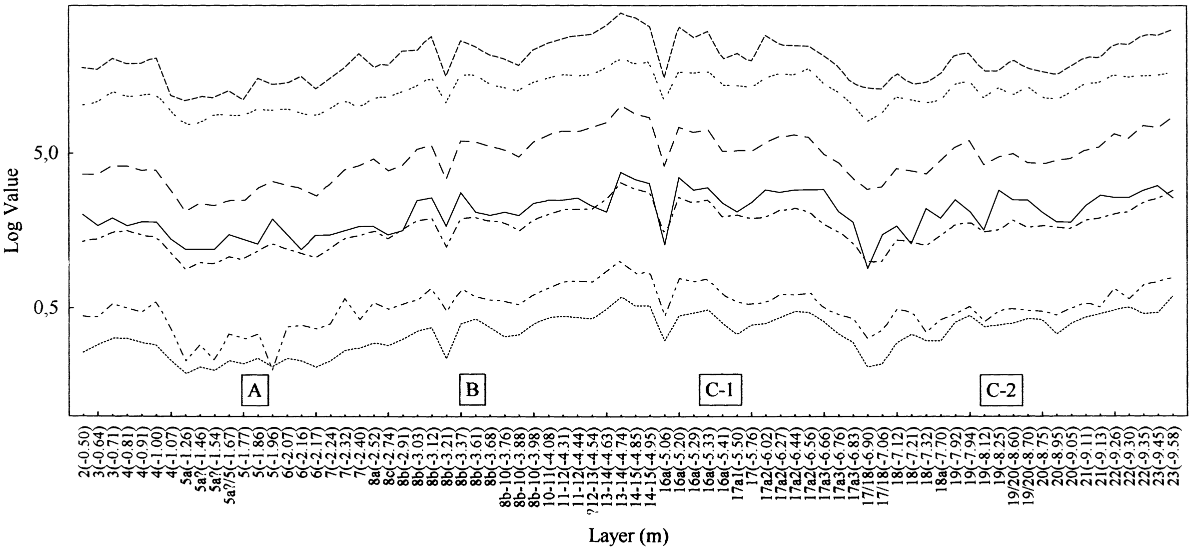
continued ...

Tab. 5.4.1 (nadaljevanje / cont.)

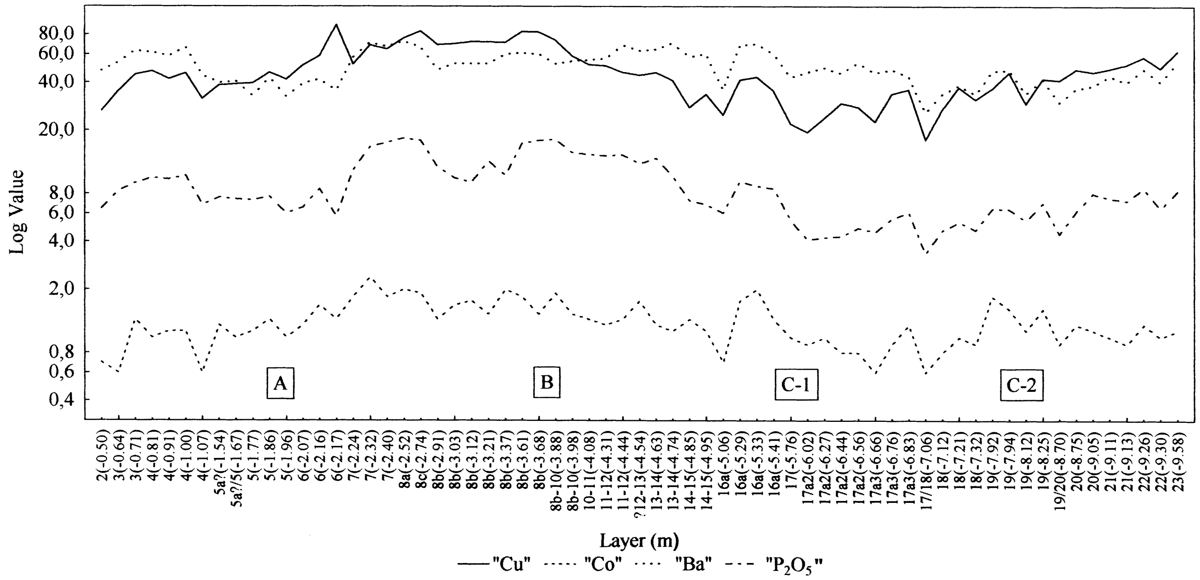
Layer (m)	Profile (x)	Facies	"Cu" (ppm)	"Th" (ppm)	"Zr" (ppm)	"Ce" (ppm)	"Co" (ppm)	"Ba" (ppm)	"Sr" (ppm)	"SiO_2" (%)	"Al_2O_3" (%)	"Fe_2O_3" (%)	"K_2O" (%)	"CaO" (%)	"MgO" (%)	"P_2O_5" (%)
18(-7.12)	5	C-2	27.1	1.7	16.7	11.6	0.8	33.7	83.3	4.0	1.4	0.5	0.3	31.2	18.2	4.7
18(-7.21)	5	C-2	37.3	1.3	14.0	11.1	1.0	38.3	84.0	3.9	1.4	0.5	0.3	31.9	18.3	5.3
18(-7.32)	5	C-2	31.2	2.2	14.3	10.6	0.9	33.6	81.4	3.7	1.3	0.4	0.3	31.0	18.5	4.7
18a(-7.70)	4	C-2	33.6	1.9	16.1	10.9	2.0		78.0	4.5	1.5	0.4	0.3	31.7	16.3	5.2
19(-7.92)	4	C-2	36.7	2.5	21.7	13.9	1.8	47.0	87.0	5.5	1.7	0.5	0.4	31.2	17.0	6.4
19(-7.94)	4	C-2	46.1	2.1	22.2	14.8	1.5	47.8	94.3	6.0	1.8	0.5	0.5	31.4	16.6	6.4
19(-8.12)	4	C-2	29.4	1.6	17.1	11.4	1.1	34.0	84.2	4.2	1.5	0.4	0.4	32.1	18.2	5.4
19(-8.25)	4	C-2	42.2	2.9	17.1	13.3	1.5	41.8	90.5	4.8	1.6	0.5	0.4	31.2	16.4	7.0
19/20(-8.60)	4	C-2	47.2	2.5	20.2	11.9	2.5		85.8	5.0	1.9	0.5	0.4	32.4	15.2	6.3
19/20(-8.70)	4	C-2	41.2	2.5	17.7	13.6	0.9	30.0	82.1	4.4	1.7	0.5	0.4	29.8	17.3	4.5
20(-8.75)	4	C-2	48.3	2.1	17.0	11.5	1.2	36.5	82.0	4.3	1.7	0.5	0.4	31.3	17.2	6.2
20(-8.95)	4	C-2	49.6	1.8	16.1	11.2	**5.7**		87.9	4.5	1.7	0.5	0.3	34.4	14.0	8.5
20(-9.05)	4	C-2	46.4	1.8	18.3	12.3	1.1	38.1	91.3	4.7	1.6	0.5	0.4	32.8	15.8	8.0
21(-9.11)	4	C-2	48.7	2.3	20.8	14.2	1.0	43.9	87.2	5.3	1.9	0.5	0.4	31.5	15.9	7.5
21(-9.13)	4	C-2	51.8	2.7	20.8	14.3	0.9	39.9	82.9	5.5	1.9	0.5	0.5	31.2	15.5	7.2
22(-9.26)	4	C-2	57.7	2.6	25.5	16.1	1.2	48.5	98.5	6.7	2.0	0.7	0.5	31.0	14.0	8.7
22(-9.30)	4	C-2	49.2	2.6	25.4	15.7	1.0	40.2	81.2	6.3	2.1	0.6	0.5	30.6	15.7	6.5
22(-9.35)	4	C-2	55.7	2.9	29.3	15.9	1.6		89.3	7.6	2.5	0.7	0.5	32.3	13.4	8.0
23(-9.45)	4	C-2	60.8	3.1	28.9	16.0	1.9		84.2	7.3	2.6	0.7	0.5	31.7	13.6	7.5
23(-9.58)	4	C-2	62.7	2.6	31.6	16.7	1.1	53.4	83.7	8.6	2.9	0.8	0.6	30.6	14.6	8.3
MEDIAN Divje babe I. Layer 2-23			*44.6*	*2.1*	*20.2*	*12.65*	*1.25*	*48.4*	*88.1*	*4.7*	*1.7*	*0.5*	*0.4*	*32.0*	*15.2*	*7.6*
25%			*33.9*	*1.65*	*15.9*	*10.7*	*1*	*40.2*	*84*	*3.8*	*1.4*	*0.4*	*0.3*	*31.1*	*13.5*	*6.1*
75%			*56.7*	*2.6*	*25.3*	*15.75*	*1.7*	*60.2*	*101.05*	*6.2*	*2.0*	*0.6*	*0.4*	*33.3*	*16.8*	*10.4*
Potočka 2000. Layer 2			*65.9*	*2.9*	*52.6*	*19.9*	*2.1*	*138.3*	*177.6*	*12.6*	*4.0*	*1.5*	*0.9*	*36.3*	*0.5*	*19.9*
Potočka rear. soil			*65.1*	*3.3*	*52.7*	*21.5*	*2.9*	*130.6*	*180.6*	*11.0*	*4.3*	*1.7*	*0.8*	*37.2*	*0.4*	*24.2*
Mokriška. soil			*69.9*	*3*	*35.8*	*19.3*	*3*	*82.6*	*156.5*	*6.2*	*3.3*	*1.4*	*0.4*	*40.0*	*0.3*	*18.0*

V tretji skupini (*sl. 5.4.3*) so avtohtone prvine ali minerali, ki vsebujejo CaO, MgO in Sr, tj. glavne sestavine matične kamnine oz. sedimentnih klastov.

Za prvo skupino prvin sta značilna izrazita cikličnost in rahel trend, ki se kaže v zmanjševanju vrednosti vseh prvin od spodaj navzgor v profilu. Te prvine se tudi danes spirajo s površja nad jamo (glej vrednosti modernega vzorca v *tab. 5.4.1*). Sodeč po toriju in zlasti aluminiju, ki med preperevanjem ne migrira, večjih premikov znotraj profila ni bilo. Vrhunci prvin v profilu so



Sl. 5.4.1: Ciklus prve skupine prvin v sestavljenem profilu. Vrednosti so logaritemske. Skupina je utemeljena s podobnostjo krivulj.
Fig. 5.4.1: Cycle of first group of elements in the composite profile. Values are logarithmic. Group is based on similarities of curves.

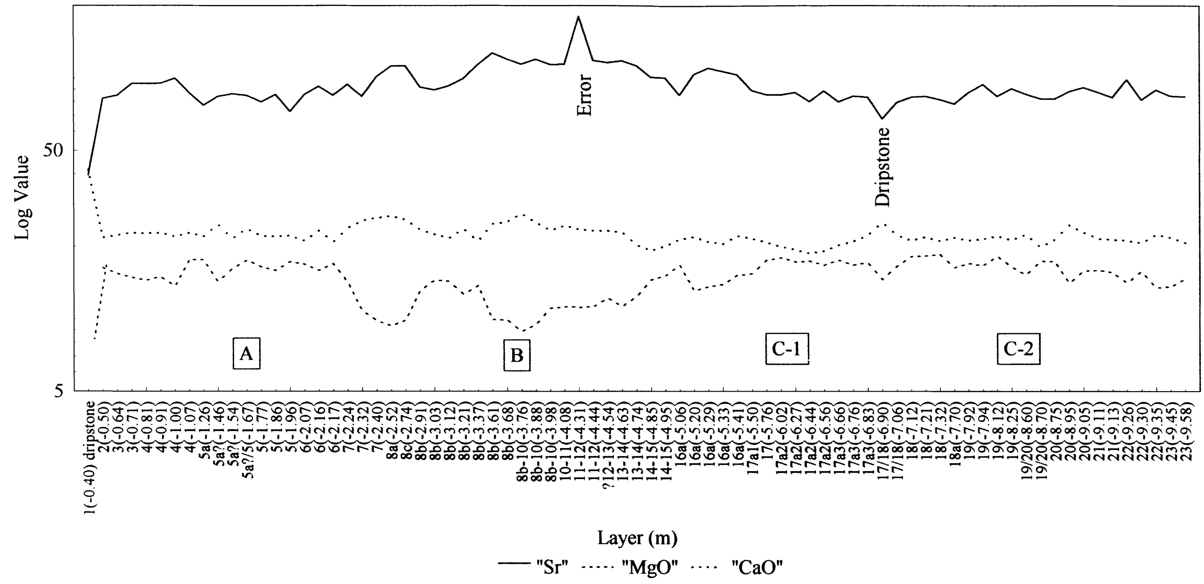


Sl. 5.4.2: Ciklus druge skupine prvin v sestavljenem profilu. Skala je logaritemska.
Fig. 5.4.2: Cycle of second group of elements in the composite profile. The scale is logarithmic.

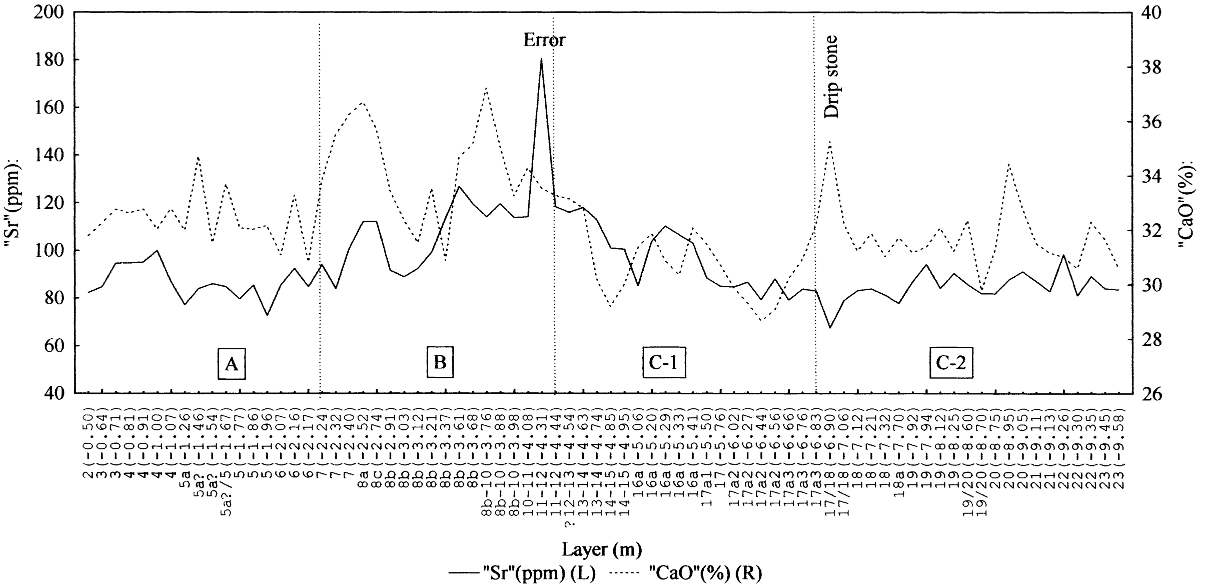
povezani s povečanim prinosom alohtonega materiala v jamo.

Povprečne vrednosti prvin prve skupine so vse po vrsti manjše kot v Potočki zijalki in Mokriški jami ter bistveno večje kot v dolomitu (*tab. 5.4.1*). Sedimenti Potočke zijalke in Mokriške jame vsebujejo očitno več preperine (beri ilovice). Obe najdišči se nahajata na 3-4-krat večji nadmosrski višini kot Divje babe I, drugačno pa je tudi sedimentno okolje.

Za drugo skupino prvin sta značilni slabše izražena cikličnost in odsotnost dolgoročnega trenda, pogostejši pa je tudi fazni odmik na posameznih odsekih (*sl. 5.4.2*), kar še posebej velja za kobalt. S površja nad jamo se danes spirata predvsem baker in v manjši meri kobalt. Vrhunci treh prvin so povezani z vrhunci ostankov jamskega medveda, kar so pokazale tudi analize njihovih kosti (Skaberne *et al.* 2006). Barij in baker variirata v profilu podobno kot fosfor. Medtem ko pri bakru ni faznega odmika, je pri bariju takšen odmik ob koncu subfacije C-1 in na začetku facije B. Danes se barij, enako kot fosfor, spira v jamo v količinah, ki so trikrat manjše od povprečne pleistocenske vrednosti (*tab. 5.4.1*). Zato upravičeno domnevamo, da barij v pleistocenskih sedimentih izvira predvsem iz ostankov jamskega medveda.



Sl. 5.4.3: Ciklus tretje skupine prvin v sestavljenem profilu. Skala je logaritemska.
Fig. 5.4.3: Cycle of third group of elements in the composite profile. The scale is logarithmic.



Sl. 5.4.4: Odnos med kalcijem in stroncijem v sestavljenem profilu.
Fig. 5.4.4.: Relation between calcium and strontium in the composite profile.

Domnevo podpirajo tudi posamezni podatki za Potočko zijalko in Mokriško jamo[6], ki imata v primerjavi s povprečjem v Divjih babah I povečano vsebnost tako fosforja kot bakra in barija (*tab. 5.4.1*).

Za tretjo skupino prvin je značilen linearen vzorec podatkov (*sl. 5.4.3*). Kalcij in magnezij sta antagonista, prav tako magnezij in stroncij. Njihove vrednosti v profilu so obratno sorazmerne. Vrednosti magnezija imajo največjo amplitudo, stroncija najmanjšo, kalcijeve pa so med obema. Standardno odstopanje pri magneziju je bistveno večje kot pri kalciju.

Kjer je v profilu v sedimentni frakciji prisoten sekundarni kalcit, tako kot v sigi iz plasti 1, opažamo, da se vsebnost stroncija in magnezija zmanjša, kalcija pa poveča (*sl. 5.4.3*). To se zelo jasno vidi samo v plasti 17/18, katere sediment sestavlja med drugim tudi drobtinčasta siga. V drugih plasteh je skundarni kalcit v peščeno-meljasti frakciji prisoten kvečjemu v sledovih, kar pa nujno ne velja za druge frakcije in različne prevleke in obloge na večjih klastih. Zato je smotrno interpretirati odnos med stroncijem in kalcijem, ki ga prikazuje *sl. 5.4.4.*

Sekundarni kalcit je samo v zasigani plasti 2 in v plasti 17/18 (drobtinčasta siga), za katero je značilna velika vsebnost kalcija in majhna vsebnost stroncija. V vseh ostalih plasteh je kalcij vezan na apatit. Zato se razmerje med kalcijem in stroncijem spreminja v profilu enako kot se spreminja vsebnost fosfatnih agregatov (glej podpoglavje 5.3 v tem zborniku, *sl. 5.3.6*). Vse skupaj pa je povezano z variabilnostjo vlage oz. padavin in omogoča delitev profila na že predlagane štiri dele (facije in subfacije). Facije A in subfacija C-2 sta si podobni. Nekaj posebnega je facija B in predvsem subfacija C-1, kar se tiče vsebnosti kalcija in stroncija ter njunega razmerja (*sl. 5.4.4*).

5.5. NEOBIČAJEN MINERAL V OGNJIŠČIH IZ DIVJIH BAB I

Izvleček

Analizirali smo belo snov (BS), ki je bila najdena pri flotaciji žganine v ognjiščni plasti v Divjih babah I. S pomočjo elektronske mikroskopije, infrardeče spektroskopije in difrakcije rentgenskih žarkov smo ugotovili, da je BS magnezijev muskovit 1M, ki ima za to spojino neobičajno trakasto obliko monokristalov, do sedaj še neznano za ta mineral. Prisotnost BS smo v ognjiščnih jamah in okolici ognjišč pripisali razpadu skrilavih glinavcev, ki so bili v jamo prinešeni in najdeni poleg oglja in zažganih kosti, kar odpira možnost za domnevo, da je človek uporabljal skrilave glinavce pri ognjiščih. Ostaja pa odprto vprašanje geokemijskega nastanka trakaste BS iz skrilavih glinavcev v najdišču.

Pri pregledovanju ognjišča v plasti 5 (Turk, Kavur 1997, 141) smo pri flotaciji žganine (sedimenta z večjo količino oglja) naleteli na drobce bele snovi (na kratko BS) (*sl. 5.5.1*). Pozneje se je pokazalo, da to ni bil osamljen primer. BS smo našli tudi v ognjišču v plasti 6 pri jemanju vzorcev za analize ESR v profilu y = 2 m, v ognjišču na meji plasti 7 in 8 v kvadratu 41, reženj −273 cm, v ognjišču v plasti 8a v kvadratih 17 in 19, režnja −261 cm in −273 cm, v ognjišču v spodnjem delu plasti 8 v kvadratih 13, 16, 34 in 35, režnjev −346 cm in −357 cm. V

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[6] Gre za lastne meritve skupaj z vzorci iz Divjih bab I, in sicer v plasti 2 izkopavanj v Potočki zijalki leta 2000, t. i. fosfatni zemlji iz izkopa S. Brodarja na konci jame in fosfatni zemlji iz Mokriške jame (plast 7?). Za obe najdišči so, tako kot za Divje babe I, značilni številni ostanki jamskega medveda.

vseh primerih gre za dobro ohranjena, *in situ* odkrita ognjišča z večjo količino oglja in zoglenelih kosti (glej poglavji 8 in 19 v tem zborniku).

Med flotacijo voda v drobce BS ni prodrla, BS je ohranila svojo belo barvo. Vlaknasta struktura BS, ki je vidna že s prostim očesom, je krhka in se ob pritisku poruši. Mineralne kisline ne raztapljajo BS, prav tako je ne raztapljajo organska topila, BS ne gori. BS je torej porozen in mikrokristaličen anorganski material, ki siplje svetlobo in je zato bele barve.

Prisotnost materiala z izrazito mikro vlaknasto sestavo je dokaj neobičajna za mineraloško okolje v Divjih babah I s pretežno karbonatnimi minerali (glej poglavje 2 v tem zborniku). Vendar je podrobnejša analiza sedimentne sestave okoli ognjišč pokazala, da imajo vsa ognjišča, kjer se pojavlja tudi BS, v žganini in v njihovi neposredni okolici drobce temnosivih skrilavih glinavcev, kamnin, ki običajno ležijo pod skladi dolomita. Zato v najdišče, predvsem pa v ognjišča, niso mogli priti po naravni poti, tj. gravitacijsko, ampak jih je tja nekdo prinesel.

Skrilave glinavce v predelu ognjišč v Divjih babah I lahko povežemo s še nedoločeno dejavnostjo paleolitskih obiskovalcev. Ploščice skrilavih glinavcev z vrezanimi motivi so sicer že bile najdene na različnih drugih lokacijah, vendar gre za mlajšepaleolitska najdišča (Bosinski, Fischer 1974; Kavur, Petru 2003). Skrilavi glinavci v določenih hidrotermalnih pogojih razpadajo in iz njih lahko zaradi geokemijskih procesov nastajajo nove spojine s specifično mineralno sestavo in mikrokristaličnostjo. Pozitiven odgovor za kemijsko sorodnost med BS in skrilavimi glinavci bi dal vsaj posreden dokaz o tem, da njihova prisotnost v ognjiščnih jamah ni naključna in da je povezana z njihovo smotrno uporabo. Zato smo se odločili, da z uporabo elektronske mikroskopije, infrardeče spektroskopije in difrakcije rentgenskih žarkov določimo kemijsko naravo BS in ugotovimo kemijsko sorodnost med BS in skrilavimi glinavci, najdenimi v ognjiščnih kotanjah in ob njih.

Sl. 5.5.1: Bela snov (BS) iz ognjišča v plasti 8 spodaj (kv. 34, reženj –346 cm). Merilo v mm. Fotografija I. Turk.
Fig. 5.5.1: White substance (WS) from hearths in Layer 8 lower (quadrat 34, cut –346 cm). Scale in mm. Photograph I. Turk.

EKSPERIMENTALNI DEL

Mikroskopsko analizo vzorcev iz kvadrata 34 in režnja –345 cm smo opravili s pomočjo vrstičnega elektronskega mikroskopa *Scanning Electron Microscop Supra 35 VP Carl Zeiss*, Nemčija. Vzorce smo predhodno naparili z zlatom, ki je zagotavljal električni kontakt in s tem omogočil velike povečave (5000x, 10000x, 50000x, 100000x). Elementno analizo (*Energy Dispersive X-ray spectroscopy* – EDX) smo opravili s pomočjo analitičnega orodja SEM-mikroskopa.

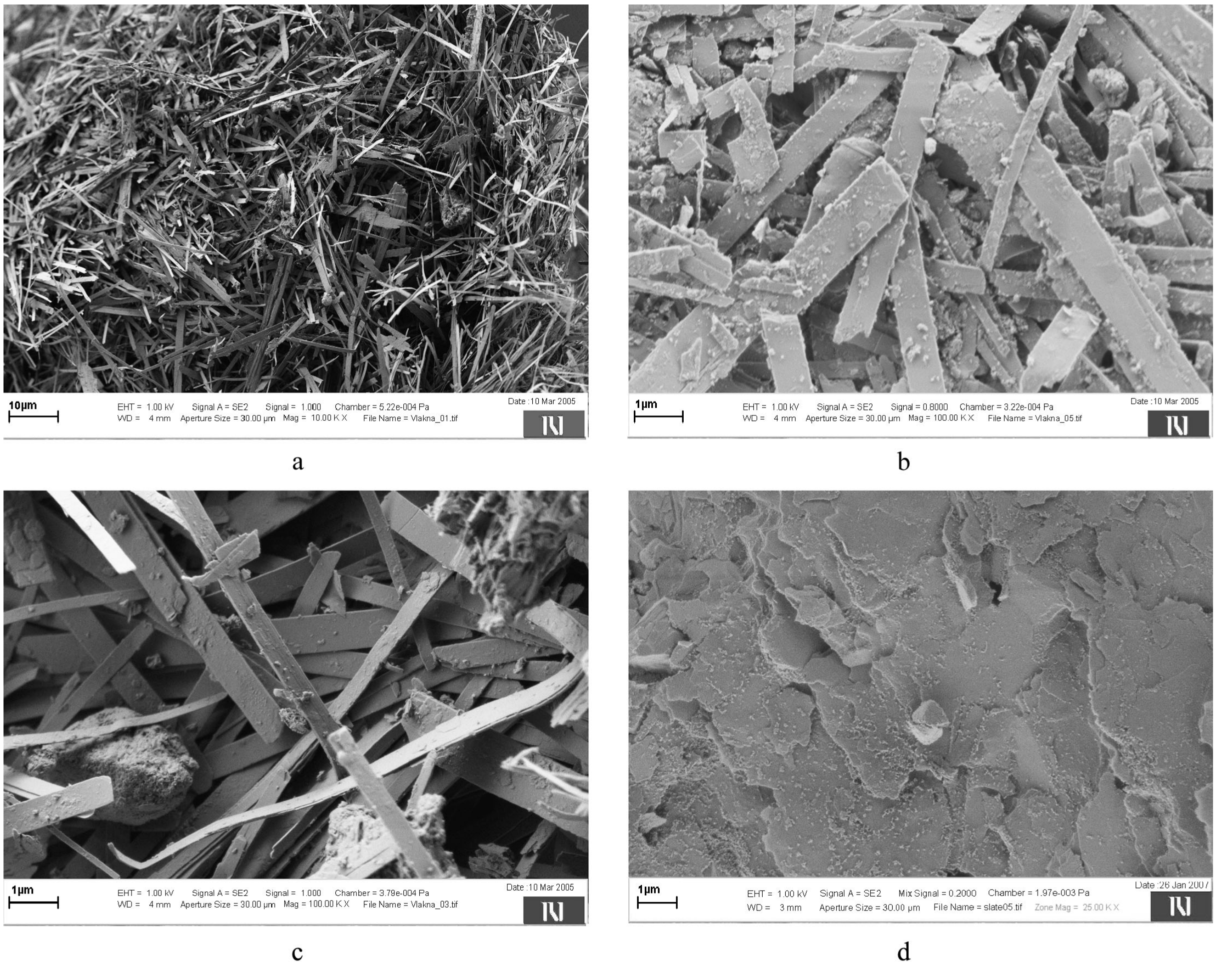
Infrardeče (IR) spektre smo snemali na FT IR-spektrometru *Bruker FTS 66*. Vzorce smo strli s parafinskim oljem in posneli ustrezne transmisijske spektre.

Rentgenski praškovni difraktogram je bil posnet na difraktometru *PANalytical X'Pert PRO* z refleksijsko tehniko in bakrovim žarčenjem $K_{\alpha 1}$. Prisotne kristalne faze smo določili s pomočjo iskalnega programa *Crystallographica Search-Match Version 2,1,1,0; Copyright 1996–2003, Oxford Cryosystems,* in zbirke podatkov *PDF-4, Release 2006, Inernational Centre for Diffraction Data, ZDA*. Kvantitativno fazno analizo smo opravili s programom *Topas 2.1, Bruker AXS, Nemčija.*

REZULTATI Z RAZPRAVO

SEM-meritve in *EDX-analize*. Raziskavo o kemijski sestavi BS smo pričeli z določitvijo njenih morfoloških lastnosti. SEM-posnetki so pokazali prevladujočo prisotnost "trakaste faze" (na kratko TF BS), nekaj je morfološko neizrazitih somernih vključkov (*sl. 5.5.2b, c*). Posebnost TF BS so trakovi s pravokotnim presekom; najkrajša stranica (a – debelina) je dolga od 30 do 100 nm, daljša (b – širina) od 200 do 1000 nm, medtem ko je dolžina trakov (c) tudi do 50-krat večja in je dolga do 40 μm. Razmerje med stranicami (a:b:c = 1: 10: 40) je torej izrazito na strani najdaljše stranice traku; medtem ko je debelina trakov v nanometrskem območju, je dolžina že v mikrometrskem (do 40 μm). Pravilnost in ponovljivost TF BS kaže, da gre za enovit mineral in ne za mešanico različnih mikrokristalov z različno kemijsko sestavo.

Presenečata enakost trakov ne glede na eventualne razlike v debelini in širini ter naključna zraščenost; tako ni mogoče opredeliti njihove preferenčne usmerjenosti, značilne za druge minerale s podobno trakasto ali igličasto morfologijo. Glede na trakasto strukturo smo sprva domnevali, da je TF BS ferierit (Gramlich-Meier *et al.* 1985); presojen, igličast zeolit, nepričakovano najden v septarijih na Gorenjem Štrihovcu (Žorž *et al.* 2006), ki so mu nedavno določili tudi njegovo kemijsko

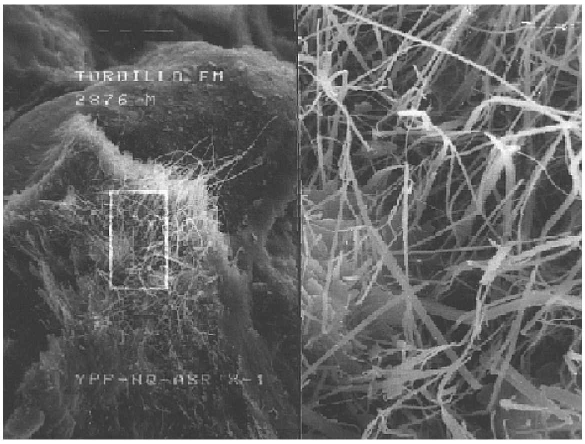


Sl. 5.5.2a-d: SEM-posnetki: trakaste strukture bele snovi – a) povečava 10000x, b) 100000x, c) 100000x in d) skrilavega glinavca (povečava 25000x).
Fig. 5.5.2a-d: SEM photographs: ribbon structure of the white substance (RPh WS) – a) 10000x magnification, b) 100000x, c) 100000x and d) slate (25000x).

sestavo in strukturo (A. Rečnik, privatno sporočilo). Za ferierit je značilna še večja anizotropija (dolžina presega debelino tudi do 10000x), vendar so debeline trakov TF BS in ferierita približno enake. Poleg tega so kristali ferierita urejeni in kažejo tendenco rasti, medtem ko TF BS kaže izrazito prepleteno in neurejeno strukturo, ki napeljuje na možnost, da je BS nastala s sekundarnim procesom (recimo z razpadom skrilavih glinavcev) in ne s počasno kristalizacijo.

Omejujoč se le na trakasto morfologijo ferierit ni edini mineral, ki bi lahko ustrezal TF BS. Še posebno podoben TF BS je ilit (hidromuskovit) (*sl. 5.5.3*), ki je poleg muskovita eden od glavnih mineralov, ki se nahajajo v glinah. Ta mineral je poleg muskovita glavni mineral skrilavih glinavcev.

Kot prvi korak k določitvi kemijske narave TF BS smo izvršili EDX-meritve in s tem dobili njegovo elementno sestavo. Ta je pokazala precejšnjo vsebnost kalija in potrdila pričakovano prisotnost Al, Mg in Si (*sl. 5.5.4b, tab. 5.5.1*) glede na pričakovan ilit, muskovit ali kakšen drug mineral, ki ga vsebujejo skrilavi glinavci. Čeprav gre nesporno za kalijev magnezijev alumosilikat, pa elementna analiza ne omogoča dokončne identi-



Sl. 5.5.3: Mikroskopski posnetek ilita (http://www.arenisca.com/tordillo.gif).
Fig. 5.5.3: Microscopic photo of the mineral illite (http://www.arenisca.com/tordillo.gif).

Tab. 5.5.1: EDX-analiza bele snovi – TF BS (glej *sl. 5.5.4b*).
Tab. 5.5.1: EDX analysis of the white substance – RPh WS (see *Fig. 5.5.4b*).

Element	Weight%	Atomic%
O	55.18	68.21
F	2.03	2.11
Mg	2.45	1.99
Al	13.04	9.56
Si	21.73	15.31
K	5.56	2.81
Total	100	100

fikacije TF BS, ker je mineralov s tako ali zelo podobno sestavo veliko. V naslednjem koraku smo zato posneli rentgenske praškovne difraktograme BS in opravili njihovo analizo.

Analiza difraktogramov. Rentgenski praškovni difraktogrami trakaste BS (*sl. 5.5.6*) kažejo vrsto ostrih in dobro definiranih vrhov, kar potrjuje dobro kristaličnost BS. Analiza vrhov je pokazala, da je v vzorcu v manjši meri prisoten dolomit ($CaMg(CO_3)_2$), na njegovo prisotnost smo sicer sklepali tudi na osnovi rezultatov EDX-analize. Široka, nizka vrhova v difraktogramu pri uklonskih kotih 12,4 in 25,0 stopinje očitno pripadata kostni žganini, praviloma pojavljajoči se v ognjiščnih jamah; je organskega izvora in slabo kristalizirana.

V vzorcu TF BS pa je glavna komponenta mineral z enoplastno monoklinsko strukturo (*sl. 5.5.5*: osnovna celica je približno a = 5,2; b = 9,0; c = 10,2 Å; γ = 101°; simetrija C2/m). Sestava mineralov s tako strukturo je spremenljiva. V osnovi je v oktaedrični plasti Al, v tetraedrični plasti pa Si in Al, negativni naboj pa kompenzirajo kalijevi ioni med plastmi. Izhodiščna kemijska formula takih mineralov je $A_yB_2C_4O_{10}X_2$, pri čemer je A velik, navadno enovalenten kation (na primer K), y pa je lahko največ 1. Kationi B so oktaedrično koordinirani, pretežno sta to Al in Mg, lahko tudi železo, kationi C so tetraedrični in na teh mestih najdemo predvsem Si in Al, anioni X so OH ali F. Konkretno lahko za izhodišče vzamemo na primer formulo $KAl_2(AlSi_3)O_{10}(OH)_2$, v kateri se lahko posamezni kationi nadomestijo z drugimi, podobnih velikosti. Prva sprememba je lahko na tetraedričnih mestih, kjer se lahko spreminja razmerje Al/Si. Druga sprememba je lahko na oktaedričnih mestih, kjer se lahko Al delno zamenja z Mg, Fe ali drugimi kationi podobnih velikosti. Vse te zamenjave lahko zaradi različnih valenc kationov, ki se zamenjujejo, tudi precej vplivajo na celokupni naboj plasti. To sproža tudi zahtevo po tretji možni spremembi, ki jo predstavlja v tem primeru količina kalija med plastmi (če je neto negativni naboj alumosilikatne plasti manj od ena, ni nujno, da so kalijeva mesta popolnoma zasedena, lahko pa se kalij delno nadomesti tudi z drugimi kationi). Četrta možna sprememba sestave je delna zamenjava hidroksilnih ionov s fluoridnimi v anionski plasti. Ta ne vpliva na naboj plasti.

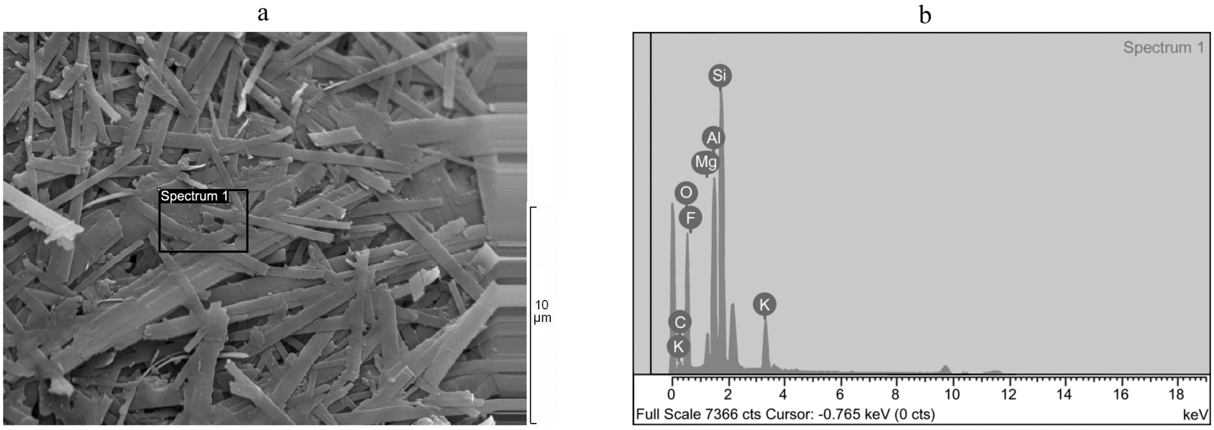
Za ilustracijo navajamo nekaj primerov:

$KAl(Mg_{0.2}Al_{0.8})(Al_{0.42}Si_{3.58})O_{10}(OH)_2$ – mineral muskovit (Sidorenko *et al.* 1975),

$(K_{0.80}Na_{0.02}Ca_{0.01})(Al_{1.66}Fe_{0.06}Fe_{0.02}Mg_{0.28})(Si_{3.41}Al_{0.59})O_{10}(OH)_2)$ – mineral muskovit (Plancon *et al.* 1985),

$K_{0.7}Al_2(Si,Al)_4O_{10}(OH)_2$ - mineral ilit (Brindley 1977) in $KFe_{1.5}Mg_{0.5}Si_4O_{10}(OH)_2$ – mineral celadonit (Zhuk-hlistov *et al.* 1977).

Poudariti velja, da vse te zamenjave zaradi podobne velikosti kationov, ki se zamenjujejo, malo vplivajo na samo strukturo in so si zato praškovni difraktogrami teh snovi zelo podobni. Do najbolj ustrezne formule TF BS zato lahko pridemo le s kombinacijo rezultatov elementne analize in dejstva, potrjenega z difrakcijo, da je struktura taka, kot je opisana, in zahteva določeno število kationov in anionov na danih kristalografskih mestih ($A_yB_2C_4O_{10}X_2$), kot je opisano zgoraj. Iz določene kemijske sestave in teh pogojev lahko sklepamo, da je približna, vendar najbolj verjetna, kemijska formula TF



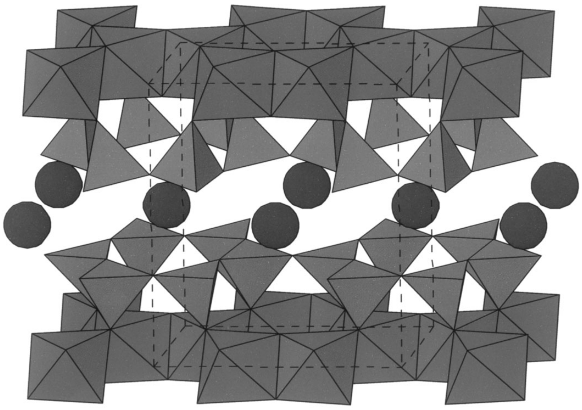
Sl. 5.5.4a, b: SEM-posnetek (a) in EDX-analiza (b) trakaste BS.
Fig. 5.5.4a, b: SEM micrograph (a) and EDX analysis (b) of ribbon-like WS.

BS: $K(Mg_{0.4}Al_{1.6})(Si_{3.4}Al_{0.6})O_{10}(F,OH)_2$ (*Sl. 5.5.5*), značilna za magnezijev muskovit 1M.

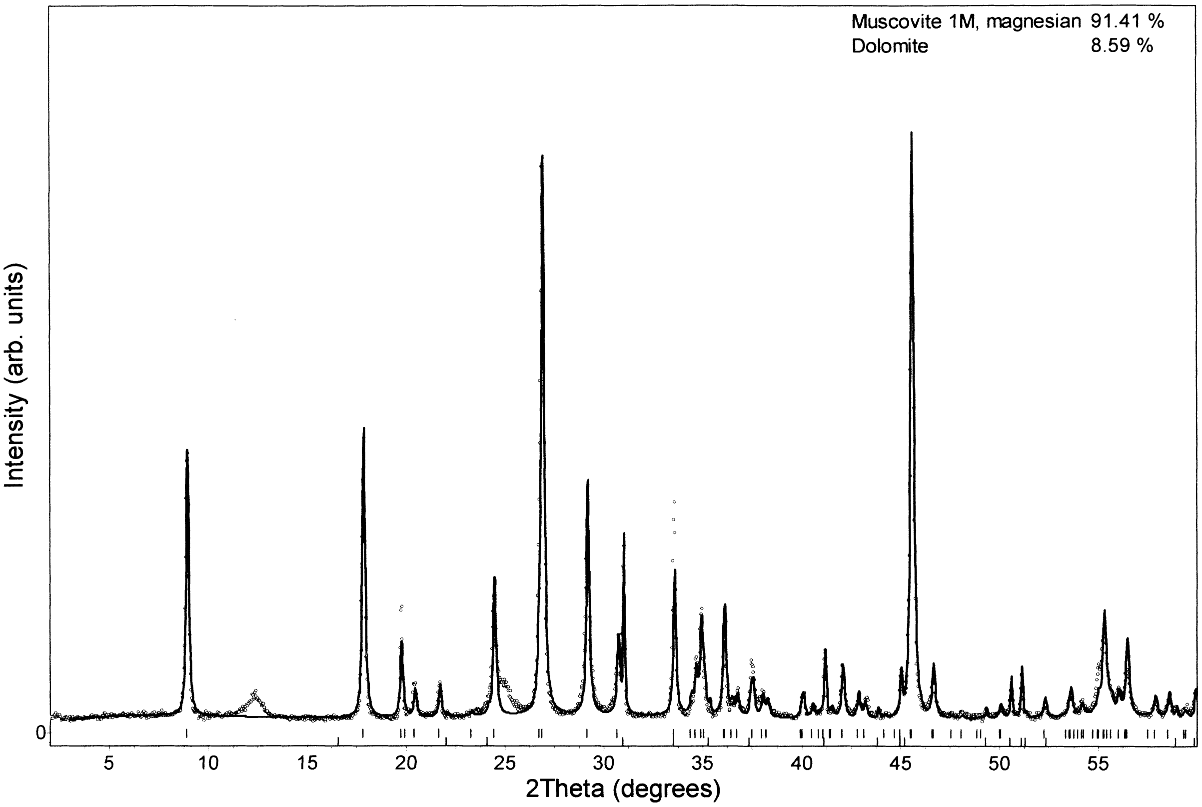
Iz elementne analize in strukture izpeljano kemijsko formulo smo preverili še z Rietveldovo primerjavo, kjer iz strukturnih podatkov prisotnih kristaličnih faz izračunamo teoretični difraktogram in ga primerjamo z izmerjenim difraktogramom vzorca. Če je ujemanje zadovoljivo, pomeni, da je strukturni model pravilen, s prilagajanjem vsebnosti faz pa lahko izračunamo tudi približno razmerje med fazami, ki so vključene v model.

Končna primerjava izračunanega in izmerjenega difraktograma je prikazana na *sl. 5.5.6*. Ujemanje je glede na majhno količino vzorca in zelo neugodno morfologijo (pri trakastih vzorcih pride do izrazitega pojava preferenčne orientacije) zadovoljivo. S tem sta potrjeni kristalna struktura in približna kemijska formula trakastega minerala za magnezijev muskovit 1M. Izkazalo se je še, da je masno razmerje med magnezijevim 1M muskovitom in dolomitom v vzorcu približno 10:1.

Prisotnost dolomita v BS smo pričakovali glede na to, da se BS pojavlja v dolomitnem sedimentnem okolju, tipičnem za vsa ognjišča v Divjih babah I. Nasprot-



Sl. 5.5.5: Kristalna struktura trakastega belega minerala (TF BS). Kalijevi atomi so temno modri, tetraedrična (Si, Al) plast je svetlo modra, oktaedrična (Al, Mg) plast pa vijolična. Osnovna celica je označena črtkano.
Fig. 5.5.5: Crystal structure of the ribbon-like white mineral (RPh WS). Potassium atoms are dark blue, the tetrahedral (Si, Al) layer is light blue, and the octahedral (Al, Mg) layer violet. The unit cell is shown with broken lines.



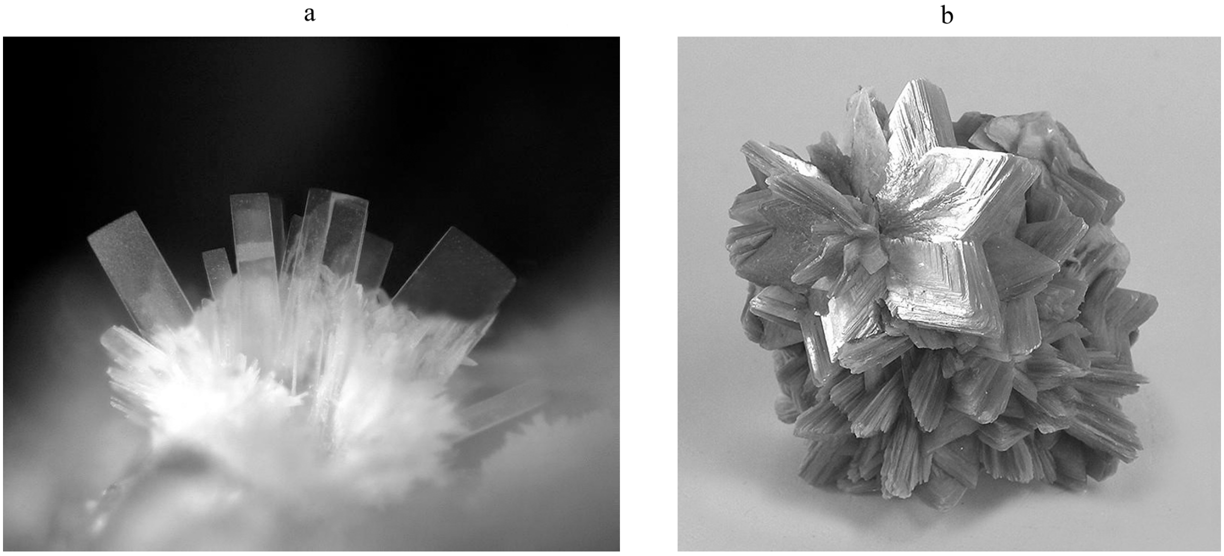
Sl. 5.5.6: Primerjava izračunanega (črta) in izmerjenega (krogci) difraktograma BS. V računu sta bili upoštevani monoklinska plastovita faza s formulo $K(Mg_{0.4}Al_{1.6})(Si_{3.4}Al_{0.6})O_{10}(F,OH)_2$ in dolomit; v spodnjih dveh vrstah so z navpičnimi črtami označene lege njunih uklonov.
Fig. 5.5.6: Comparison of calculated (line) and measured (circles) diffractograms of WS. The calculation took into account the monoclinic layered phase with the formula $K(Mg_{0.4}Al_{1.6})(Si_{3.4}Al_{0.6})O_{10}(F,OH)_2$ and dolomite; in the lower two rows their locations are marked with vertical lines.

no pa je prisotnost magnezijevega muskovita 1M z mineraloškega vidika presenečenje, saj neposredno geološko okolje v jami Divje babe I ne podpira prisotnosti tovrstnih alumosilikatov; ti se praviloma pojavljajo v drobnozrnatih klastičnih sedimentnih, piroklastičnih in magmatskih kamninah, ki jih najdemo v relativno ozkem pasu od Stopnika do Pisanc na Krniškem grebenu, približno 3 km južneje od Divjih bab I (glej Čar, Skaberne 2003). Dodaten problem je trakasta oblika TF BS, saj muskovit le redko kristalizira v trakasti obliki, običajno imajo kristali obliko ploščic (*sl. 5.5.7a, b*), nasprotno pa je trakasta oblika kristalov pogosta za ilit. Očitno združuje TF BS lastnosti ilita in magnezijevega muskovita 1M. Da bi vsaj deloma osvetlili ta problem, smo posneli infrardeče spektre TF BS.

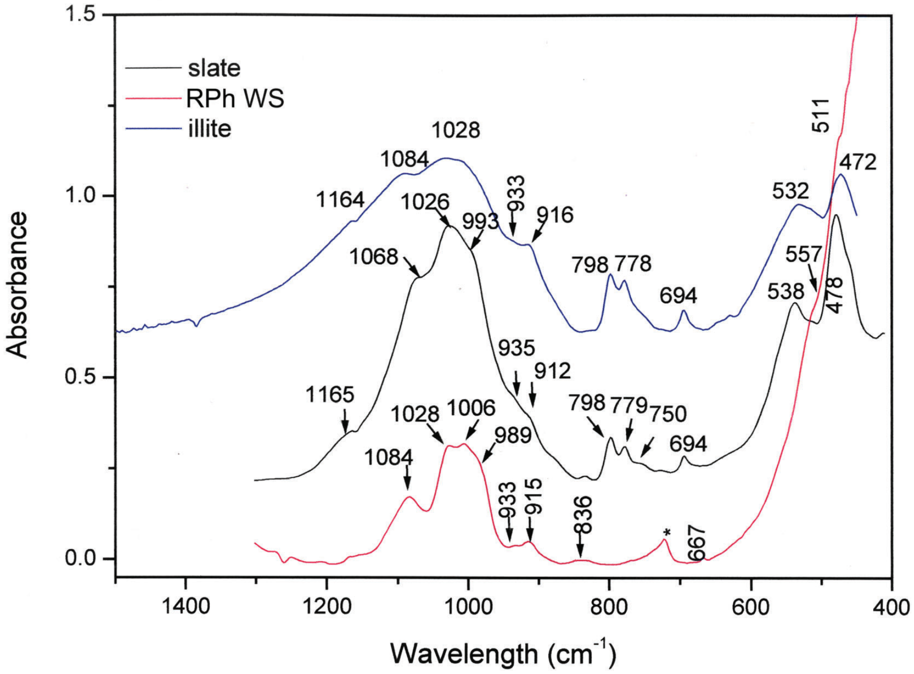
IR-spektri. Infrardeči spekter skrilavega glinavca iz ognjiščne jame je podoben spektru TF BS (*sl. 5.5.8*). Podobnost je presenetljiva, če upoštevamo, da vsebujejo skrilavi glinavci, podobni tistemu iz ognjiščnih jam v Divjih babah I, vrsto mineralov, kot so kremen, muskovit ali ilit, klorit, hematit ali pirit z vključki apatita, grafita, kaolina, magnetita, turmalina ali cirkona. Absorbcije prisotnih mineralov v skrilavem glinavcu se nalagajo in vodijo do končnega spektra, ki se ne razlikuje bistveno od spektra TF BS. Da bi lahko sklepali o njegovi strukturi, smo spekter TF BS primerjali s spektri strukturno sorodnih mineralov: ilita, muskovita, celadonita in sericita – slednji predstavlja vmesno fazo pri metamorfozi ilita v muskovit (P. Kralj, privatno poročilo; Hunziker *et al.* 1986).

Vendar primerjava spektrov muskovita, celadonita (Velde 1978), ilita (*http://minerals.caltech.edu/files/infrared_MIR/Minerals_From_JK/Illite.txt*) in sericita ($(K, Na)Al_2(AlSi_3O_{10})(OH)_2$) (Zhang *et al.* 2005) s spektrom TF BS pokaže, da se nobeden od teh popolnoma ne ujema s spektrom TF BS (*sl. 5.5.8* in *5.5.9*). Celadonit iz teh primerjav izločimo brez težav; trakovi, ki ustrezajo valenčnim nihanjem skupin SiO_4 (960–1100 cm^{-1}), so drugačni kot za TF BS. To se tudi ujema z dejstvom, da je celadonit značilne modre barve, medtem ko je BS bele barve. Poleg tega celadonit vsebuje železo, ki ga analiza difraktogramov TF BS ni pokazala. Prav tako bi lahko iz primerjave izločili sericit, ker EDX-analize niso pokazale prisotnosti Na.

Spektri vseh mineralov (ilita, muskovita in sericita) so v območju, kjer se pojavljajo trakovi skupin SiO_4 (960–1100 cm^{-1}) (valenčna Si-O in Al/Si-O nihanja v tetraedrični (T) plasti), podobni (Farmer 1964; 1974; Reshetnikova 1969; Velde 1978), vendar se v določenih trakovih razlikujejo od TF BS. V spektru TF BS se lepo vidi dodaten ramasti trak pri 989 cm^{-1}, sicer viden tudi v spektru muskovita, ki povzroča razširitev tega traku v spektrih ilita in skrilavega glinavca. Pričakovano še večje razlike opazimo v trakovih, ki ustrezajo valenčnim –OH nihanjem na površini (3670–3690 cm^{-1}) in v notranjosti plasti (3620–3630 cm^{-1}) (*sl. 5.5.9*). Enovit trak pri 3630 cm^{-1} je značilen za muskovit, razširjen trak, sestavljen iz več komponent, najdemo v spektrih ilita in sericita, v spektru TF BS pa se pojavljata le dva izrazita, relativno ostra trakova pri 3618 in 3695 cm^{-1}, ki se po frekvenci ujemata z dvema glavnima trakovoma v spektru ilita. TF BS ima dodatne hidroksilne skupine kot muskovit, vendar te ne vežejo vode iz okolja; TF BS ostaja na površini nehidratiran, v nasprotju z muskovitom, ki po izpostavi vodi postane hidrofilen (van Oss, Giese 1995) in ga voda sčasoma popolnoma zmoči. Vendar voda TF BS ne zmoči, saj je bil izoliran s flotacijo. Razlog za vodoodbojnost TF BS ni torej samo v njegovi



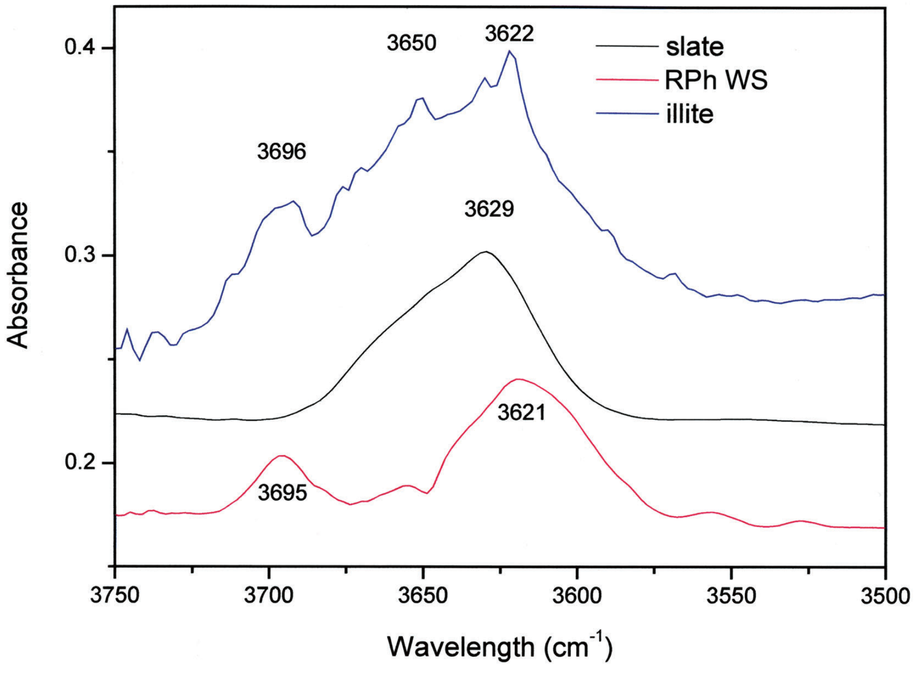
Sl. 5.5.7a, b: Kristalne ploščice muskovita, a) Nemčija (http://wannenkopfe.strahlen.org/muscovite31.html) in b) Brazilija (http://www.mindat.org/photos/0393724001155652558.jpg).
Fig. 5.5.7a, b: Platy crystals of muscovite, a) Germany (http://wannenkopfe.strahlen.org/muscovite31.html) and b) Brasil (http://www.mindat.org/photos/0393724001155652558.jpg).



Sl. 5.5.8: IR-spektri skrilavega glinavca, TF BS in ilita (http://minerals.caltech.edu/files/infrared_MIR/Minerals_From_JK/Illite.txt).
Fig. 5.5.8: IR spectra of slate, RPh WS and illite (http://minerals.caltech.edu/files/infrared_MIR/Minerals_From_JK/Illite.txt).

površinski strukturi, temveč tudi v tem, da so trakovi kristalov TF BS nanodimenzij – lastnost, ki jo s pridom izkoriščajo za pridobivanje površin s superhidrofobnimi lastnostmi (recimo aerogeli SiO_2 ali nanostrukturiran Al_2O_3) (Venkateswara *et al.* 2003).

V območju od 800–870 cm^{-1}, ki vključuje Si-O deformacijska nihanja teraedrov (T-O-T) v obročih, je intenzivnost trakov v spektru TF BS podobna kot v spektru muskovita. Ilit teh trakov nima, ima pa trakova pri 789 in 778 cm^{-1} (valenčna nihanja $Si\text{-}O\text{-}Al^{VI}$), ki ju ima



Sl. 5.5.9: Infradeči spektri muskovita in celadonita.
Fig. 5.5.9: Infrared spectra of muscovite and celadonite.

tudi muskovit – čeprav so bistveno manj intenzivni – , ne opazimo pa ju v spektru TF BS. Ilit ima intenziven raztegnjen trak pri 915 cm^{-1} (δ(H-O-Al^{VI}) (Post, Borer 2002), medtem ko je ta v spektru TF BS šibek. To lahko le približno povežemo s prisotnostjo $(Mg^{+2})^{VI}$ ionov v TF BS, ki jih sicer muskovit nima (Reshetnikova 1969). Da končamo, skeletna nihanja v spektru TF BS ($K(Mg_{0.4}Al_{1.6})(Si_{3.4}Al_{0.6})O_{10}(F,OH)_2$) po pričakovanju, glede na njuno različno kemijsko sestavo, niso identična s spektrom muskovita, vendar se razlikujejo od ilita ($K_{0.7}Al_2(Si,Al)_4O_{10}(OH)_2$). Nasprotno pa se nihanja hidroksilnih skupin TF BS dobro ujemajo s spektrom ilita, prav verjetno zaradi njune morfološke podobnosti, ki posredno vpliva na zmanjšanje hidratacije površine TF BS.

SKLEPI

Kot sklep lahko povzamemo, da je magnezijev muskovit 1M glavna sestavina trakaste BS. Difrakcijska analiza, kombinirana z EDX-meritvami, potrjuje prisotnost Mg, ne pa ionov Fe, ki so značilni za soroden celadonit, izključuje pa ta mineral tudi odsotnost zanj značilne modre barve. Prav tako TF BS ne moremo uvrstiti kot sericit, saj EDX-meritve niso pokazale prisotnosti natrija v strukturi.

Infrardeči spektri pokažejo veliko sorodnost med ilitom, sericitom in muskovitom – slednji je spektru TF BS najbolj podoben, pa čeprav ne enak. Razlike v skeletnih nihanjih TF BS in muskovita smo pripisali prisotnosti Mg v TF BS, ki ga muskovit nima. Razlike so tudi v valenčnih nihanjih hidroksilnih skupin, ki kažejo podobnost s spektrom ilita. TF BS nima na površino vezanih molekul vode, ne zmoči se z vodo in ga je bilo zato možno dobiti s flotacijo.

Zato pa nesporno drži, da je izvor TF BS v skrilavih glinavcih, najdenih v srednjepaleolitskih ognjiščnih jamah in njihovi bližini, v Divjih babah I. Skrilavi glinavci so alohtona primes v sedimentih z izrazito dolomitno klastično komponento (glej podpoglavje 5.1 v tem zborniku) in se danes nahajajo na lokacijah, ki izključujejo njihov vnos v jamo z delovanjem gravitacije (glej Osnovna geološka karta SFRJ, Tolmin in Videm, L 33–64, in poglavje 2 v tem zborniku). To kaže na možnost, da so bili večji kosi skrilavih glinavcev prineseni v jamo, kjer so pozneje razpadli. Dejstvo, da se trakasta BS pojavlja skupaj s skrilavimi glinavci v ognjiščnih jamah poleg oglja in zažganih kosti (glej poglavje 18 v tem zborniku), pa odpira možnost za domnevo, da je človek uporabljal skrilave glinavce pri ognjiščih. Seveda pa lahko o namenih uporabe le domnevamo. Več o tem morda v drugem, arheološkem delu monografije. Ostaja pa odprto vprašanje geokemijskega nastanka trakaste BS iz skrilavih glinavcev v jami Divje babe I.

5.6. SPLOŠEN SKLEP

Razlaga analize sedimentov paleolitskega najdišča Divje babe I je pokazala, da je nekatere lastnosti sedimentov mogoče povezovati s paleoklimatskimi razmerami v času njihovega nastanka. Paleotemperatura se najbolje odslikava v količini talnih zmrzlinskih klastov (kongelifraktov), na podlagi katerih smo posamezne plasti povezali v facije A, B in C. V zgornjem delu profila (faciji A in B) je več zmrzlinskih klastov, kar nakazuje hladnejšo klimo, kot v spodnjem delu (facija C, ki smo jo razdelili na podfaciji C-1 in C-2), ki naj bi nastajal v toplejši klimi. Meja med facijama B in C sovpada na podlagi datacij posameznih plasti s kronološko opredeljeno mejo med izotopsko stopnjo MIS 3, za katero je značilna hladna klima in MIS 5, za katero je značilna toplejša klima (glej poglavje 6 v tem zborniku).

Za najboljši kazalec oz. približek paleovlage so se pokazali reliefno korodirani klasti ter skupina sestavno povezanih lastnosti sedimentov: fosfatni agregati, fosilni ostanki jamskega medveda, fosfor, kalcij, stroncij in magnezij. Vse naštete lastnosti je mogoče tako ali drugače povezati in razložiti z vlago oz. s padavinami in skupaj s talnimi zmrzlinskimi klasti, ki nakazujejo nihanje temperature, predstavljajo ključ za klimatostratigrafsko razlago profila.

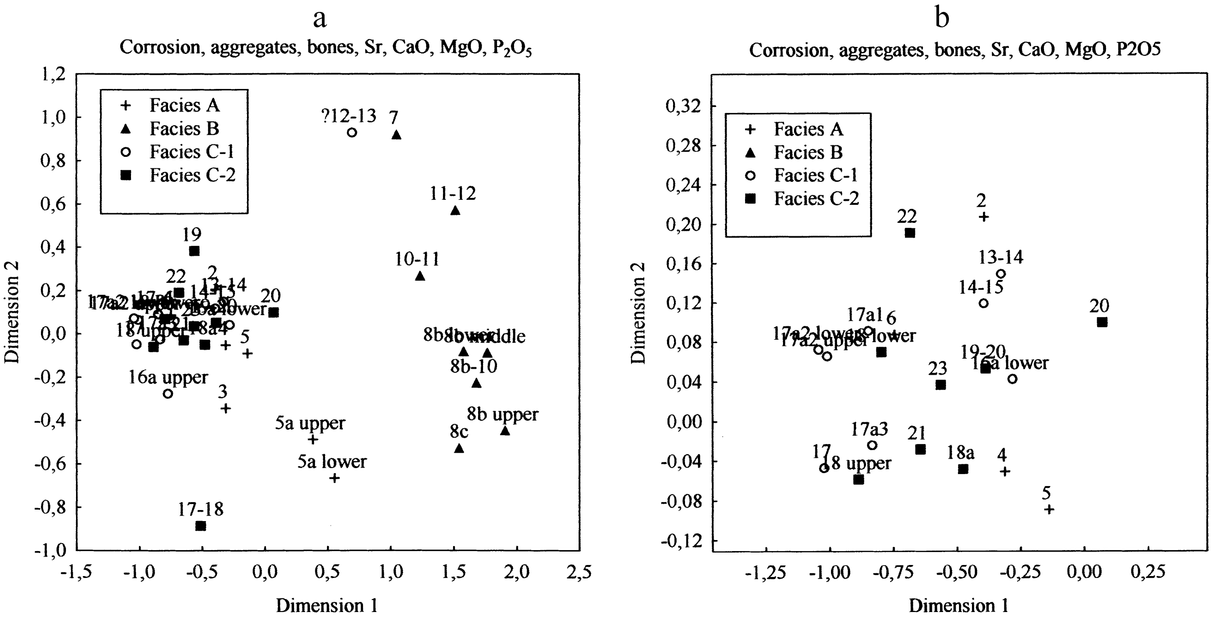
Kako skladno delujejo v sistemu najdišča, smo preverili s pomočjo multivariatne tehnike večdimenzionalnega skaliranja (*Multidimensional scaling*). Ta postopek je najprimernejši, ker ne zahteva normalne porazdelitve vhodnih podatkov. Multivariatno analizirani podatki so prikazani v *tab. 5.6.1.*

Sl. 5.6.1a, b prikazuje rezultat dvodimenzionalnega skaliranja, pri čemer *sl. 5.6.1b* predstavlja detajl skupine plasti v levem srednjem delu *sl. 5.6.1a*. Shepardov diagram in majhna vrednost *stresa* (0,04), jamčita, da dve dimenziji zadostujeta za ugotavljanje podobnosti oz. različnosti med plastmi in facijami. Prvo dimenzijo razlagamo s padavinami oz. vlažnostjo. Na njeni podlagi razlikujemo med facijami in posameznimi plastmi. Druga dimenzija razlikuje samo med plastmi, ne pa facijami, in se jo ne da razložiti.

Plasti facije B in C tvorijo ločeni skupini, medtem ko so plasti facije A nekje vmes. Glede na dosedanje ugotovitve zgolj na podlagi agregatov (glej podpoglavje 5.3 v tem zborniku, *sl. 5.3.6*) so plasti facije B proizvod ekstremno vlažne klime. Najbolj vlažna plast facije C je plast ?12-13, ki ji sledi plast 20, tej pa plast 18a, 16a spodaj, 19–20 in 17/18 iste facije. Te plasti so na abcisi (dimenzija 1) najbližje plastem facije B, kar pomeni, da so nastale v bolj vlažnih pogojih kot druge plasti facije C. Najbolj vlažni plasti facije A sta plast 5a in 5a? oz. 5a zgoraj in 5a spodaj (*sl. 5.3.6*). Za obe je značilno, da ležita med plastmi facije B in C oz. najbližje faciji B (*sl. 5.6.1a*). Najbolj suha plast facije A je plast 6 (*sl. 5.3.6*), ki je na abcisi najbolj oddaljena od plasti facije B (*sl. 5.6.1b*).

Tab. 5.6.1: Izbor različnih neodvisno pridobljenih sedimentoloških parametrov, ki lahko služijo kot približki za paleovlago oz. paleopadavine. Po vrsti so navedeni korozija, agregati, fosilni ostanki in prvine, povezane z odlaganjem sekundarnega kalcita in cementiranjem. Večina podatkov se nanaša na sedimentno frakcijo 0,5–3 mm. Krepko je izpisana močno odstopajoča vrednost.
Tab. 5.6.1: Selection of various independently obtained sedimentological parameters which can serve as approximations for palaeohumidity or palaeoprecipitation. In order are stated corrosion, aggregates, fossil remains and chemical elements bound to deposited secondary calcite and cementation. The majority of data refer to the sedmentary fraction 0.5–3 mm. A strongly deviating value (outlayer) is written in bold type.

Layer (Depth in cm)	Profile (x)	Facies	Corroded clasts >40 mm (%)	Density <3>0.5 mm (g/vol.)	Bone fragments > 3mm (g/vol.)	"Sr" in sed. frac. <3>0.5 mm (ppm)	"CaO" in sed. frac. <3>0.5 mm (%)	"MgO" in sed. frac. <3>0.5 mm (%)	"P_2O_5" in sed. frac. <3>0.5 mm (%)
2 (-48)	17	A	2.4	1.27	66	79.5	35.3	14.7	6.1
3 (-72)	17	A	6.3	1.38	65	65.4	36.0	13.4	10.5
4 (-100)	17	A	6.1	1.22	49	80.4	34.9	15.6	7.9
5a upper (-136)	17	A	14.5	1.08	90	86.0	36.4	13.4	11.2
5a lower (-157)	17	A	15.7	1.05	20	89.5	37.0	11.9	13.0
5 (-186)	17	A	7.5	1.24	110	80.0	35.6	14.5	9.7
6 (-207)	17	A	4.5	1.36	127	72.9	33.3	18.4	3.9
7 (-232)	17	B	4.9	1.01	536	101.1	35.7	9.5	17.2
8c (-284)	17	B	17.4	0.94	269	101.1	40.8	7.4	19.5
8b upper (-312)	17	B	18.5	0.87	308	117.4	41.2	5.7	20.7
8b middle (-321)	17	B	13.8	0.96	346	108.8	41.8	5.1	20.7
8b lower (-345)	12	B	11.8	0.9	208	130.3	40.1	7.7	19.1
8b-10 (-388)	12	B	13.9	0.8	255	120.3	40.2	6.5	19.0
10-11 (-418)	12	B	8.2	0.89	347	111.5	38.6	8.8	16.0
11-12 (-444)	12	B	9.9	1.01	522	117.0	38.8	7.9	18.0
?12-13 (-463)	12	C-1	0.5	1.14	395	111.5	37.6	10.7	14.1
13-14 (-474)	12	C-1	4.0	1.29	43	92.7	34.4	15.4	7.4
14-15 (-495)	12	C-1	4.0	1.32	**8**	87.3	34.3	15.2	7.8
16a upper (-517)	12	C-1	10.0	1.45	38	81.3	33.0	18.3	3.0
16a lower (-530)	6	C-1	7.0	1.25	53	93.8	33.5	15.2	6.8
17a1 (-560)	6	C-1	3.5	1.37	32	71.7	32.6	18.2	3.3
17 (-600)	6	C-1	6.2	1.39	45	67.0	31.6	19.8	1.5
17a2 upper (-612)	6	C-1	4.1	1.47	71	70.1	32.4	19.7	1.4
17a2 lower (-655)	6	C-1	3.8	1.47	51	65.5	32.3	19.3	1.6
17a3 (-676)	5	C-1	6.3	1.4	74	71.7	32.6	18.3	2.7
17-18 (-700)	5	C-2	8.1	1.31	27	52.2	38.9	13.9	0.9
18 upper (-721)	5	C-2	6.7	1.41	49	71.0	32.7	19.0	1.8
18 lower (-731)	5	C-2	4.4	1.38	105	74.6	32.9	18.3	2.9
18a (-783)	4	C-2	5.1	1.2	26	77.5	33.7	16.3	5.8
19 (-825)	4	C-2	3.2	1.5	154	78.5	35.2	15.4	6.2
19-20 (-870)	4	C-2	5.0	1.24	82	84.6	33.9	15.7	6.4
20 (-905)	4	C-2	4.8	1.16	58	93.7	35.9	12.8	11.4
21 (-923)	4	C-2	6.1	1.31	55	76.5	32.9	17.3	4.6
22 (-945)	4	C-2	3.1	1.43	66	84.5	33.1	16.9	4.7
23 (-958)	4	C-2	6.7	1.38	80	87.0	32.7	16.2	5.3
MEDIAN			*6.2*	*1.3*	*71.0*	*84.5*	*34.9*	*15.2*	*6.8*
25th %			*4.1*	*1.1*	*49.0*	*72.9*	*32.9*	*10.7*	*3.3*
75th %			*9.9*	*1.4*	*208.0*	*101.1*	*37.6*	*18.2*	*14.1*



Sl. 5.6.1a, b: Grafični prikaz rezultata dvodimenzionalnega skaliranja za plasti in podatke, prikazane v *tab. 5.6.1.*
Fig. 5.6.1a, b: Graphic presentation of the results of two-dimensional scaling for layers and data shown in *Tab. 5.6.1.*

Ujemanje med *sl. 5.3.6*, ki nam je služila za prvotno oceno vlage, in *sl. 5.6.1a,b*, ki je sinteza več nedvomnih kazalcev vlage, je skoraj popolno. To pomeni, da je naša razlaga sprememb vlage na podlagi agregatov v frakciji 0,5–3 mm popolnoma zanesljiva in bi zanjo težko našli boljšo podlago. Če podatkom v *tab. 5.6.1* dodamo podatke za frakcijo, manjšo od 0,5 mm, se slika na ravni facij ne spremeni, ampak se popolnoma poruši slika na ravni plasti. Vzrok temu je domnevno povečanje alohtonih primesi v frakciji, manjši od 0,5 mm.

Za jamskega medveda, ki je prispeval izvorni material za fosfatno vezivo agregatov in breč, lahko na podlagi rezultata dvodimenzionalnega skaliranja trdimo, da se je v jamo brlog zatekal predvsem v vlažnih obdobjih. Nizke temperature niso bile pri tem odločilne, je pa temperatura vplivala na obseg žive populacije, kar se nenazadnje lahko odslikava tudi v količini fosilnih ostankov.

V sedimentih ognjišč je bila odkrita tudi doslej neznana trakasta oblika minerala muskovita, katerega izvor lahko iščemo v skrilavih glinavcih in njihovi uporabi v ognjiščih. Odkritje je pomembno tako z mineraloškega kot arheološkega vidika.

5. SEDIMENTS AT THE DIVJE BABE I SITE

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Detailed analysis of sediments was not an activity for which members of the field team responsible for excavations were trained, with the exception of the original head of the excavation, M. Brodar, who, in view of the nature of the sediments, was against the use of traditional sedimentological methods (M. Brodar 1999). Since there was no substitute for solving the problem, we did not devote particular attention to sediments right up to the conclusion of the second phase of the excavations. However, we nevertheless collected conventional textural data in the hope that they could be later climato-stratigraphically and chrono-climatically interpreted (see Laville 1975). There was only a breakthrough in the search for alternative solutions at the end of the second phase of excavations when, unfortunately, it was too late to check the reliability of all the results required for climatostratigraphic interpretation of the profile.

Studying sediments has specific aims, such as establishing the origin of the sediments, the mode of sedimentation, the course of diagenesis etc. None of this is normally useful for archaeology and only burdens the already overfilled database. However, the data are extremely important for archaeological studies of changes in the former environment or climate. This is climatostratigraphy combined with sedimentology. Climatostratigraphy is also possible linked with palaeontology, if the sediments contain sufficient suitable palaeontological finds. The combination enables a more reliable assessment of past climatic events on the basis of cross-checking of the results of individual studies.

Because more than one hundred cubic metres of material was carefully examined, sediments provide the largest treasury of data and information. It must be stressed that these are continuous stratigraphic data, which cannot be said of almost any other data at the site. In view of this, it is only to be expected that the majority of the text will be devoted precisely to these data and that sedimentological-stratigraphic results will be a guide to the planning of other, primarily palaeontological research. Such thinking also dictates the order in which individual research will take place. In short, successful work requires a common denominator of all research, which in this case is provided by sedimentological-stratigraphic results.

We present here only a small proportion of the collected data from the rich treasury of sediments[1], which we believe to be crucial for the interpretation of the site as a system. We did not succeed in documenting a great deal of data and they are temporarily lost for analysis and interpretation. A great deal still waits for someone to 'discover' during excavation and to use for interpretative purposes.

5.1. GENERALLY ABOUT SEDIMENTS

Abstract

The majority of what is dealt with in this sub-chapter has already been described and translated into English in Turk, Bastiani 2000 and Turk *et al.* 2005. Sub-chapter 5.1. is essentially a summary of the state of general research and methodology of work in the sphere of sedimentology. More specific themes are dealt with in the following sub-chapters, which also introduce some innovations into this sphere.

The basic characteristics of sediments in layers 2–23 are textural, morphological, colour, chemical, biogenetic and diagenetic. Some of these characteristics were studied in more detail on the basis of specific parameters, other less so, as necessary.

The coarsest and the finest fractions play the leading role in texture (*Fig. 5.1.1a, b*; *Table 5.1.1*). Coarser fractions, mainly blocks and boulders, were created syn-

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[1] More about sediments is published in TURK, I. et al. 2002, *Elaborat Divje babe I, izkopavanja 1989–1999, 1. Tekst,* 142 p., 130 figures, 37 tables, *2. Osnovni stratigrafski in sedimentološki podatki,* 139 p. Annex, *3. Osnovna stratigrafska in sedimentološka dokumentacija*, 103 photographs, 13 drawings, kept in the archives of the Institute of Archaeology ZRC SAZU. See also TURK, J. 2004, *Odsev klime s klastov pleistocenskih sedimentov v paleolitskem nahajališču Divje babe I.* Graduation thesis, University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology.

sedimentally by the weathering of the cave roof (Turk *et al.* 2005a). Finer fractions were created mostly postsedimentally by weathering on the cave floor (*Fig. 5.1.2*).

Blocks very much predominate in all layers. In layers 6–16 (depth -261 cm to -465 cm) in the central part of the cave there was thus 51 m^3 of sediment, of a total of 86 m^3, predominantly consisting of blocks larger than 100 mm. The share of blocks ranged from 51 % to almost 100 % per volumetric unit. The remaining 35 m^3 of sediment had less than 50% of blocks per volumetric unit (*Fig. 5.1.3*). Blocks larger than 100 mm averaged 75 %, which indicates sediment with an explicitly coarse skeletal texture.

The share of blocks increases from the entrance towards the interior of the cave and from the east cave wall to the west. The spatial distribution of blocks corresponds well with documented blocks in the profiles (*Fig. 5.1.4; Table 5.1.2*).

Large blocks are a result of rockfalls from the roof, which are still visible in the form of hollows in the roof at places above concentrations of sedimented blocks. Blocks, primarily smaller ones are post-sedimentarily weathered, though more at the entrance than in the interior of the cave. Evidence of this is provided by numerous congelifracts of various sizes (Turk *et al.* 2001) and the explicitly spatial gradient of representation of blocks and congelifracts. The share of blocks in the sediment increases from the entrance towards the interior of the cave, while the share of congelifracts decreases.

There are the remains of several successive rockfalls in the central part of the cave, which were deposited over the millennia one on top of another and today give the impression in the profiles of a single or at most two major rockfalls. Some rockfalls, especially in Layer 8 are strongly weathered, so that not many of the larger blocks remain. Individual rockfalls are separated by discrete, genetically unexplained "inter-rockfall" horizons, such as in layers $17a_1$, 14, 10, 8 (several levels) and 6. It is perhaps no coincidence that the low values in the curve of blocks corresponds stratigraphically with these horizons, documented in several profiles (*Fig. 5.1.4*). They are also connected with major breaks in the deposition of blocks since the nether (roof) faces of blocks in these layers displayed strong cavernous corrosion (*Fig. 5.1.5*). Substantial corrosion of the cave roof occurred each time that the cave roof was stable for an extended time. This certainly means a sedimentation gap with all the possible consequences for the sediment and its content, such as stratigraphic contemporaneity of finds from different chronological periods. Sedimentation gaps will be dealt with in other chapters of this volume.

The rockfall blocks in front of the cave, which were created with the crumbling of the vertical dolomite cliff in which the cave entrance opens, are a specific question. That there are fewer blocks here than would be expected with the weathering of the rocks can be explained by the steep slope below the cave, down which the blocks could roll into the valley. If M. Brodar's hypothesis (1999) that there were powerful rockfalls at the Pleistocene/Holocene boundary, which moved the original cave entrance back several metres, there would be the remains of these rockfalls on the banks of the River Idrijca, and only in a narrow belt below the cave. There are, in fact, but only some smaller boulders, which represent the modest remains of much older Pleistocene rockfalls rather than testimony of more recent catastrophes, the traces of which are elsewhere normally excellently preserved and make a powerful impression on the observer. The numerous post-glacial rockfalls in the nearby mountains confirm this, where old ones were joined by new ones in the same place during the Posočje earthquakes of levels VII and VIII on the European macroseismic scale (EMS) in 1998 and 2004 (Vidrih, Ribičič 1998; 2004; Vidrih *et al.* 2001). In Divje babe I, which lies outside the epicenter, these earthquakes did not remove even the smallest piece of rock from the approximately 100 m^2 area of the cave roof surveyed, let alone trigger a rockfall. The frequency of rockfalls increases with earthquake intensity, from level VI and higher (Vidrih, Ribičič 1998, Table 11, 391 and following).

Finer fractions (<4 mm) represent an insignificant volumetric share of sediments. However, they play an important role, since because of their mobility they fill all the pores in the skeletons of larger clasts. Inter-grain porosity is an important property of clastic cave sediments, especially in connection with the constant trickling of groundwater, which carries tiny grains and thus close the pores in the sediment. In very porous sediment, the majority of the water and grains move downwards. In the long term, the flow of water estimated on the basis of one year's measurements on a floor area of 91 m^2 in Divje babe I, is enormous (minimum 192.7 litres $^{-m2/year}$, average 756.9 litres $^{-m2/year}$). The vertical transfer into the ground was therefore not negligible. It is important to know how much water the sediment can receive and how much it can retain in the form of bound (retention) water, which layers are more and which less permeable, whether any of the layers could occasionally be water supporting and how much capillary rise of water there was in various layers. These properties of sediments in the Divje babe I case are not constant but change over time because of infiltration of the matrix into the pores between the clasts and because of diagenetic processes. It is therefore impossible to give a reliable explanation of the complex past events connected with the action of water in the sediments.

Our experiments confirmed that sandy sediment with a large amount of phosphate aggregates can also accept rather more than 50% water per volumetric unit of sediment. The majority of this water is bound to the pores of the aggregates and filters off with difficulty. If water saturated sediment is frozen, the volume does not increase, because the increased volume of ice (approximately 9%) is presumably compensated in the pores of the aggregates. A minor part of the sediments thus crumbles. After freezing and thawing the sediment breaks up. In contrast to this, sandy sediment without aggregates and with weathered clasts only accepts 40% of water per volumetric unit of sediment. The majority of this water is not bound and easily filters off. After freezing and thawing such sediment is more consolidated and is reduced in volume by about 5%.

Because of the aforementioned properties of sediments, we can seek an answer to the question of why signs of cryoturbation are only visible in layers that have few aggregates and why there are none in any of the numerous layers with a lot of aggregates, although a number of parameters suggest that these layers were also occasionally exposed to an extremely cold climate (e.g., Layer 8b-10). Similarly, an answer to why all layers with aggregates are more loosely packed (less consolidated) and some layers without aggregates are compacted (more consolidated), which we noticed during excavation, can be sought in the described properties of the sediments.

Water saturated sandy and/or silty sediment with a lot of aggregates becomes more impermeable than sediment with few aggregates and little silt. If there is porous and permeable sediment above it, free water can collect in it. The locally limited Layer 16 in the entrance part of the cave, for example, is such a case. The clasts in the layer are cemented and the reddish colour of the phosphate coating on them indicates an oxidative environment.

The granularity of the sediments also affects the rise of capillary water, which is significantly higher in fine than in coarse grained sediments.

There are major differences in granularity between the lower and combined middle and upper parts of the profile, or between layers 2–15 and 16–23. The lower part of the profile is more permeable than the middle and upper part, since it contains more medium and fine rubble and above all less silt and aggregates (*Fig. 5.1.1a, b*). This can also contain more free water, which did not rise by capillary action as much as in the middle and especially the upper part of the profile. Because of the greater flow of water, more cement can also be formed in the lower part of the profile, which bound the clasts into breccia.

The granularity of the sediment affects the reduction-oxidation process in the sediments, which is displayed in the variously coloured layers.

In a number of places in the cave we came across explicitly coarse grained, porous and permeable sediments with individual rockfall blocks surrounded by finer grained less permeable sediments (*Fig. 5.1.6*). Coarse grained sediment which is almost without matrix and without any finds is included among finer grained sediments rich in various finds. Lithological relations show that these beds/lenses are connected with the last major rockfall, the blocks of which are partially buried and partially visible on the present surface. One possible explanation for the creation of beds/lenses could be their connection with thermokarst (see Williams, Smith 1989, 141 and following). Individual larger cores of ground ice may have formed close to the entrance in the late glacial maximum. When the ice melted in the Late Glacial or later, depressions would have been created on the surface, which would have filled with the most recent cryoclastic sediments, such as appear in places in Layer 2.

The mass share of the finer sediment fraction in the central part of the cave is in inverse relation with blocks because of the effect of the total sum (*Fig.1.1a, b; Table 1)*. Its share falls from the entrance towards the interior of the cave, while the share of blocks rises (*Fig. 5.1.7a, b; Table 5.1.3a, b*). The phenomenon could also be seen in a larger volume of sediment (*Fig. 5.1.8a, b*). This may mean that the fine sediment fractions, as has been said, were created mainly by the weathering of blocks, i.e., post-sedimentarily. So with blocks, as with finer sediment fractions, volumetric analysis showed that the variability between layers is not greater than the variability within layers. The variability between layers cannot therefore be interpreted.

The average grain size of individual grain fractions complements and, in certain aspects, even well replaces data on volumetric/mass shares of sediment fractions. The sizes of clasts were estimated on the basis of the average volume of grains, which was obtained by dividing the weight of all grains by their number and then, on the basis of the specific weight of dolomite, which is on average 2.9 g/cm^3, the average volume of grains as a measure of size which is independent of grain shape was calculated. The following formula was used for the calculation: $v = m / (n * 2.9)$, where m is the mass and n the number of grains. The reliability of the data depends on how weathered the grains are and their number. The number of grains varied by layers, depending on the fraction. With blocks (>65 mm) there were 9–59 clasts, course rubble (<65>40 mm) 42–230 clasts, medium rubble (<40>10 mm) 383–2184 clasts, and with fine rubble (<10>3 mm) 324–848 clasts. Clasts were sampled in the composite profile and we did not quarter them except for fine rubble, where Jonson's divider was used for that purpose but only for layers from the upper and middle part of the profile.

The average size of clast in the fractions in the profile is shown in *Fig. 5.1.9*. Layer 10-11 appears to be specific, composed of above average sized clasts in all fractions. Layer 10-11 also has fewer fractions than average less than 10 mm. This may indicate powerful primary weathering (rockfall?) and weak secondary disintegration of clasts, which may be connected with the relatively rapid sedimentation in this part of the profile.

There are specific differences in the average size of clasts larger than 40 mm and the average size of clasts smaller than 40 mm, between the layers of the upper part of the profile (layers 2–12) and the lower (layers 13–23), bearing in mind the chronoclimatic delimitation (see sub-chapters 5.2 and 5.3 and Chapter 6 in this volume). These differences are reasonably explained by primary and secondary weathering (Turk *et al.* 2005a). Clasts larger than 40 mm are mainly primary or synsedimentary and clasts smaller than 40 mm mainly secondary or post-sedimentary. The former were deposited with the weathering of the cave roof and the latter by weathering of the topsoil sediments. On average, among clasts smaller than 40 mm larger clasts predominate in the lower, warmer and drier part of the profile than in the upper, colder and damper part, which is associated with greater topsoil weathering in the upper part of the profile. It is exactly the reverse with clasts larger than 40 mm. These are on average larger in the upper part of the profile.

The nature of clasts was studied, together with texture, by spreading out the washed rubble of samples of all layers and making a direct comparison among them. The following was found:

Clasts in all layers were more or less rounded (but see Brodar 1999, 39, who states otherwise). The surface of rounded clasts could be 1.) smooth, i.e., healthy, 2.) minimally weathered or rough, i.e., floury, and 3.) very weathered. The coarse rubble in layers 5a and 5a? is the most weathered in the entire profile. Several layers of the upper and middle part of the profile have very weathered surfaces of the coarse rubble and blocks: 8b-10, 8b, 5a, 5a? and 4, and only two layers in the lower part of the profile, layers $17a_3$ and 18. All the enumerated layers also contain completely weathered 'phantom' rubble, which is familiar from a number of other Upper Pleistocene cave sites. There is no reliable explanation for its occurrence[2]. The surface of very rounded clasts in layers 8c and 10–12 is 'healthy', not crumbly.

It is interesting in relation to the weathering of clasts that the coarse rubble in surface Layer 2 is not very weathered, which perhaps does not apply to rubble that lies on the surface. The degree of weathering could not in this case be established because of the thick coating of consolidated mud and calcareous sinter which had to be removed with acid and which also broached the surface of the clasts.

The degree of weathering can be affected by the rock not being homogenous. Two colour variants of dolomite are present in the layers: dark grey, compact, very finely grained dolomite and white grainy dolomite (see Chapter 2 in this volume).

We found various forms of rubble during excavation and sampling of the profiles: from occasional very flat (oblate) forms (*plaquettes*), frequent oblong (prolate) forms (*prismatiques*?), equant (almost spheroid to cuboid) forms and various polyedric forms (Miskovsky 1974, fig. 133 and following, Laville 1975: pl. 37 and following). However, we did not quantify all forms. Similarly, we did not quantify rounded rubble and superficially and deeply weathered rubble and various coatings on it (see Campy 1989, 41ss), all of which appear in several variants in the sediments of Divje babe I.

The degree that the rubble was rounded was studied in slightly more detail in 7 samples from profile x = –1m (*Table 5.1.4*). The methodology for studying fluvial gravel morphometrically was used. Two samples of recent rubble from the nearby Divje babe II cave were additionally processed for better presentation and comparison (see Chapter 2 in this volume, *Fig. 2.2a, b*).

The age of rubble does not in itself condition the roundness or granularity of the rubble. Thus in the lower two layers (16 and 17) of rubble, there is the largest, least rounded and, at the same time, the flattest rubble, so most similar to recent rubble. It is not known exactly why rubble in some higher lying layers is so well rounded, like some gravel. However, it is certainly evident from the profile that rubble does not necessarily change with age, become more rounded and flatter (see M. Brodar 1959, 425). The variable structure and resistance of the host rock can have an impact on it, which also conditioned the rate of sedimentation and determined the quantity and composition of the matrix. In no case did the surface of individual pieces indicate the action of running water, since nowhere could traces of a polished surface be observed, which is most characteristic of real gravel.

Data from morphometric analysis is shown in more detail in *Table 5.1.4*. It should be noted that flatness and sphericity are two different indicators of the same processes and they are therefore in inverse proportion: the higher the index of flatness the lower the index of sphericity, although this relationship is not mathematically exact or calculable.

Recent rubble, samples from layers 16 and 17 and the sample from Layer 9 have the highest index of flatness (for Layer 16 see Chapter 4 in this volume, *Fig. 4.7*). This supports the thesis that greater flatness is not the result of later changes but is original, probably depending on the structure of discontinuity (joints, bedding etc.) in the rock. The roundness index also confirms this, which is also smallest in these samples.

In connection with the roundness index, it should be said that fluvial sediment with a roundness index of more than 100 is ranked among gravel, otherwise among rubble, although the "boundary" cannot be at all sharp but is a relatively wide transitional belt. In this case it is not gravel (see Chapter 4 of this volume, *Fig. 4.5*) but rubble, although with a high roundness index. The indexes show that the rubble in some layers (7, 12a, 8) was very greatly transformed. By way of illustration, the

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[2] Completely weathered clasts which could be crumbled by hand have been noted in the Alpine high mountains, 25-50 cm above the permanently frozen ground (Retzer 1974, 777).

results of 33 measurements of carbonate gravel from a number of Slovene caves are cited (Kranjc 1986): the median value of the roundness index of these measurements is 250, in a range from 117 to 551. The roundness index of rubble from Layer 7, which is 284, actually is therefore high. We came across greatly rounded rubble with a compact smooth surface and phosphate coatings deposited when the rubble was already rounded, in a number of places, e.g., on the base of Layer 8 and in one place on the base of Layer 5, which corresponds to an increase in precipitation (see sub-chapters 5.3.and 5.5 in this volume, *Fig. 5.3.6* and *5.5.1a*).

Comparison of the average size of rubble and the roundness index with the aid of Spearman's coefficient of correlation rank and the Student-t probability test (Briggs 1977) shows a less than 5 % probability that the average size (PV) and roundness (Za) are only coincidently dependent. The ratio between the two parameters is in inverse proportion – the smaller the average size, the higher the roundness index. This confirms the thesis that the rising index of roundness is because of post-depositional processes or gradual successive weathering and removal of the weathered coatings. The final product may be 'phantom' rubble. We did in fact often come across rubble during excavation that had a few millimetres of poorly bound coating of weathered surface, which could easily be removed mechanically, and the weathering process can then continue in depth.

We devoted more attention to special forms of clasts, which are explained as topsoil congelifracts and features of cavernous corrosion in the topsoil or on the cave ceiling (see sub-chapter 5.2 in this volume).

Brownish tones predominate in the colour of the sediments, with lighter and darker shades connected with their reduction-oxidation potential. The basic white to very light grey dolomite rock has been more or less transformed by post-sedimentation processes in the majority of layers. The colour of the sediments is mainly influenced by the coatings (thin layer) or encrustations (thick layer) on the clasts, which contain secondary ferrous minerals (hematite, goetite, lepidocrocite). Phosphate cements are especially strongly coloured. The colour of sediments depends on the geochemical composition and chemical processes, mainly the level of oxidation[3].

The chemical and biogenenous properties of sediments have been dealt with in sub-chapter 5.4 of this volume, and autogenic aggregates and diagenesis in sub-chapter 5.3. Only brief mention will therefore be made here to coatings or encrustations and breccia.

There are thin coatings on clasts in all layers but encrustations only in some layers. There are the most encrustations in the complex Layer 8. Thin clay coatings on fine rubble and sand are a particularity in layers 2, 5, 8b-10 and 11 (Turk, Dirjec 1997a, *Fig. 3.1: 2*). There are most such coatings in Layer 8b-10 (30 %). The colour of coatings and encrustations was determined on rubble of 40–65 mm size, because this was more quickly coloured than the base (Gale, Hoare 1991, 151). The colour of the coating in layers 2–5 is 10YR 7/8 (reddish yellow), in layers 6–8c: 10R 3/4 (dusky red), in layers 10–20: 7.5YR 4/4 (brown) and in layers 21–23: 10YR 3/2 (very dark greyish brown). The colours lead to the conclusion that they are predominantly oxidized iron compounds.

Mud and flowstone encrustations are characteristic of rubble in Layer 2 (mainly on the surface). Such encrustations are otherwise found only rarely and separately, either from consolidated mud or from flowstone (e.g., in layers 4, 6, 10 and 17a$_2$), and not together as in Layer 2.

Breccia is located in several layers. Phosphate bindings for the most part bind the dolomite clasts into the breccia. The colour of the breccia by layers is as follow: Layer 8a (10R 3/4 dusky red), Layer 10 (5YR 4/4 reddish brown), Layer 16 (breccia without base: 10R 3/4 dusky reddish, breccia with base: 2.5YR 3/4 dark reddish brown), layers 18a, 19 and 20 (7.5YR 4/4 – brown), layers 22 and 23 (10YR 3/2 very dark greyish brown). Individual larger phosphate aggregates in layers 7, 8c, 8b, 8b-10, 13, 16a, 17, 18 and 19/20 have the same colour as breccias.

Finally, mention must be made of the folding of layers, which is normally connected with cryoturbation (S. Brodar 1960; M. Brodar 1991; Osole 1961). Such folding mainly affected layers 2–5a, and some other layers to a lesser extent (e.g., 16a, 17a$_1$). Vertically positioned bones and oblong stones are associated with folds (see Chapter 16 in this volume, *Fig. 16.1*). The folds in layers 2–5a can be traced from the cave entrance to profile x = 21 m (*Fig. 5.1.10*). These layers are no longer folded behind this profile, which is perhaps connected to some extent with a change in the structure of the sediments. Behind profile x = 21, the grey Layer 4 with a low density of fossil remains containing few aggregates is suddenly replaced by a brown layer with a high density of fossil remains, containing a maximum of aggregates. In view of the suspicion that aggregates facilitate the expansion effects that occur when groundwater freezes, differences in the structure of sediments could have an impact on folding. The folds are most pronounced and largest in the central part of the cave, which may be connected with the micro-environment and/or microclimate. Sediments were constricted here by the narrowness of the cave and partially at the head, while in the entrance part they are only confined laterally. This had

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[3] We came across a band of reddish phosphate encrustation in rock in Layer 18, which corresponded exactly with the thickness and shape of the thin grey layer. In the grey coloured layers, the encrustations on individual clasts are the same colour as in brown layers. This suggests that, despite the different colours, the same process is concerned

an impact on expansion and bulging because of the segregation of the ice and the increase in volume. The temperature required for permafrost is significantly higher in caves than in the open, because of the absence of snow cover and vegetation cover. Permafrost can already occur in soils with fine-grained components, such as Divje babe I, with an average annual cave temperature of 2° C, but in the open with snow cover of 25 cm or less, only at –3° C (Van Andel 2002). The measured temperature of the air in the part behind profile x = 21 m in the winter of 1981 was 8° C with an outside temperature of – 1° C. However, it must be stressed that there was no active layer or molisol in Divje babe I, because of which gelifluction and solifluction did not occur except on the slope in front of the cave.

5.2. MORPHOLOGICAL CHARACTERISTICS OF CLASTS AND CLIMATO-STRATIGRAPHY

Abstract

The majority of what is dealt with in this sub-chapter has already been described and translated into English in Turk, Bastiani 2000 and Turk *et al.* 2001; 2005. Soil congelifracts served for approximation of variation of palaeotemperature (*Fig. 5.2.6*), cavernously corroded clasts for an approximation of variation of palaeohumidity (*Fig. 5.2.4*). We checked how cave bear responded to climatic changes (*Fig. 5.2.10; 5.2.11a,b*) and found that humidity had more impact than temperature on the dynamics of cave bear visits to the cave-lair and mortality.

The morphology of clasts has not to date received particular attention in the study of autochthonous cave sediments. The idea of studying it occurred to I. Turk on the basis of field observations in washing all sediments on sieves with mesh diameters of 10 mm, 3 mm and 0.5 mm. Some shapes of clasts, of all sizes, namely, were repeated to various extents and number in all layers. It was clear with some fragments that their surface had been transformed on the cave roof. Other shapes could only have been created postsedimentarily on the cave floor and its topsoil. Since moisture and temperature mainly affected the transformation of clasts and the transformation of the cave roof, it provided a unique opportunity for climatostratigraphic articulation and interpretation of the profile. The variability of morphological forms in the profile is thus ascribed to the influence of climate. The linkage of climatostratigraphy and chronology is discussed in Chapter 6 of this volume.

The results of morphologic analysis enabled division of the profile into three facies (A, B and C) and in certain cases into sub-facies (C-1 and C-2) (Turk 2003a). Such a division later appeared to be appropriate and chronologically well-founded (see Turk 2006). It thus served as a basis for various stratigraphic studies, and will also be useful in planning archaeological analyses. The boundary between facies A and B was arbitrarily determined between layers 6 and 7 and the boundary between facies B and C between layers 12 and 13. The boundary between sub-facies C-1 and C-2 was set between layers 17a3 and 17/18.

When we set about morphological analysis of the clasts, we were primarily concerned with two things:

1. Moisture, which condenses on the cave roof and walls, causes cavernous corrosion of the dolomite rock (see Slabe 1995). Because of the action of freezing, pieces of the corroded areas fall off and are mixed with other clasts (see sub-chapter 5.1 in this volume, *Fig. 5.1.5*).
2. Groundwater, the inflow of which is directly connected with precipitation, corrosively etches the dolomite clasts and mass of fossil remains on the cave floor. It thus first rounds the edges of clasts and bone fragments and then gradually the whole clasts. In certain cases, a specific cavernous corrosion occurs on both clasts and bones (*Fig. 5.2.1*). Because of the action of freezing on/in the cave topsoil, the rounded and other clasts crumble into congelifracts (see Ehlers 1996, Fig. 60) (*Fig.5.2.2*).

By topsoil is meant exclusively the relatively thin surface layer in which intensive post-sedimentary processes take or took place. In deeper layers, these processes are slowed or are not pronounced, which is confirmed by the lack of linkage between diagenetic processes and the age of sediments.

The etched (cavernously corroded) surfaces of clasts, as has been said, are a result of primary cavernous corrosion and secondary corrosion on the floor. Ceiling and topsoil cavernous corrosion, the share of which can theoretically be assessed by means of corroded clasts, is an indicator of moisture and gaps in autochthonous clastic sedimentation (Turk *et al.* 2005a). Etched bones are created exclusively in the topsoil and are considerably rarer than etched (cavernously corroded) clasts.

Congelifracts of all types are connected with moisture and temperature, but they are exclusively a result of negative temperatures. The method of sampling is extremely important for the interpretation of congelifracts. Among the congelifracts we selected those which were created on/in the floor by secondary weathering, i.e., post-sedimentarily, because of which, with the exception of the most recent edges, other edges have become rounded. These were designated topsoil congelifracts, in distinction to other congelifracts. The influence of the rate of sedimentation on the quantity of soil congelifracts was reduced by selection of clasts of the last generation, which had been created immediately before deposition of new sediments from primary weathering (Turk *et al.* 2001). Time intervals in which the topsoil congelifracts were created on individual levels were thus also equated. We were unable, though, to remove the effects of uneven sedimentation, because of which time gaps were created between individual levels of topsoil congelifracts.

There was the same difficulty also with cavernously corroded clasts and bones. Cavernously corroded clasts and topsoil congelifracts were studied in different profiles, some of which are duplicated in an extended series of layers, so that it was possible to compare results from different profiles. Unfortunately, we did not succeed in systematically collecting data relating to a large volume of sediments or sedimentation levels, as we succeeded in doing with bone remains and aggregates (Turk 2003a).

Cavernous corrosion of clasts was studied on the basis of samples that contained 62–253 clasts larger than 40 mm. The results obtained by profiles were checked with etching of bones in sedimentation levels, which were compared with layers as determined in the profiles. Because of the low occurrence of etching on bones, the samples of bones were essentially larger than the samples of clasts, numbering from 3,132 to 24,212 bones. There is thus large correspondence between cavernously corroded clasts and etched bones (*Fig. 5.2.3*), so that only results obtained only on the basis of clasts can be trusted. These are shown in *Fig. 5.2.4* and in *Table 5.2.1*.

Cavernous corrosion was shown as deviation from the Holocene average for Divje babe I, which amounts to 4 % ± 2.8 % (= 2 SE). Larger deviations are characteristic of the upper part of the profile (facies A–B), which belong to isotope stage 3 (MIS 3) (see Chapter 6 in this volume). This means that there were at that time a number of major gaps in sedimentation and that the climate was damper than in the lower part of the profile (facies C), which belongs to isotope stage 5 (MIS 5). The curve of cavernously corroded clasts corresponds very well to the curve of distribution of aggregates, which parallels changes in humidity and the share of congelifracts, indicating changing temperatures (see *Fig. 5.2.7a, b* and sub-chapter 5.3 in this volume, *Fig. 5.3.3a*). More about this below.

Postsedimentary or topsoil weathering was estimated on the basis of the share of topsoil congelifracts of medium coarse rubble (<40>10 mm) within the total number of rounded pieces of rubble in a sample. In the case of samples that contained an average of 1,300 whole pieces with rounded edges and congelifracts together, we decided on sub-sampling in quarters. The shares of congelifracts are shown in *Tables 5.2.1* and *5.2.2*.

The criteria for determining congelifracts were made uniform by examining all samples and sub-samples at least ten times. Congelifracts were excluded by examining all original samples and sub-samples twice in succession in two days. There were no significant differences between the first and second selection of congelifracts, despite a one year gap. We selected congelifracts with fractures that were as fresh as possible in appearance, which was best seen by sharp edges and relief at the fractures and a different level of weathering of old fracture faces and new fracture faces. Relatively older fractures all have more or less rounded edges and weathered surfaces. Where possible, we did not mix them with the youngest fractures. We had slight difficulties in the classification of fractures in the case of extremely weathered clasts in layers 4, 5a, 7 and 8b. Classification of fractures was not feasible in cemented sediments.

The method was checked on two fractions with congelifracts of two of the same profiles. The fractions gave similar results in both cases, one of which is shown on *Fig. 5.2.5*. We therefore think that the method can be fully trusted. However, it would be sensible in the future also to monitor the phenomenon spatially at the site, as we did with aggregates and bones (Turk 2003a).

Congelifracts occur wherever it freezes. They are especially frequent in periglacial areas. Although they occur in almost all Pleistocene and Holocene cave sites in Slovenia, nobody has studied them systematically. They should certainly be taken into account in the future.

The results obtained on the basis of analysis of congelifracts are shown in *Fig. 5.2.6*.

The action of freezing on/in the ground is shown as deviation of the share of congelifracts from the Holocene value, which is 4.4 % ±3.2 % (= 3 SE) or 6.5 % ±2.6 % (= 3 SE). The value refers to the action of freezing more than 4 millennia ago. This was established on the basis of comparison of the thickness of the flowstone coating on prehistoric pottery and congelifracts.

A larger share of congelifracts is characteristic of the upper part of the profile (facies A–B) than of the lower (facies C). This means a colder or warmer climate, which entirely corresponds to the dating of the layers in the two parts of the profile to isotope stages MIS 3 and 5 (see Chapter 6 in this volume).

The distribution of congelifracts in the profile corresponds very well with the distribution of cavernously corroded clasts (*Fig. 5.2.7*). This is understandable, since moisture is required for the occurrence of either. In addition, there is more condensation at lower temperatures than at higher ones. There are few cavernously corroded clasts and congelifracts in facies C and a lot in facies A–B (*Fig. 5.2.7a*). Because corrosion of the cave roof occurred during gaps in clastic sedimentation, some of the cavernously corroded clasts may be older than the associated congelifracts. Some of the cavernously corroded clasts are probably a result of corrosion on/in the ground. This indicates a comparatively good correlation between the representation of etched bones and cavernously corroded clasts (*Fig. 5.2.3*). If this is the case, there is a real danger that in interpreting cavernously corroded clasts, we remain stuck in the circle of cavernously corroded clasts – fossil remains or that cavernously corroded clasts are a direct result of the accumulation of fossil remains of cave bear, rather than being a direct result of a damper climate. Since there can be a stratigraphic gap between etched clasts and fossil remains, connected with processes in the ground, we shifted the curve of cavernously corroded clasts back three stratigraphic units (*Fig. 5.2.8*). The correspondence of the two curves allows the possibility of a cause-effect link between fossil remains (i.e., cave bear) and ground corrosion, which can be explained in two ways: 1.) Cave bear contributed organic substances which, together with increased humidity caused corrosion of lower lying clasts. The main cause of corrosion would be organic substances. 2.) Cave bear sought shelter in the cave mainly in long periods of increased humidity. The main cause of corrosion would be the increased humidity. Increased humidity is undoubtedly proven on the basis of roof corrosion and precipitation of secondary calcite in the form of thin crusts on bones (*Fig. 5.2.9*), clasts and cavernously corroded surfaces which had previously been incrusted with phosphate. The latter suggests an extended period of increased humidity or increased precipitation, which are reflected both on the roof and on the ground in the following successive processes: cavernous corrosion, phosphate incrustation and flowstone deposition.

There is no doubt that the presence of cave bear at the site is connected with climate. Similarly, there is no doubt that the remains of cave bear had a feed-back effect on sediment, which is especially true of cavernously corroded clasts and authigenic phosphate aggregates or new pedogenetic forms. So comparison between the identified climate on the basis of aggregates and congelifracts on the one hand, and fossil remains and congelifracts on the other, is instructive (*Fig. 5.2.10*).

In the presumed dry and moderately warm climate of isotope stage MIS 5 there is no connection between temperature and cave bear on the basis of topsoil congelifracts as an approximation of palaeotemperature. The moderate temperature oscillations did not significantly affect the presence and mortality of cave bear. In the presumed damp, or dry and cold, or moderately warm climate of isotope stage MIS 3 there is a pronounced positive correlation between temperature and cave bear. The only exception is Layer 5a. The presence and mortality of cave bear is absolutely significantly greater in warm periods than in cold. The layers of facies A and B show that there are more bone remains in warm periods and fewer in cold ones. The exception is Layer 5a. There are fewer remains in cold damp periods than in warm damp ones.

If the approximation of palaeotemperature is replaced with an approximation of palaeohumidity (see sub-chapter 5.3 in this volume), then there are more bone remains in damper phases and fewer in drier ones. In the layers of facies B that belong to warm and damp climates, there is a positive connection between approximations of palaeotemperature and bone remains (*Fig. 5.2.10* and *5.2.11a*), and an explicitly negative connection between approximations of palaeohumidity and bone remains (*Fig. 5.2.11b*). There is no special relationship between climate and cave bear in the remaining layers of MIS 3.

In the cryoturbation folded layers 2–5a, the share of post-sedimentation congelifracts is as in all other layers of the upper part of the profile. Against expectation, their share did not increase. We therefore conclude that permafrost occurred in layers 2–5a, without an active layer that melted in summer and refroze in winter. This was possible in the cave environment and because of the shady position of the cave entrance. Under such conditions, cryoturbation would occur with gradual freezing and gradual unfreezing of sediments of all the affected layers. This may have been repeated several times, but always without a real active layer in which there were significantly more post-sedimentation congelifracts than we actually found in folded layers 2–5a. If this was so, the idea of pronounced gelifluction of sediments forming layers 2–5a is unfounded.

5.3. AGGREGATES, BRECCIA AND CLIMATO-STRATIGRAPHY

Abstract

Some themes dealt with in this sub-chapter have already been described and translated into English in Turk et al. 2005 and Turk 2005; 2006. Authigenic soil aggregates served for an approximation of palaeohumidity, whereby the results well matched approximations of palaeohumidity on the basis of cavernously corroded clasts (*Fig. 5.3.4a*). Cave bear played a decisive role in the creation of both aggregates and cavernously corroded clasts, contributing phosphate binding and organic acids (*Fig. 5.3.4b, 5.3.5a,b*). On the basis of soil congelifracts and aggregates, we obtained a climatogram of the site (*Fig. 5.3.6*). Climatic approximations for palaeotemperature and palaeohumidity show that colder periods were generally more humid, which means that there was also more precipitation. This does not correspond to the majority of explanations to date of climate in the Upper Pleistocene on the basis of cave sediments and simulations of climate in MIS 3 for the Mediterranean and Southeast Europe on the basis of heterogeneous data from 380 palaeolithic sites (Barron et al. 2003).

A peculiarity in the sediments is the breccia in layers 6, 7, 8, 10, 16, 16a, 18, 18a, 19, 20, 22–24 and 26. The breccia in layers 6/7, 8a, 8c/8b and 8b-10 is characterised by a higher quantity of phosphorus, which originates primarily from bioapatites. A content of phosphorus in breccia is not bound to a specific type of climate. In addition, sporadic appearances of breccia in the profile of the site does not correspond to estimates of palaeohumidity.

Authigenic aggregates, which were created by diagenetic processes on the cave floor with the interaction of water and cement, are typical topsoil formations. Although they represent only an insignificant share of clastic sediments, they can be very important for ascertaining palaeohumidity or palaeoprecipitation. Aggregates appear in all finer fractions and are also a composite part of breccia (*Fig. 5.3.1*). They are made from tiny clasts, microscopic fragments of bone and cement. New formations are often from pure phosphate cement. In certain cases larger bone and dolomite fragments (*Fig. 5.3.2*) as well as hairs are cemented in the latter (see Chapter 13 in this volume).

The share of aggregates was determined with the aid of mass by volume (density) in the 0.5–3 mm fraction, whereby the density is in inverse relation to the amount of aggregates. The choice of fraction was of an exclusively practical nature, since we obtained this fraction by rinsing the sediments in sieves. In addition, we could successfully control visually the content of the aggregates and their spatial variability (see Chapter 1 in this volume, *Fig. 1.4*). This fraction has the smallest mass share of all the fractions. It ranges from a minimum 1.4% in Layer 10-11 to a maximum of 14.8% in caplayer 8b-10.

Aggregates as an approximation of palaeohumidity were determined in a mixed sediment sample, so that they represent the average of the sample (*Fig. 5.3.3a, b*). The density of the 0.5–3 mm fraction is a maximum of 1.54 g/cm^3 (dolomite clasts without aggregates) and a minimum of 0.82 g/cm^3 (aggregates without dolomite clasts). The error in determining density amounted at most to ± 0.05 g/cm^3 or 3.2 % to 6 % in relation to the range of volumetric mass. Sampling was done both in the profiles and in sedimentation levels, which enabled a good insight into variability connected with time and space (Turk 2003a). As with topsoil congelifracts, in the case of aggregates, too, we were unable to remove the effect of uneven sedimentation, because of which there could be more aggregates in individual levels than in others.

In the case of aggregates containing predominantly phosphate cement, their creation is questionable and, consequently, the use of representation of aggregates as an approximation of palaeohumidity. It is not clear, namely, whether aggregates are autocyclic and causally connected with the life and death of cave bear, which contributed phosphorous, or alocyclic and causally connected with climate, or a combination of the two, which seems most likely (see also Turk 2003a, 2006).

The curves of aggregates and cavernously corroded clasts are similar. Both indicate strongly increased moisture in facies B and a similar trend of values in the majority of the profile (*Fig. 5.3.4a*). The curve of fossil remains of cave bear do not show a trend in relation to aggregates and cavernously corroded clasts (*Fig. 5.3.4b*), but peaks in facies B correspond with increased humidity expressed by aggregates and cavernously corroded clasts. Lateral checking of the content of aggregates and fossil remains of cave bear by sedimentation levels revealed even greater similarities, and even a synchronicity between the curves of aggregates and fossil remains (Turk 2003a, *Fig. 6*). The phenomenon of aggregates and cavernously corroded clasts can be explained by the interaction of sediment, cave bear and climate (*Fig. 5.3.5a, b*). Certainly the changes are more alocyclic than autocyclic, on which climate, more precisely humidity or precipitation, had an impact. As is evident from *Fig. 5.3.5a,* and *b,* very similar causes can have different effects, and for one cause to trigger an effect, the interaction of a number of causes is sometimes required.

Climatic approximations to palaeotemperature and palaeohumidity show that colder periods were general more humid, which means that there was more precipitation (*Fig. 5.3.6*). This does not correspond with the majority of explanations to date of climate in the Upper Pleistocene on the basis of cave sediments and by simulation of climate in isotope stage MIS 3 for the Mediterranean and Southeast Europe on the basis of heterogeneous data from 380 Palaeolithic sites (Barron *et al.* 2003). On the other hand, our results accord with envisaged changes in the climatic minimum or late or last glacial maximum (LGM) on the basis of another (meteorological?) model. Climate in the temperate zone (between latitude 35° and 50°) would have been damper than today because of changes in the circulation of air masses and redistribution of climatic zones (Reading, Levell 1996, 10, sl. 2.1b).

Breccia or cemented clastic sediments in layers 6, 7, 8, 10, 16, 16a, 18, 18a, 19, 20, 22–24 and 26, with predominantly phosphate cement, are genetically connected with phosphate aggregates. Only smaller parts of individual layers were cemented in the entrance part of the cave, mainly in Layer 8, but the breccia in Layer 8 covers almost the entire excavated area in the central part. This breccia, with carbonate-phosphate binding, belongs to two main phases of cementing, interrupted by an unbound mixture of dolomite rubble, sand and silt. The older phase embraced layers 8 and 10 (Layer 9 is of local character) and the more recent layers 6 to 8. Each individual phase is not necessarily uniform, since the associated breccia is broken in places by small insertions of unconsolidated sediment, which cannot be equated with the main interphase packet of unconsolidated sediments. This extends above/below 46 % of the cemented area. On 27 % of this area there is extremely weathered rubble ('phantom rubble'). Between the two main phases of cementing there is probably a third, less pronounced phase which covers approximately 10 % of the entire excavated area (Turk, Bastiani 2000). The three phases of cementing correspond well with the three phases of pre- and postdepositional corrosion, expressed by cavernously corroded clasts in layers 7–10, which reflect the amount of precipitation (see *Fig. 5.2.7*). All the signs suggest that there was an extremely humid climate in facies B.

The layers above the upper breccia in Layer 8 are no longer cemented anywhere, with the exception of the present cave floor, which is in places sealed with flowstone. Below the region of holocene flowstone, up to Layer 16 inclusive we nowhere came across an older flowstone area which could be connected with any explicitly humid period of the last glacial or with the last, more correctly penultimate, interglacial (OIS/MIS 5e). The first modest flowstone only appears in Layer 17/18, which is in essence composed of loosely packed flowstone particles or calcite aggregates.

It is difficult to connect the breccia in the various layers of the profile of Divje babe I into a sensible totality with other climatic and environmental indicators. The classification of cemented layers on the model of classification on the basis of analysis of approximations of climate given by topsoil congelifracts and phosphate aggregates showed that breccia has no connection with the estimate of climate as a whole, consisting of temperature and precipitation (Turk 2006). In cases in which there is partial coincidence, such as in Layer 8, in which both aggregates and breccia and cavernously corroded clasts and etched bones testify to an extremely damp climate, this is only coincidence. We therefore tend to the opinion that climate at the time of deposition of the layers of facies C was drier than at the time of deposition of facies A and B, despite the more frequent cementation of sediments which probably occurred subsequently and with a considerable time lag after deposition of the layer.

Cementing is a process which generally takes place gradually, from cementing of the smallest particles (creation of aggregates) to the largest (breccias). The most phosphate cement, which is at the same time the purest, is in the breccias. The chemical composition of the cements in the various layers of the profile of Divje babe I are shown in *Table 5.3.1*. For the analyses made in the laboratories of ACME Analytical laboratories LTD in Canada using inductively coupled plasma emission spectrometry, the purest cement possible in breccias, as far as possible without clastic dolomite components, was delivered. Despite careful sampling, in some cases we were unable to avoid dolomite clasts, which contaminated the phosphate cement.

In the first row of *Table 5.3.1* are the values which, in terms of our measurements, would have accumulated in a thousand years per square metre in sediment excreted from water trickling through the roof of the cave[4]. We have marked them as the modern standard. All values of elements of the modern standard are more or less comparable with the values in the sediment profile. The only exception is copper. In the modern standard there is also a great deal of loss on ignition, mainly because of the content of organic substances, represented by carbon, which amounts to 30.6 %.

Layer 1 is calcareous sinter, which is still being deposited in the cave. It is characterised by a large amount of CaO, large loss on ignition and small values of all elements, above all strontium.

In order to understand the diagenesis of the breccias, the fractions of loosely packed sediment are also important. They contain aggregates which represent the early phase of cementing. We therefore analysed the cement of the breccias and fractions in the same layers so that the fractions belong to approximately the same stratigraphic levels as the cement of breccias (*Table 5.3.2*).

A proper understanding of the geochemistry of the fractions and breccias requires recognition of the components and properties of the analysed fractions.

The fraction 0.5–3 mm consists of aggregates, dolomite clasts and bone fragments. The aggregates are authigenic new forms that were created *in situ* in the early diagenesis of the cave sediments. They consist of cave sediments bound with phosphate cement. The cave sediment is mainly dolomite clasts and various alochthonous admixtures. The shares of chemical elements in the fraction vary mainly because of the different ratios of components that make up the 0.5 – 3 mm fraction.

The fraction smaller than 0.5 mm, has a similar composition to the 0.5 – 3 mm fraction but with the possible addition of exogenous new forms and disintegrating alochthonous aggregates. The shares of chemical elements vary for similar reasons as with the coarser fraction.

In all fractions and in the breccia there is significantly less Al_2O_3, Fe_2O_3, SiO_2 and other oxides and trace elements characteristic of the regolith which make up the carbonate soils in the near vicinity (see Chapter 3 in this volume, *Table 3.1*). This proves indisputably that at the time of deposition of each individual layer there was not a significant leaching of the regolith above the cave into the cave (see also Turk 2006 and sub-chapter 5.4 in this volume), because of the specific relief above the cave which conditioned the constant erosion of the soil. Divje

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[4] The fraction smaller than 0.5 mm, which is carried through the roof today by trickling water was sampled over a period of 7 years in the central part of the cave on an area of about 150 m^2. On the basis of the chemical elements in the sediment, which was collected in overflow accumulation vessels measuring 1x1x1 m, we calculated the entry of exogenous elements per square metre in a thousand years.

babe I is thus a rare example of almost completely autochthonous, exceptionally thick cave sedimentation in a carbonate environment. This is an attribute which it would certainly be worth making better use of in the future.

5.4. GEOCHEMICAL ANALYSIS OF THE SAND-SILT SEDIMENTARY FRACTION

Abstract

The theme of this sub-chapter was partially dealt with and translated into English in Turk 2006. In the sand-silt fraction we analysed three groups of chemical elements (*Fig. 5.4.1-5.4.4*).

Ratio between calcium and strontium (*Fig. 5.4.4*) vary in the profile in the same way as content of phosphate aggregates (see sub-chapter 5.3 in this volume, *Fig. 5.3.6*). All this is correlated with the variation of humidity or precipitation and support divison of the profile on four already proposed parts (facies A–B and subfacies C-1 to C-2). Facies A and Subfacies C-2 are similar while facies B and especially subfacies C-1 are very specific in terms of the content of calcium and strontium and their ratio (*Fig. 5.4.4*).

During excavations in 1990–1999 among other things we systematically sampled the fraction smaller than 0.5 mm, which we continuously analysed geochemically in the composite profile (*Tab. 5.4.1*)[5] and cuts of quadrat 36 (Turk 2006). The analysed fraction represents the most mobile part of the sediments which, together with some other fractions, fill the pores between the larger clasts and blocks

The basic characteristic of the geochemical composition of the fraction smaller than 0.5 mm is that it contains absolutely the largest share of the majority of the analysed elements of all the fractions. Only Zn, Cu, Cd, Ni, MgO, CaO, P_2O_5, Sr and U are exceptions. These are more represented in the larger fractions, of which bone fragments and aggregates are also a component, which to a larger extent contain mainly phosphates, more rarely calcite cement.

In the fraction smaller than 0.5 mm, various alochthonous admixtures are possible, carried by water, wind, animals and people.

Water washed out the fine soil components from the shallow soil and leached rocks immediately above the cave and re-deposited them as cave sediments. The same processes also occurred within the profile of the cave sediments or cave floor. Because of this, it is impossible to ascertain the real nature of the elluvial-illuvial horizons. The result of this is an uncertain chronological interpretation of this phenomenon. The more abundant presumed pleistocene regolith have been preserved in a number of places on the plateau above the cave, but not directly above it (see Chapter 3 in this volume).

The wind carried sand and smaller grains and aerosols from the distant and immediate vicinity. These constituents may have been deposited directly because of the activity of the wind or have been washed into the ground by precipitation.

Cave bear brought not insignificant amounts of dust and mud on his fur from the nearby surroundings. Bears that died contributed the main bio-elements (C, H, N, Ca, P, O, K, S, Cl, Na, Mg), as well as trace elements (Fe, Zn, Cu, Mn, Ni, Mo, Cr, Se, I, Co, F, Sn, Si, V and As). Organic acids, which were created on the basis of the bio-elements, played a significant role in the diagenesis of sediments.

Various human activities locally influenced the geochemical composition of sediments in the hearths and in their immediate vicinity, as was shown by comparative analyses between hearths and sediments (unpublished) (see also sub-chapter 5.5 in this volume). However, because of his modest presence mankind cannot be ranked among the more influential factors.

In relation to new diagenetical forms, it was established that they were created exclusively on/in the cave topsoil or sediment and are therefore authigenic. Authigenic new creations were greatly dependent on the rate of deposition of sediments. They may have been created autocyclicly if they were mainly affected by factors connected with the sediments, in this case the remains of cave bear, or alocyclicly if they were mainly affected by climate.

The values of the analysed elements show patterns in the profile characteristic of individual groups of elements which can also be established by principal components analysis (PCA). The patterns differ among themselves on the basis of numerous phase lags, while these are rare within individual group. We verified whether the analytical data are reliable by comparison of data in two profiles and with repeated sampling in the same profile (Turk 2006).

In the first group (*Fig. 5.4.1*) there are minerals containing SiO_2, Al_2O_3, Fe_2O_3, K_2O, Na_2O, Th, Ce, Zr and other rare earths. This group for the most part represents alochthonous components of the sediment.

In the second group (*Fig. 5.4.2*) are para-alochthonous elements of organic origin or minerals containing P_2O_5, Cu, Co and Ba. Sodium also belongs in this group (see Turk 2006) and calcium, since calcium is one of the main components of apatite, i.e., bone and phosphate cements.

In the third group (*Fig. 5.4.3*) are autochthonous elements or minerals containing CaO, MgO and Sr, i.e., the main components of the host rock or sediment clasts.

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[5] The geochemical analyses were made in the laboratories of ACME Analytical Laboratories LTD in Canada by the ICP method (inductively coupled plasma emission spectrometry): Group 4A-Whole rock ICP analysis, Group 4B and Group 1DX.

The first group of elements are characterised by an explicitly cyclical nature and a slight trend which appears in falling values of all elements from below upwards in the profile. These elements are also today leached from the surface above the cave (see values of modern sample in *Table. 5.4.1*). Judging by the thorium and especially the aluminium, which does not migrate during weathering, there have not been major shifts within the profile. The peaks of elements in the profile are connected with increased transport of alochthonous material into the cave.

The average values of elements of the first group are all smaller than in Potočka zijalka and Mokriška jama and significantly higher than in dolomite (*Table 5.4.1*). The sediments of Potočka zijalka and Mokriška jama clearly contain more residuals of weathering (for which read loam). Both sites are at a 3–4 times higher altitude than Divje babe I, and the sedimentary environment is also different.

The second group of elements are characterised by more weakly expressed cyclicity and an absence of a long-term trend, the phase lag in individual sections is also more frequent (*Fig. 5.4.2*), which applies in particular for cobalt. Copper and to a lesser extent cobalt are today leached from the surface above the cave. The peaks of the three elements are connected with peaks of the remains of cave bear, which analyses of their bones also showed (Skaberne *et al.* 2006). Barium and copper vary in the profile, similar to phosphorus. While there is no phase lag with copper, there is such a lag with barium at the end of sub-facies C-1 and at the start of facies B. Today barium, and similarly phosphorus, is leached and accumulates in the cave in quantities which are three times lower than the average pleistocene values (*Table 5.4.1*). We therefore justifiably suspect that barium in the pleistocene sediments derives mainly from the remains of cave bear. The assumption is supported by individual data for Potočka zijalka and Mokriška jama[6], which have a higher content of phosphorous, copper and barium than the average in Divje babe I (*Table 5.4.1*).

A linear pattern of the data is characteristic of the third group of elements (*Fig. 5.4.3*). Calcium and magnesium are antagonist, and similarly magnesium and strontium. Their values in the profile are precisely inverse. The values of magnesium have the highest amplitude, strontium the least, and calcium between the two. Standard deviation with magnesium is significantly greater than with calcium.

Where secondary calcite is present in the profile in the sediment fraction, such as in the dripstone from Layer 1, it can be observed that the content of strontium and magnesium is smaller, and calcium increased (*Fig. 5.4.3*). This is very clearly seen only in Layer 17/18, the sediment of which consists also of calcite concretions among other clastic material. In other layers, secondary calcite in the sand-silt fraction is present at most in traces, which does not necessarily apply for other fractions and different coatings and encrustations on larger clasts. It is therefore reasonable to interpret the relation between strontium and calcium, which is shown in *Fig. 5.4.4.*

There is only secondary calcite in Layer 2 with dripstone formation and in Layer 17/18 with calcite concretions, which is characterised by a large amount of calcium and small strontium content. In all other layers, the calcium is bound in appatite. The ratio between calcium and strontium changes in the profile in the same way as the content of phosphate aggregates (see subchapter 5.3 in this volume, *Fig. 5.3.6*). Altogether, it is bound to the variability of moisture or precipitation and enables division of the profile into the already proposed four parts (facies and sub-facies). Facies A and sub-facies C-2 are similar. Facies B is individual, as is above all sub-facies C-1, in terms of the content of calcium and strontium and their ratios (*Fig. 5.4.4*).

5.5. UNUSUAL MINERAL IN A HEARTH FROM DIVJE BABE I

Abstract

A white substance (WS) found by flotation of charred material in hearth layers in Divje babe I was analysed. With the aid of electron microscopy, infrared spectroscopy and diffraction of X-rays, it was found that WS is magnesium 1M muscovite, with an unusual ribbon-like shape of crystal for this compound, so far unknown for this mineral. The presence of WS in and around cave hearths is ascribed to the disintegration of slates, which had been brought to the cave and were found in hearths beside charcoal and charred bones. This raises the suspicion that people used slates by the hearths. The geochemical formation of the ribbon-like WS from slate in Divje babe I cave remains an open question.

During examination of a hearth in Layer 5 (Turk, Kavur 1997), during flotation of burnt material (sediment with a large amount of charcoal), we came across fragments of a white substance (hereinafter WS) (*Fig. 5.5.1*). It subsequently appeared that this was not an isolated case. WS was additionally found in a hearth in Layer 6 while taking samples for ESR analysis in the profile y = 2 m, in a hearth on the boundary of layers 7 and 8 in quadrat 41, cut –273 cm, in a hearth in Layer 8a in quadrats 17 and 19, cuts –261 cm and –273 cm, in a hearth in the lower part of Layer 8 in quadrats 13, 16, 34 and 35, cuts –346 cm and –357 cm. In all cases they

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[6] They are our own measurements together with the samples from Divje babe I, specifically in Layer 2 of excavations in Potočka zijalka in 2000, 'phosphate earth' from the excavation by S. Brodar at the end of the cave and phosphate earth from Mokriška jama (Layer 7?). Both sites, like Divje babe I, are characterised by numerous cave bear remains.

were well preserved hearths discovered *in situ*, with a large amount of charcoal and charred bones (see Chapter 8 in this volume).

During the course of flotation, water did not penetrate the fragments of WS and the WS retained its white colour. The fibrous structure of the WS, which was visible to the naked eye, is fragile and crumbles with pressure. The mineral acids do not decompose WS and, similarly, organic liquids do not dissolve and WS does not burn. WS is therefore a porous and microcrystalline inorganic material, which scatters light and is therefore white.

The presence of material with an explicitly microfibrous composition is fairly unusual for the mineralogical environment of Divje babe I, with predominately carbonate minerals (see Chapter 2 in this volume). However, more detailed analysis of the mineral composition around the hearth showed that all hearths in which WS also occurs have fragments of dark grey slate in the burnt material and in its immediate vicinity. Slate is a rock which normally occurs in the region beneath strata of dolomite, so the slates could not therefore have come to the site by a natural path, i.e., gravitational; someone brought them.

The slates in the area of hearths in Divje babe I may be associated with still unidentified activities of Palaeolithic visitors. Flat slates with engraves motifs have been found in various other locations, but Upper Palaeolithic sites (Bosinski, Fischer 1974; Kavur, Petru 2003). Slates disintegrate under certain hydrothermal conditions and geochemical processes can create new compounds from them, with specific mineral composition and microcrystallinity. A positive answer in relation to a chemical relation between WS and the slates would provide at least indirect evidence that their presence in the cave hearths is not coincidental but is connected with their deliberate use. We therefore decided to use electron microscopy, infrared spectroscopy and X-ray diffraction to determine the chemical nature of WS and to discover the chemical relation between WS and the slates found in and beside hearth depressions.

EXPERIMENTAL WORK

Microscopic analysis of the samples was done with the aid of a Scanning Electron Microscope Supra 35 VP Carl Zeiss, Germany. Samples were previously plated with gold, which ensured an electric contact and thus met the requirements for high magnification (5000x, 10000x, 50000x, 100000x). Energy Dispersive X-ray spectroscopy (EDX) was performed with the aid of an SEM microscope.

The infrared (IR) spectra were measured on a FT IR Bruker FTS 66 spectrometer. Samples were crushed together with paraffin oil and the relevant transmission spectra measured.

The powder X ray diffraction spectra was measured on a PANalytical X'Pert PRO using a reflection technique and copper $K_{\alpha 1}$ radiation. We identified the crystal phases present with the aid of the search programme Crystallographica Search-Match Version 2,1,1,0; Copyright 1996-2003, Oxford Cryosystems and the PDF-4, Release 2006, International Centre for Diffraction Data, USA database. Quantitative phase analysis was performed with the Topas 2.1, Bruker AXS, Germany, programme.

RESULTS AND DISCUSSION

SEM measurements and EDX analysis. Investigation of the chemical composition of WS was begun by determining its morphological properties. SEM photographs showed a predominate presence of a "ribbon phase" (hereinafter RPh WS) with some morphologically non-expressed symmetrical inclusions (*Fig. 5.5.2b, c*). A particularity of RPh WS are ribbons with a rectangular cross-section; the shortest side (a – thickness) is 30 to 100 nm long, the longest (b – width) from 200 to 1000 nm, while the length of ribbons (c) is up to 50x greater, up to 40 µm. The ratio between the sides (a:b:c = 1:10:40), is therefore explicitly in favour of the longest side of the ribbon; while the thickness of the ribbon is in the nanometre region, the width is already in micrometers (up to 40 µm). The regularity and repeatability of RPh WS shows that it is a uniform mineral and not a mixture of various micro-crystals with different chemical compositions.

The uniformity of the ribbons, irrespective of possible differences in the thickness and width, and the haphazard growth, is surprising; it is not therefore possible to identity their preferential orientation, typical of other minerals with a similar ribbon-like or needle-shaped morphology. In view of the ribbon structure, it was first suspected that the RPh WS is ferrierite (Grammlich-Meier *et al.* 1985); a transparent, needle-shaped zeolite unexpectedly found in septaria in Gorenje Štrihovec (Žorž *et al.* 2006), the chemical composition and structure of which was recently identified (A. Rečnik, personal communication). Ferrierite is characterised by even greater anisotropy (length exceeds width up to 10000x), but the thickness of the ribbons of RPh WS and ferrierite are approximately the same. In addition, crystals of ferrierite are organised and show the trend of growth, while RPh WS displays an explicitly interwoven and disorganised structure, which suggests that WS was perhaps created by a secondary process (such as the disintegration of slate) and not by slow crystallisation.

In terms of the ribbon-like morphology only, ferrierite is not the only mineral which could correspond to RPh WS. Illite (hydromuscovite) (*Fig. 5.5.3*) which, in addition to muscovite, is one of the main minerals found in clays, is particularly similar to RPh WS. This mineral belongs among clays and, as well as muscovite, is the main mineral of slate.

As a first step in identifying the chemical nature of RPh WS, EDX measurements were taken and the composition of elements thus obtained. This showed a considerable content of potassium and confirmed the expected presence of Al, Mg and Si (*Fig. 5.5.4b; Tab. 5.5.1*), in view illite, muscovite or any other mineral that slates would be expected to contain. Although it is undoubtedly a potassium magnesium alumo-silicate, EDX does not enable final identification of RPh WS, since there are a large number of minerals with such or very similar a composition. In the following step, we therefore took a powder X-ray diffractogram of the WS and analysed it.

Analysis of diffractograms. Powder X-ray diffractograms of the ribbon WS *(Fig. 5.5.6)* show sharp and well defined peaks, which confirms that the WS is well crystallised. Analysis of the peaks showed that dolomite is present to a lesser extent in the sample ($CaMg(CO_3)_2$). Its presence can also be concluded on the basis of the results of EDX analysis. The wide, low peaks in the diffractogram at 12.4 and 25.0 degrees clearly belong to burnt bone, generally appearing in cave hearths; it is of organic origin and poorly crystallised.

The main component in the sample of RPh WS is a mineral with a single layered, monoclinic structure (*Fig. 5.5.5)*: the basic cell is approximately a = 5.2, b = 9.0, c = 10.2 Å, $\gamma = 101^\circ$, symmetry C2/m). The mineral composition of such a structure is variable. Basically, all Al atoms are located in the octahedral layer and Si and Al in the tetrahedral layer, and potassium ions between the layers compensate the negative charge. The general chemical formula of such minerals is $A_yB_2C_4O_{10}X_2$. A is a large, normally single charged cathion (for example K), and y can be a maximum of 1. B cations occupy octahedral coordination, (predominantly Al and Mg, but may be Fe etc.), C cations (Si and Al) occupy tetrahedral site while X anions are OH or F. Specifically, one can take as a starting point, for example, the formula $KAl_2(AlSi_3)O_{10}(OH)_2$, in which individual cations can be replaced by others of similar size. The first change can be in the tetrahedral sites, at which the Al/Si ratio can vary. The second change can be in the octahedral sites, at which the Al can be partially replaced by Mg, Fe or other cations of similar size. Because of the different valence of the cations, which is variable, all these exchanges can also considerably influence the entire charge of the layer. This also triggers a demand for a third possible change, which in this case represents the amount of potassium ions between the layers (if the net negative charge of the alumo-silicate layer is less than one, the potassium sites do not need to be completely occupied but potassium can still be partially replaced by other cations). A fourth possible change of composition is the partial exchange of hydroxyl ions with fluoride in the anion layer. This does not affect the total charge of the layer.

The following cases provide illustration:
$KAl(Mg_{0.2}Al_{0.8})(Al_{0.42}Si_{3.58})O_{10}(OH)_2$ – mineral muscovite (Sidorenko *et al.* 1975),
$(K_{0.80}Na_{0.02}Ca_{0.01})(Al_{1.66}Fe_{0.06}Fe_{0.02}Mg_{0.28})(Si_{3.41}Al_{0.59})O_{10}(OH)_2)$ – mineral muscovite (Plancon *et al.* 1985),
$K_{0.7}Al_2(Si,Al)_4O_{10}(OH)_2$ – mineral illite (Brindley 1977) and $KFe_{1.5}Mg_{0.5}Si_4O_{10}(OH)_2$ – mineral celadonite (Zhukhlistov *et al.* 1977).

It is worth stressing that all these exchanges, because of the similar size of the cations which are exchangable, have little influence on the structure itself and the powder diffractograms of these substances are very similar. The most appropriate formula for RPh WS can therefore only be achieved by the combination of results of EDX and X ray diffraction analysis, the latter giving the specific number of cations and anions in the given crystallographic sites ($A_yB_2C_4O_{10}X_2$). It can be concluded from the determined chemical composition that the chemical formula of RPh WS is approximately, but most probably: $K(Mg_{0.4}Al_{1.6})(Si_{3.4}Al_{0.6})O_{10}(F,OH)_2$ (*Fig. 5.5.5*), characteristic of magnesium 1M muscovite.

The chemical formula derived from EDX and the structure determined from X ray analysis was further checked by Rietveld analysis, in which a theoretical diffractogram is calculated from the structural data of crystalline phases present, and compared with the measured diffractogram of the sample. If the match is satisfactory, it means that the structural model is correct and, by adjusting the contents of the phases, an approximate ratio between phases included in the model can be calculated.

The final comparison of the calculated and measured diffractogram is shown in *Fig. 5.5.6*. In view of the small quantity of the sample and the very unfavourable morphology (with ribbon-like samples there is a pronounced phenomenon of preferential orientation) the match is satisfactory. The crystal structure and approximate chemical formula of the ribbon-like mineral is thus confirmed as magnesium 1M muscovite. It further appears that the weight ratio between the magnesium 1M muscovite and dolomite in the sample is approximately 10:1.

The presence of dolomite in the WS was expected in view of the fact that the WS appears in a dolomite sedimentary environment typical of all hearths in Divje babe I. In contrast, the presence of magnesium 1M muscovite is surprising from a mineralogical point of view, since the immediate geological environment of the cave Divje babe I does not support the presence of such alumo-silicates, which generally appear in fine grained clastic sediments and pyroclastic and igneous rocks, which are found in a relatively narrow belt from Stopnik to Pisance on Krniški greben, approximately 3 km south of Divje babe I (see Čar, Skaberne 2003). The ribbon-like form of RPh WS is an additional problem, since muscovite only rarely crystallises in ribbon form, the normal crystal form is plate-like (*Fig. 5.5.7a, b*), whereas a ribbon-like form is common for illite. RPh WS clearly combines the properties of illite and magnesium 1M muscovite. In order at least partially to clarify the problem, we measured the infrared spectra of RPh WS and compared it with spectra of illite, muscovite, slate and some other minerals with similar composition.

IR spectra. The infrared spectrum of slate from the cave hearths is similar to the spectrum of RPh WS (*Fig. 5.5.8*). The similarity is surprisingly good, bearing in mind that slate similar to that from the hearths in Divje babe I contains a range of minerals, such as quartz, muscovite or illite, chlorite, hematite or pyrite with inclusions of apatite, graphite, kaolin, magnetite, turmaline or zirkone. The vibrational bands of minerals present in slates accumulate and lead to a final spectrum that does not differ significantly from the spectrum of RPh WS. In order to be able to obtain additional evidences about its structure, the RPh WS spectrum is compared with the spectra of structurally related minerals: illite, muscovite, celadonite and sericite – the last named is an intermediate phase in the metamorphosis of illite into muscovite (Kralj, personal communication; Hunziker *et al.* 1986).

However, comparison of the spectra of muscovite, celadonite (Velde 1978), illite (http://minerals.caltech.edu/files/infrared_MIR/Minerals_From_JK/Illite.txt) and sericite ($(K, Na)Al_2(AlSi_3O_{10})(OH)_2$) (Zhang *et al.* 2005)) with the spectrum of RPh WS shows that none of these fully matches the IR spectrum of RPh WS (*Fig. 5.5.8* and *Fig. 5.5.9*). Celadonite can be excluded from the comparison without difficulty; ribbons corresponding to the stretching bands of the SiO_4 groups (960–1100 cm^{-1}) differ from those for RPh WS. This also agrees with the fact that celadonite is a characteristic blue colour, while the WS is white. In addition, celadonite contains iron, which analysis of the diffractogram of RPh WS did not show. Similarly, sericite can be excluded because the EDX analyses do not show the presence of Na.

The spectra of all the minerals (illite, muscovite and sericite) are quite similar but not identical in the spectral region in which the stretching bands of the SiO_4 groups (960–1100 cm^{-1}) (Si-O and Al/Si-O stretching modes of SiO_4 in the tetrahedral layers) appear (Farmer 1964; 1974; Reshetnikova *et al.* 1969; Velde, 1978), and they differ from bands observed in the IR spectra of RPh WS. In the RPh WS spectrum, an additional shoulder band at 989 cm^{-1} can clearly be seen, observed also in the IR spectrum of muscovite at 993 cm^{-1}. The bands in the spectra of illite and slate in the region from 1030–1000 cm^{-1} are much broader and the shoulder band at 993 cm^{-1} observed in the spectra of RPh WS could not be seen. As expected, even bigger differences can be seen in stretching bands attributed to the –OH stretching bands of the –OH surface groups (3670–3690 cm^{-1}) and those in internal layers (3620–3630 cm^{-1}) (*Fig. 5.5.9*). A single band at 3630 cm^{-1} is characteristic of muscovite, contrasting several bands in the spectra of illite and sericite. In the spectra of the RPh WS only two pronounced, relatively narrow bands appear at 3618 and 3695 cm^{-1}, which frequencies, but not the band shape and intensity match those of illite. The fact that the RPh WS exhibits two –OH stretching bands while muscovite shows just a single band, could be related to the number of sites which are accessible for water in both materials. While the muscovite adsorbs water and become hydrophilic after exposure to water (van Oss, Giese 1995), the surface of the RPh WS remains non-hydrated. This could be correlated to the fact that RPh WS is isolated by flotation. Another possible reason for the well expressed hydrophobicity of the RPh WS surface could be its ribbon morphology; the small size of the ribbons having few nanometers in dimensions decreases the dispersive part of the surface energy, increasing the water contact angle pronouncedly above 90 degree, similar to reported superhydrophobic silica aerogels and nanostructured Al_2O_3 (Venkateswara *et al.* 2003).

In the spectral region from 800–870 cm^{-1}, where Si-O deformation modes of the tetrahedra (T-O-T) attributed to the Si-O-Al rings appear, the RPh WS exhibits the band at 836 cm^{-1}, which are barely seen in the spectra of illite and slate but could be seen in the spectra of muscovite (not shown here). The bands at 789 and 778 cm^{-1} attributed to the stretching bands of Si-O-Al^{VI} are strong in the spectra of illite and slate but they are absent in the spectra of RPh WS. Additional difference between the spectra of illite and RPh WS we notice for the band at 933 cm^{-1} (δ(H-O-Al^{VI})) (Post, Borer, 2002), which is much weaker in intensity in the spectra of the latter. This could be related to the absence of $(Mg^{+2})^{VI}$ ions, which illite and muscovite do not contain (Reshetnikova 1969) and accordingly exhibit much stronger intensity of this band. To conclude, the differences in the skeletal vibrations observed in the spectra of RPh WS (i.e. $K(Mg_{0.4}Al_{1.6})(Si_{3.4}Al_{0.6})O_{10}(F,OH)_2)$) and those observed in the spectra of illite and muscovite could be partially ascribed to the differences in their chemical composition. However, the bands attributed to the –OH stretching bands of RPh WS are very similar to those of illite, very probably due to the similarity of the ribbon-like morphology of illite and RPh WS and the type of the hydroxyl groups at the surface of the ribbons.

CONCLUSIONS

Magnesium 1M muscovite is the main component of the ribbon-like WS. Diffraction analysis combined with EDX measurements, confirms the presence of Mg but not Fe ions, which are characteristic of related celadonite, and the absence of its typical blue colour also excludes this mineral. Similarly, RPh WS cannot be classified as sericite, since EDX asnalysis did not show the presence of sodium in the structure.

Infrared spectra show major relationships among illite, sericite and muscovite. Although the spectrum of RPh WS is most similar to muscovite, it is not the same. Differences in skeletal modes of RPh WS and muscovite were ascribed to the presence of Mg in RPh WS, which muscovite does not have. There are also differences in the stretching bands attributed to the -OH groups, which show similarity to the illite spectrum. RPh WS does not have surface hydrogen bonded water molecules, and is relatively hydrophobic and consequently could be separated by flotation.

It is undoubtedly the case that the origin of RPh WS is the slates found in or in the vicinity of the Middle Palaeolithic hearths in Divje babe I. Slates are an allochthonous addition to the typical clastic sediments (see Chapter 5 in this volume) and today are located in places which exclude their entry to the cave by gravitation (see Basic Geological Map SFRY, Tolmin and Videm, L 33-64 and Chapter 2 in this volume). This suggests the possibility that larger pieces of slate were brought to the cave, where they later disintegrated. The fact that the ribbon-like WS appears together with slate in cave hearths beside charcoal and charred bones (see Chapter 18 in this volume) raises the possibility that people used the slates at the hearths. We can only guess at the intended use, of course. More about that will be perhaps outlined in the second, archaeological part of the monograph. The question of the geochemical formation of the ribbon-like WS from slate in Divje babe I remain open for future.

5.6. GENERAL CONCLUSION

Interpretation of the analysis of sediments of the palaeolithic site of Divje babe I showed that some of the properties of sediments may be connected to palaeoclimatic conditions at the time of their creation. Palaeotemperature is most reflected in the amount of congelifracts, on the basis of which we combined individual layers into facies A, B and C. There are more congelifracts in the upper part of the profile (facies A and B), which indicates a colder climate than in the lower part (facies C, which was divided into sub-facies C-1 and C-2) which would have been deposited in a warmer climate. The boundary between facies B and C, on the basis of dating of individual layers corresponds to the chronologically identified boundary between isotope stage MIS 3, which is characterised by a cold climate and MIS 5, which is characterised by a warmer climate (see Chapter 6 in this volume). The best indicator or approximation of palaeohumidity appeared to be cavernously corroded clasts and a group of constituent linked properties of sediments: phosphate aggregates, fossil remains of cave bear, phosphorous, calcium, strontium and magnesium. All the enumerated properties can be connected to or explained in one way or another by moisture or precipitation and, together with congelifracts, which indicate temperature oscillations, represent the key to a climato-stratigraphic explanation of the profile. We checked how concordantly they operate in the system of the site with the aid of the multivariate technique of multi-dimensional scaling. This procedure is the most suitable, because it does not require a normal distribution for entry data. The multivariate analysed data are shown in *Tab. 5.6.1.*

Fig. 5.5.1a, b shows the result of two-dimensional scaling, in which *Fig. 5.6.1b* presents the detail of the group of layers in the left central part of *Fig. 5.6.1a*. The Shepard diagram and the small value of *stress* (0.04), guarantee that two dimensions are sufficient for ascertaining similarities or differences between layers and facies. We explain the first dimension by precipitation or humidity. We distinguish between facies and individual layers on its basis. The second dimension only distinguishes between layers, and not facies and cannot be explained.

The layers of facies B and C form separate groups, while the layers of facies A are somewhere in between. In view of the findings to date only on the basis of aggregates (see sub-chapter 5.3 in this volume, *Fig. 5.3.6*) the layers of facies B are a product of an extremely humid climate. The most humid layer of facies C is Layer ?12-13, followed by Layer 20, and then layers 18a, 16a lower, 19-20 and 17/18 of the same facies. These layers are on the abscissa (dimension 1) of the nearest layer of facies B, which means that they were created in damper conditions than the other layers of facies C. The most humid layers of facies A are layers 5a and 5a? or 5a upper and 5a lower (*Fig. 5.3.6*). It is characteristic of both that they lie between the layers of facies B and C or closest to facies B (*Fig. 5.6.1a*). The driest layer of facies A is Layer 6 (*Fig. 5.3.6*), which is most distant on the abscissa from the layers of facies B (*Fig. 5.6.1b*).

The correspondence between *Fig. 5.3.6*, which served for an original assessment of humidity and *Fig. 5.6.1a, b*, which is a synthesis of a number of indisputable indicators of humidity is almost complete. This means that our approximation of humidity change on the basis of aggregates in the sedimentary fraction 0.5-3 mm is entirely reliable and it would be difficult to find a better base for it. If we add to the data in *Tab. 5.6.1* data for the fraction less than 0.5 mm, the picture on the level of facies does not change, but the picture on the level of layers is completely destroyed. The cause of this is presumably the increase of alochthonous admixture in the fraction smaller than 0.5 mm.

Cave bear, which contributed the original material for the phosphate binding of aggregates and breccia, on the basis of two-dimensional scaling, can be said to have taken shelter in the cave-lair mainly in very humid periods. Low temperatures were not decisive in this, but temperature influenced the extent of the living population, which is also illustrated not least by the quantity of fossil remains.

An unknown ribbon form of the mineral muscovite, the origin of which can be found in the slates and their use in hearths, was found in the sediment of the hearths. The discovery is important from mineralogical and archaeological points of view.

6. ESR-DATIRANJE NAJDIŠČA DIVJE BABE I, SLOVENIJA

BONNIE A. B. BLACKWELL, EDWIN S. K. YU, ANNE R. SKINNER, IVAN TURK,
JOEL I. B. BLICKSTEIN, JANEZ TURK, VICKY S. W. YIN in BEVERLY LAU

Izvleček

Obsežno zaporedje arheoloških plasti v najstarejšem[1] slovenskem najdišču Divje babe I je v sebi skrivalo mousterjenske artefakte in ognjišča, preluknjano medvedjo golenico, ki jo razlagamo kot piščal, musterjenska in orinjasjenska koščena orodja, in približno 200.000 določljivih kosti in zob jamskega medveda (*Ursus spelaeus*), skupaj z ostanki druge favne. Enajst arheološko pomembnih plasti je bilo datiranih v 44 neodvisnih analizah s standardno elektronsko spinsko resonanco (ESR), opravljeno na 28 zobeh. Tako določene starosti so izražene v koledarskih letih. Da bi izračunali volumensko povprečje za hitrost doze zunanjega obsevanja, je bila z nevtronsko aktivacijsko analizo (NAA) raziskana kemijska sestava 146 sedimentnih vzorcev.

Številne sedimentne značilnosti nakazujejo, da so Divje babe I v mlajšem pleistocenu doživljale močna klimatska nihanja, ki se kažejo v štirih ločenih interstadialih ter petih stadialih v kisikovih izotopskih stopnjah OIS 3–4, in v podaljšanih toplih interglacialnih razmerah v OIS 5, med katerimi so ljudje obiskovali jamo in tako v njej puščali musterijenske artefakte. Od plasti 2 do 23 datacije z metodo ESR predvidevajo, da se vsaj tri, najverjetneje pa štiri obdobja hitre sedimentacije menjujejo s sedimentacijskimi vrzelmi. V času nepretrgane sedimentacije pri hitrosti 0,02 cm/leto od približno 116 tisoč let (*ka*) do 102 *ka* v kisikovi izotopski stopnji OIS 5d so se odložile plasti 23 do spodnjega dela plasti 17a2 v toplih, suhih do zmerno vlažnih razmerah. V OIS 5b-5c se je sedimentacija drastično upočasnila ali ustavila do približno 85 *ka*. V zgodnji OIS 5a, v obdobju Dansgaardovega in Öschgerjevega dogodka 21 (DÖ 21), približno 85 *ka* do 80 *ka*, je bila hitrost sedimentacije v povprečju 0,036 cm/leto, in tako so nastale plasti od zgornjega dela 17a2 do 13 v toplih in suhih do zmerno suhih razmerah. Naslednja vrzel je zajela prvo mrzlo fazo v OIS 4 od 80 *ka* do približno 70 *ka*. Sedimentacija s hitrostjo približno 0,012 cm/leto se je obnovila v plasteh 10–12 do 8a, od približno 70 *ka* do 55 *ka*, v delu OIS 4 v hladnih do mrzlih in vlažnih razmerah. Piščal je bila izdelana in izgubljena, pozabljena ali zavržena pred približno 60 *ka*. Sedimentacija se je ponovno upočasnila ali ustavila v obdobju okoli 55 *ka* do 50 *ka*, torej v zgodnji OIS 3. Približno od 50 *ka* do 38–40 *ka* med interstadiali Mörshoofd-Glinde in Hengelo, DÖ 14–10 v OIS 3, se je hitra sedimentacija ponovila in dosegla hitrost okoli 0,04 cm/leto ter tako pripomogla k nastanku plasti 7 do 2 v razmerah, ki so se močno spreminjale od zelo mrzlih do zmerno toplih, in od suhih do zmerno vlažnih. Pleistocenski profil se konča s plastjo 2, ki vsebuje zgodnje orinjasjensko konico s precepljeno bazo v sedimentu, ki odslikava interstadialne razmere. V OIS 2 je plast 2 prizadela globoko delujoča krioturbacija. V zgodnjem holocenu se je po 28–30-tisočletni vrzeli ponovila skromna sedimentacija.

V Divjih babah I, Slovenija (*sl. 6.1*), je bila najdena piščal izdelana iz kosti jamskega medveda (*Ursus spelaeus*), ki jo povezujemo z musterjenskimi artefakti. Najprej so Lau *et al.* (1997) potrdili, da je piščal starejša od 43 *ka* (za prvo datacijo glej Nelson 1997). Nadaljnje raziskave so se osredotočile na izdelavo podrobnejše kronologije in zanesljivejših paleoklimatskih približkov, posebej za plast 8 ter za najdiščni profil kot celoto, pa tudi na preverjanje možnosti, da dogajanje v sedimentih ni prizadelo datiranih zob (prim. Blackwell, 1994). Elektronska spinska ali paramagnentna rezonanca (ESR) v zobni sklenini je bila uporabljena za določitev 44 neodvisnih koledarskih starosti 28 zob vrste *Ursus spalaeus* v plasteh 2 do 20 (*tab. 6.1; sl. 6.2*), da bi plasti Divjih bab I lahko povezali z drugimi, datiranimi evropskimi najdišči ter določili podrobno kronologijo za paleookoljske spremembe v alpskih in dinarskih predelih v mlajšem pleistocenu Slovenije (npr. Turk *et al.* 2001; Turk *et al.* 2002b; Turk 2006).

Veliko ^{14}C-datacij je bilo narejenih na kosteh in oglju iz najdišča (Nelson 1997). Večina jih je presegala mejo za ^{14}C-datiranje, veliko pa jih je bilo tako blizu tej meji, da bi jih že majhna količina kontaminacije s sodobnim ogljikom lahko znatno spremenila. Starost kosti v plasti 2, ki vsebuje orinjasjenske najdbe, je bila določena na 35,3 ± 0,7 tisoč let (*ky*) pred sedanjostjo (p. s.), starost kosti v plasti 6 pa na 43,3 ± 1,4 *ky* p. s.. Glede na negotovo odstopanje med nekalibriranimi ^{14}C-starostmi in pravimi koledarskimi datumi v razponu 35–50 *ka* (npr. Conrad, Bolus 2003; Conrad 2006), datiranje s ^{14}C v najboljšem primeru samo potrjuje starost najdišča ter ESR-datacije, kot sledijo. Lau *et al.* (1997) poročajo o preliminarni določitvi ESR-starosti za pet zob v plasteh 13, 17a2 in 20, pri čemer so za datiranje uporabili relativno malo sedimentnih analiz. Nova raziskava upora-

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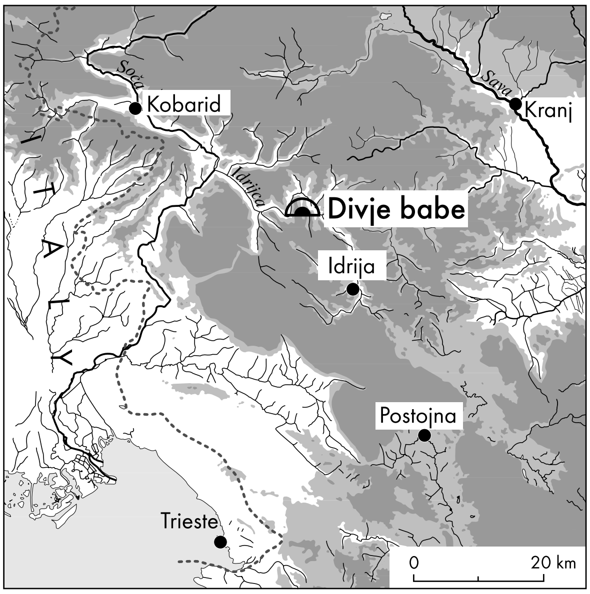
[1] Najstarejše je mišljeno v smislu koledarske starosti, določene z ESR-metodo. Ker druga podobna najdišča v Sloveniji niso ustrezno datirana, žal, ne vemo, kakšna je njihova dejanska starost v odnosu do Divjih bab I.



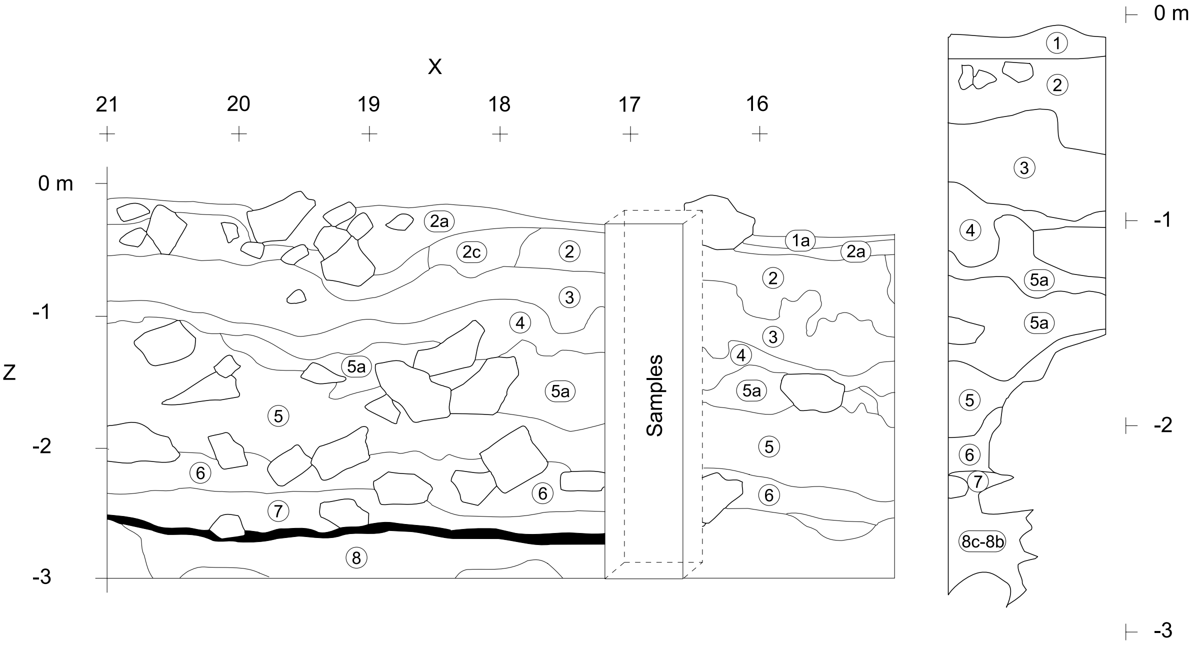
Sl. 6.1: Jama Divje babe I, Slovenija. Jama leži na višini 450 m, približno 230 m nad dolino reke Idrijce, v zahodni Sloveniji.
Fig. 6.1: Divje babe I Cave, Slovenia. The cave is located at 450 m elevation, approximately 230 m above the Idrijca River valley, in western Slovenia.

blja 146 analiz sedimentnih komponent (*tab. 6.2*) za izboljšanje natančnosti in točnosti hitrosti zunanje doze in samega ESR-datiranja.

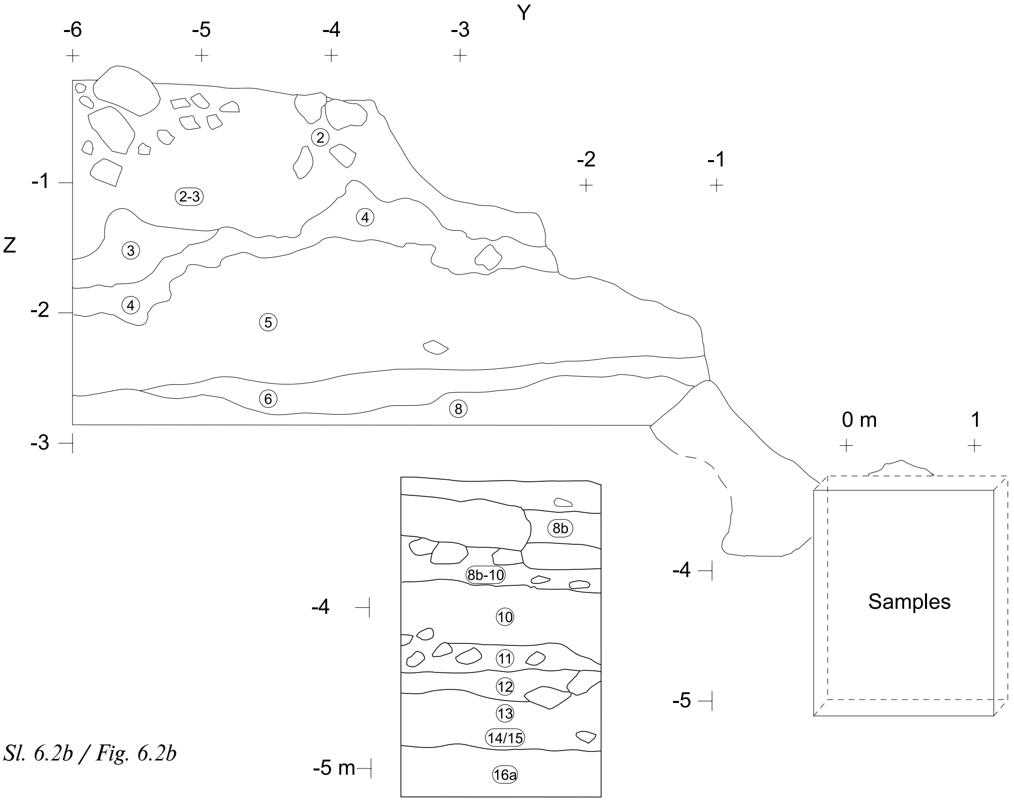
TEORIJA ESR

ESR lahko ponudi kronometrične podatke za hidroksilapatit (HAP) v zobni sklenini od starosti 5 *ka* pa vse do 5 *Ma* (milijon let), trenutno z 2–8% natančnostjo (Blackwell 2006). ESR za zobe sesalcev premosti prepad med zgornjo mejo datiranja s ^{14}C (~ 40–50 *ka*) in spodnjo mejo metode U/Pb (1–2 *Ma*). Standardno ESR-datiranje za zobno sklenino so doslej intenzivno preizkusili glede na druge metode datiranja najdišč v razponu starosti med 30 in 300 *ka* (Blackwell 2006).

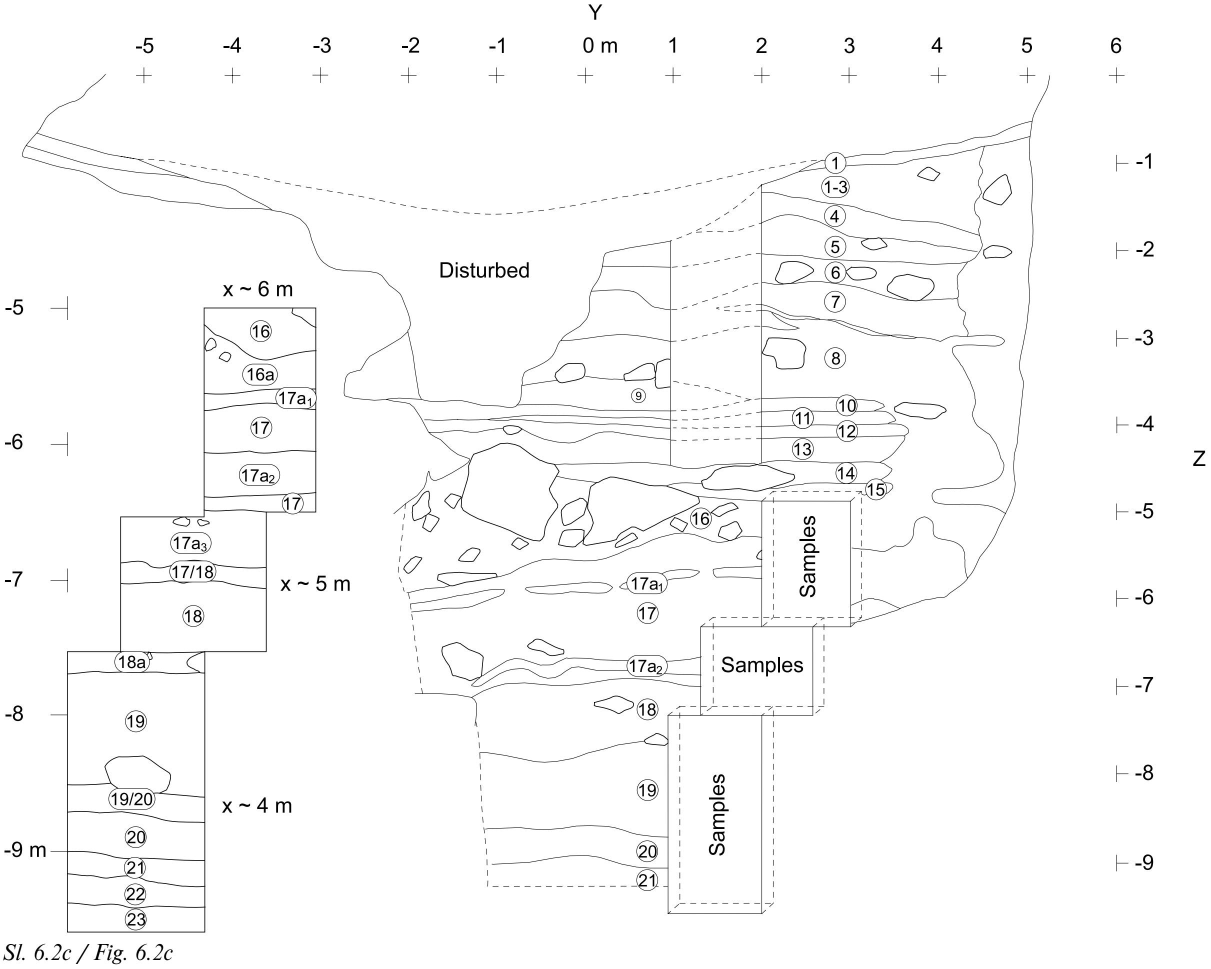
ESR-signali, ki so posledica obsevanja, rastejo sorazmerno s prejeto dozo sevanja (Blackwell 2006), ko se sproščeni elektroni zbirajo v pasteh na kristalni mreži. V hidroksilapatitu (HAP) sklenine ima ESR signal pri vrednosti giromagnetnega razmerja g = 2,0018 v pasu X povprečno življenjsko dobo signala ~ 10^{19} let, pri čemer ne poročajo o zmanjšanju jakosti signala (Skinner *et al.* 2000). Signali iz HAP se izničijo samo, če se temperatu-



Sl. 6.2a–c: Vzorčenje stratigrafskega stolpca v Divjih babah I za datiranje z ESR in analize paleoklime. Slika kaže shematizirane profile y = 2 m (a), x = 11 m (b) in x = 3 m (c), dokumentirane pri vzorčevanju v letih 1998 do 2000, ki smo jih uporabili za pridobitev sedimenta za ESR in paleoklimatske analize iz treh lokacij v jami (glej poglavje 1 v tem zborniku, *sl. 1.3*). Povečano so prikazane plasti v vzorčevanih delih profilov. Pri izkopavanjih smo identificirali vsaj 26 geoloških plasti, od katerih smo jih datirali in sedimentološko obdelali 23. Veliko plasti vsebuje znatne količine debelega krioklastičnega grušča (*éboulis*), zaradi katerega je njihova zgradba nehomogena.
Fig. 6.2a–c: Sampling the stratigraphy at Divje babe I for ESR dating and paleoclimate analyses. This figure shows the cuts (a) x = 2 m, (b) x = 11 m, and (c) x = 3 m, in the 1998–1999 excavation used to recover sediment for the ESR and paleoclimatic analyses from three locations in the cave (see Chapter 1 in this volume, *Fig. 1.3*). The enlarged sections show the layers in the sampled parts of the profiles. At least 26 geological layers have been identified in the excavations, of which 23 were ESR dated and sedimentologically analysed. Many layers contain significant amounts of large dolomitic *éboulis*, which make all the layers inhomogeneous.



Sl. 6.2b / Fig. 6.2b



Sl. 6.2c / Fig. 6.2c

Tab.6.1: Seznam datiranih zob.
Tab. 6.1: Teeth in the study.

Number		Profile (x)	Layer	Depth, Z	Species	Tooth type
Sample	Catalogue	Trench		(m)		
CT89	98231	17 m/3	2	-0.50	*Ursus spelaeus*	canine
CT88	98198	17 m/3	3	-0.91	*Ursus spelaeus*	molar
CT16	98161	17 m/3	7	-2.24	*Ursus spelaeus*	incisor
CT17	98162	17 m/3	7	-2.24	*Ursus spelaeus*	molar
RT8	98216	17 m/3	8a	-2.52	*Ursus spelaeus*	molar
RT10	98217	17 m/3	8a	-2.52	*Ursus spelaeus*	canine
RT11	98215	17 m/3	8a	-2.52	*Ursus spelaeus*	canine
RT12	98214	17 m/3	8a	-2.52	*Ursus spelaeus*	canine
CT87	98224	17 m/3	8c	-2.74	*Ursus spelaeus*	molar
RT81	98001A	12 m/2	10	-4.08	*Ursus spelaeus*	third molar
RT80	98001B	12 m/2	10	-4.08	*Ursus spelaeus*	molar
RT76	98003	12 m/2	10	-4.08	*Ursus spelaeus*	female upper left canine
RT79	98025	12 m/2	10-12	-4.31	*Ursus spelaeus*	male upper right canine
QT1	91043a	12 m/2	13	-4.20-4.45	*Ursus spelaeus*	canine
RT44	91043b	12 m/2	13	-4.20-4.45	*Ursus spelaeus*	canine
QT3	91047a	12 m/2	13	-4.20-4.45	*Ursus spelaeus*	incisor
QT4	91047b	12 m/2	13	-4.20-4.45	*Ursus spelaeus*	incisor
RT43B	98011	12 m/2	16a	-5.06	*Ursus spelaeus*	molar
RT5	98124	6 m/1	17	-5.76	*Ursus spelaeus*	molar
RT42	98094	6 m/1	17a2	-6.08	*Ursus spelaeus*	incisor
RT45	98095	6 m/1	17a2	-6.13	*Ursus spelaeus*	molar
RT39	98102	5 m/1	17a2*	-6.76	*Ursus spelaeus*	canine
RT40	98103a	5 m/1	17a2*	-6.76	*Ursus spelaeus*	incisor
RT46	98103b	5 m/1	17a2*	-6.76	*Ursus spelaeus*	molar
QT2	91042a	5 m/1	17a2*	-6.70-7.05	*Ursus spelaeus*	upper 3rd incisor
QT5	91044	4 m/1	20	-8.60-8.90	*Ursus spelaeus*	canine
QT74	98110	4 m/1	23	-9.58	*Ursus spelaeus*	canine

*= Layer 17a3 on *Fig. 6.2c.*

ra dvigne ≥ 300° C. Mletje in izpostavljenost svetlobi ne izničita signala. Pri sesalcih občutljivost na sevanje ni odvisna od vrste, je pa odvisna od kristaliziranosti, na katero vplivata starost in zdravstveno stanje živali (Skinner *et al.* 2001, 2005). Diageneza in remineralizacija znižata jakost ESR-signala in zgornjo mejo datiranja z ESR, vendar pa ne merilne natančnosti zbrane doze ($\mathscr{A}_\Sigma$) (Skinner *et al.* 2000). Če lahko višino (intenzivnost) ESR-signala, ki je posledica obsevanja, pretvorimo v prejeto dozo, in če poznamo ali lahko modeliramo hitrost doze, potem lahko ESR starost izračunamo po enačbi 1:

$$\mathscr{A}_\Sigma = \mathscr{A}_{\mathrm{int}} + \mathscr{A}_{\mathrm{ext}} = \int_{t_0}^{t_1} D_\Sigma(t)\,\mathrm{d}t = \int_{t_0}^{t_1} (D_{\mathrm{int}}(t) + (D_{\mathrm{ext}}(t))\,\mathrm{d}t$$

kjer je: $\mathscr{A}_\Sigma$ = skupna prejeta doza v vzorcu;
$\mathscr{A}_{\mathrm{int}}$ = komponenta prejete doze zaradi notranjega obsevanja;
$\mathscr{A}_{\mathrm{ext}}$ = komponenta prejete doze zaradi obsevanja iz zunanjih virov;
$D_\Sigma(t)$ = skupna hitrost doze, prejete iz zunanjih in notranjih virov;
$D_{\mathrm{int}}(t)$ = hitrost doze iz notranjih virov: U, njegovih potomcev in nekaterih drugih radioizotopov;
$D_{\mathrm{ext}}(t)$ = hitrost doze iz zunanjih virov: sedimenih U, Th in K, ter kozmičnih žarkov;
t_1 = starost vzorca;
t_0 = današnji čas.

Prejeto dozo $\mathscr{A}_\Sigma$ določijo z metodo dodane doze, pri kateri obsevajo vzorce z določeno dodatno dozo sevanja. $\mathscr{A}_\Sigma$ lahko izmerimo z 0,8–5 % natančnostjo (*sl. 6.3*) glede na kalibracijo spektrometra (Nagy 2000), kalibracijo vira sevanja (Wieser *et al.* 2006), starost vzorca in diagenetsko stanje (npr. Blackwell *et al.* 2005; Skinner *et al.* 2001, 2005). Hitrost skupne prejete doze določijo s koncentracijo radioaktivnih elementov v vzorcu in njegovi ožji okolici. Mnogi dejavniki, ki vsebujejo slabljenje toka delcev, koncentracije radioaktivnih elementov in način vnosa U, vplivajo na hitrost naraščanja zunanjih in notranjih doz. Če vzorci prejmejo nizke doze sevanja, bosta obe določljivi starosti, spodnja in zgornja, visoki (Blackwell 2006).

U v zobeh prispeva predvsem k notranji dozi $D_{\mathrm{int}}(t)$. Da bi izračunali $D_{\mathrm{int}}(t)$, izmerimo uranove koncentracije v zobeh geokemično, običajno z uporabo nevtronske aktivacijske analize (NAA). Nato izpeljemo $D_{\mathrm{int}}(t)$ iz

Tab 6.2: Geokemijska analiza sedimentov in hitrost doze sevanja v najdišču Divje babe I, Slovenija.
Tab. 6.2: Sedimentary geochemistry and dose rates at Divje babe I, Slovenia.

Sediment				Concentrations			External Dose Rates[1]	
Sample	Layer	Depth		U	Th	K	$D_{ext,\beta}(t)$[2]	$D_{ext,\gamma}(t)$[3]
(type)		(m)		(ppm)	(ppm)	(wt%)	(mGy/y)	(mGy/y)
98232	2	-0.50		0.97	1.37	0.22	0.076	0.170
(bulk sediment)			±	0.02	0.15	0.01	0.009	0.014
98233	2	-0.50		0.97	1.57	0.22	0.077	0.178
(bulk sediment)			±	0.02	0.12	0.01	0.009	0.014
98234	2	-0.50		1.02	1.43	0.21	0.076	0.175
(bulk sediment)			±	0.02	0.14	0.01	0.009	0.014
98235	2	-0.50		1.16	1.19	0.21	0.079	0.178
(bulk sediment)			±	0.02	0.12	0.01	0.009	0.014
Mean	2			1.03	1.39	0.22	0.078	0.176
(4)			±	0.09	0.16	0.01	0.010	0.017
98236	3	-0.81		1.94	1.39	0.19	0.101	0.246
(bulk sediment)			±	0.02	0.16	0.01	0.011	0.019
98199	3	-0.91		2.18	1.82	0.23	0.118	0.289
(bulk sediment)			±	0.02	0.13	0.01	0.013	0.022
98200	3	-0.91		2.19	1.46	0.24	0.118	0.278
(bulk sediment)			±	0.02	0.13	0.01	0.013	0.021
98201	3	-0.91		1.95	1.58	0.19	0.103	0.254
(bulk sediment)			±	0.02	0.16	0.01	0.012	0.019
98202	3	-0.91		1.81	1.49	0.22	0.103	0.244
(bulk sediment)			±	0.02	0.16	0.01	0.012	0.018
98203	3	-0.91		1.83	1.67	0.19	0.099	0.248
(bulk sediment)			±	0.02	0.13	0.01	0.011	0.019
98204	3	-0.91		1.44	1.07	0.23	0.091	0.200
(bulk sediment)			±	0.02	0.16	0.01	0.010	0.016
98205	3	-0.91		1.57	1.20	0.13	0.078	0.198
(bulk sediment)			±	0.02	0.11	0.01	0.008	0.016
98158	3	-1.00		1.53	–[4]	0.18	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
Mean	3			1.83	1.46	0.20	0.103	0.245
(9)			±	0.26	0.23	0.03	0.016	0.030
98155	5a	-1.26		1.49	1.28	0.16	0.081	0.199
(bulk sediment)			±	0.02	0.12	0.01	0.009	0.015
98156	5a	-1.26		1.63	0.95	0.12	0.077	0.192
(bulk sediment)			±	0.02	0.10	0.01	0.008	0.014
98157	5a	-1.26		2.23	1.50	0.18	0.109	0.272
(bulk sediment)			±	0.02	0.14	0.01	0.012	0.020
98160	5a	-1.26		1.06	0.53	0.10	0.053	0.125
(bulk sediment)			±	0.02	0.08	0.01	0.006	0.010
98212	5a	-1.54		1.22	1.08	0.13	0.067	0.164
(bulk sediment)			±	0.02	0.12	0.01	0.008	0.013
98159	5a	-1.57		1.69	1.70	0.13	0.085	0.227
(bulk sediment)			±	0.02	0.11	0.01	0.010	0.018
Mean	5a			1.55	1.17	0.14	0.079	0.197
(6)			±	0.37	0.38	0.03	0.016	0.037
98207	5	-1.86		1.27	0.95	0.14	0.069	0.165
(bulk sediment)			±	0.02	0.09	0.01	0.008	0.013
98208	5	-1.86		1.22	1.37	0.18	0.077	0.184
(bulk sediment)			±	0.02	0.09	0.01	0.009	0.014
98209	5	-1.86		1.16	1.70	0.21	0.082	0.197
(bulk sediment)			±	0.02	0.12	0.01	0.009	0.016
98210	5	-1.86		0.86	1.04	0.17	0.062	0.140
(bulk sediment)			±	0.02	0.11	0.01	0.008	0.011

continued...

Tab 6.2 / *Tab. 6.2*: (nadaljevanje / cont.)

Sediment				Concentrations			External Dose Rates[1]	
Sample	Layer	Depth		U	Th	K	$D_{ext,\beta}(t)$[2]	$D_{ext,\gamma}(t)$[3]
(type)		(m)		(ppm)	(ppm)	(wt%)	(mGy/y)	(mGy/y)
98211	5	-1.86		1.34	1.31	0.16	0.077	0.188
(bulk sediment)			±	0.02	0.11	0.01	0.009	0.015
98196	5	-1.96		1.02	1.27	0.18	0.070	0.164
(bulk sediment)			±	0.02	0.08	0.01	0.008	0.013
Mean	5			1.15	1.27	0.17	0.072	0.173
(6)			±	0.16	0.24	0.02	0.010	0.021
98213	6	-2.07		1.02	1.18	0.16	0.055	0.157
(bulk sediment)			±	0.02	0.10	0.01	0.007	0.013
98191	6	-2.17		1.10	0.99	0.14	0.053	0.153
(bulk sediment)			±	0.02	0.09	0.01	0.006	0.012
98192	6	-2.17		1.49	1.26	0.15	0.066	0.197
(bulk sediment)			±	0.02	0.09	0.01	0.007	0.015
98193	6	-2.17		0.93	0.99	0.12	0.046	0.135
(bulk sediment)			±	0.02	0.09	0.01	0.005	0.011
98194	6	-2.17		0.78	0.83	0.10	0.037	0.109
(bulk sediment)			±	0.02	0.08	0.01	0.004	0.009
98195	6	-2.17		0.89	0.57	0.08	0.037	0.109
(bulk sediment)			±	0.02	0.07	0.01	0.004	0.009
Mean	6			1.04	0.97	0.13	0.050	0.145
(6)			±	0.23	0.23	0.03	0.009	0.024
98168	7	-2.24		0.64	1.30	0.01	0.024	0.104
(bulk sediment)			±	0.02	0.10	0.01	0.003	0.009
98163	7	-2.24		0.98	0.91	0.13	0.048	0.138
(bulk sediment)			±	0.02	0.12	0.01	0.005	0.012
98164	7	-2.24		1.25	1.17	0.13	0.057	0.170
(bulk sediment)			±	0.02	0.14	0.01	0.007	0.013
98165	7	-2.24		1.49	1.52	0.16	0.069	0.209
(bulk sediment)			±	0.02	0.17	0.01	0.008	0.017
98166	7	-2.24		1.03	1.39	0.14	0.053	0.162
(bulk sediment)			±	0.02	0.15	0.01	0.006	0.014
98169	7	-2.24		1.01	0.72	0.12	0.047	0.132
(bulk sediment)			±	0.02	0.08	0.01	0.005	0.011
98222	7	-2.24		1.02	1.27	0.17	0.057	0.162
(bulk sediment)			±	0.02	0.08	0.01	0.007	0.013
98197	7	-2.40		1.34	1.49	0.23	0.074	0.207
(bulk sediment)			±	0.02	0.15	0.01	0.008	0.016
98167	7	-2.52		0.97	1.53	0.16	0.055	0.166
(bulk sediment)			±	0.02	0.11	0.01	0.006	0.013
Mean	7			1.08	1.26	0.14	0.054	0.161
(9)			±	0.23	0.27	0.06	0.012	0.027
98218	8a	-2.52		1.32	1.02	0.19	0.066	0.181
(bulk sediment)			±	0.02	0.19	0.01	0.007	0.015
98219	8a	-2.52		1.10	0.88	0.20	0.061	0.159
(bulk sediment)			±	0.02	0.16	0.01	0.007	0.013
98220	8a	-2.52		0.98	1.26	0.18	0.057	0.160
(bulk sediment)			±	0.02	0.21	0.01	0.007	0.015
98221	8a	-2.52		1.18	1.18	0.19	0.063	0.175
(bulk sediment)			±	0.02	0.15	0.01	0.007	0.014
RT8sed	8a	-2.52		–[4]	1.44	0.21	–	–
(attached sed.)			±	–	0.11	0.01	–	–
RT11sed	8a	-2.52		0.76	1.35	0.17	0.050	0.144
(attached sed.)			±	0.02	0.12	0.01	0.006	0.012
RT12sed+den	8a	-2.52		0.36[5]	–[5,6]	0.02[5]	0.012[5]	0.033[5]
(attached sed.)			±	0.02	–	0.02	0.004	0.006

continued...

Tab 6.2 / *Tab. 6.2*: (nadaljevanje / cont.)

Sediment				Concentrations			External Dose Rates[1]	
Sample (type)	Layer	Depth (m)		U (ppm)	Th (ppm)	K (wt%)	$D_{ext\cdot\beta}(t)$[2] (mGy/y)	$D_{ext,\gamma}(t)$[3] (mGy/y)
RT8den1	8a	-2.52		< 0.02[5]	–[5,6]	–[5,6]	0.000	0.000
(dentine)			±	0.02	–	–	0.002	0.005
RT11den1	8a	-2.52		0.16	–[5,6]	0.04[5]	0.010	0.020
(dentine)			±	0.02	–	0.01	0.002	0.005
RT12den2	8a	-2.52		0.17	–[5,6]	–[5,6]	0.005	0.014
(dentine)			±	0.02	–	–	0.002	0.005
Mean bulk sed.	8a			1.07	1.19	0.19	0.060	0.167
(6)			±	0.19	0.19	0.01	0.008	0.021
98187	8c	-2.74		0.73	1.04	0.14	0.044	0.124
(bulk sediment)			±	0.02	0.14	0.01	0.005	0.011
98226	8c	-2.74		0.58	1.02	0.18	0.045	0.118
(bulk sediment)			±	0.02	0.19	0.01	0.005	0.012
98227	8c	-2.74		0.73	0.88	0.16	0.046	0.122
(bulk sediment)			±	0.02	0.16	0.01	0.006	0.011
98228	8c	-2.74		0.82	1.42	0.15	0.049	0.148
(bulk sediment)			±	0.02	0.19	0.01	0.005	0.013
98229	8c	-2.74		0.59	1.26	0.17	0.045	0.126
(bulk sediment)			±	0.02	0.21	0.01	0.005	0.012
98223	8c	-2.81		0.74	1.18	0.20	0.053	0.141
(bulk sediment)			±	0.02	0.15	0.01	0.006	0.012
Mean	8c			0.70	1.13	0.17	0.047	0.130
(6)			±	0.09	0.18	0.02	0.006	0.014
98177	8	-2.86		0.97	1.45	0.20	0.062	0.170
(bulk sediment)			±	0.02	0.15	0.01	0.008	0.015
98173	8	-3.21		0.79	1.29	0.15	0.049	0.140
(bulk sediment)			±	0.02	0.16	0.01	0.007	0.014
98174	8	-3.21		0.81	1.12	0.01	0.029	0.111
(bulk sediment)			±	0.02	0.12	0.01	0.005	0.012
98175	8	-3.21		0.79	< 0.56[5]	0.18	0.050	0.118
(bulk sediment)			±	0.02	0.15	0.01	0.007	0.012
98176	8	-3.21		1.08	3.12	0.30	0.086	0.260
(bulk sediment)			±	0.02	0.15	0.01	0.011	0.021
98178	8	-3.21		0.94	1.05	0.19	0.057	0.151
(bulk sediment)			±	0.02	0.16	0.01	0.008	0.014
Mean	8			0.90	1.43	0.17	0.055	0.158
(6)			±	0.11	0.81	0.09	0.015	0.038
98182	8b	-3.03		0.97	1.87	0.28	0.075	0.200
(bulk sediment)			±	0.02	0.14	0.01	0.010	0.016
98183	8b	-3.03		0.83	1.54	0.16	0.052	0.155
(bulk sediment)			±	0.02	0.15	0.01	0.006	0.013
98184	8b	-3.03		0.75	1.79	0.17	0.053	0.159
(bulk sediment)			±	0.02	0.15	0.01	0.007	0.013
98185	8b	-3.03		0.53	1.15	0.15	0.041	0.114
(bulk sediment)			±	0.02	0.12	0.01	0.005	0.010
98186	8b	-3.03		0.72	1.37	0.18	0.052	0.143
(bulk sediment)			±	0.02	0.12	0.01	0.007	0.012
98230	8b	-3.03		0.57	1.05	0.16	0.043	0.114
(bulk sediment)			±	0.02	0.15	0.01	0.005	0.010
98188	8b	-3.36		0.91	1.42	0.23	0.064	0.169
(bulk sediment)			±	0.02	0.13	0.01	0.008	0.013
98051	8b	-3.37		1.16	1.72	0.26	0.076	0.206
(bulk sediment)			±	0.02	0.14	0.01	0.009	0.016

continued...

Tab 6.2 / *Tab. 6.2*: (nadaljevanje / cont.)

Sediment				Concentrations			External Dose Rates[1]	
Sample	Layer	Depth		U	Th	K	$D_{ext,\beta}(t)$[2]	$D_{ext,\gamma}(t)$[3]
(type)		(m)		(ppm)	(ppm)	(wt%)	(mGy/y)	(mGy/y)
98041	8b	-3.61		0.59	0.59	0.11	0.034	0.090
(bulk sediment)			±	0.02	0.07	0.01	0.004	0.007
91070	8b	-3.64		1.17	4.30	0.13	0.083	0.282
(bulk sediment)			±	0.02	0.21	0.01	0.006	0.023
98046	8b	-3.68		1.15	1.52	0.22	0.070	0.191
(bulk sediment)			±	0.02	0.16	0.01	0.010	0.015
98049	8b	-3.68		1.23	1.44	0.01	0.042	0.158
(bulk sediment)			±	0.02	0.13	0.01	0.006	0.013
98086	8b	-3.88		0.92	–[4]	0.19	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
98088	8b	-3.88		1.05	1.42	0.23	0.055	0.181
(bulk sediment)			±	0.02	0.14	0.01	0.005	0.014
98089	8b	-3.88		0.80	–[4]	0.16	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
98090	8b	-3.88		0.77	1.80	0.16	0.052	0.160
(bulk sediment)			±	0.02	0.14	0.01	0.007	0.013
98091	8b	-3.88		1.06	1.83	0.25	0.059	0.200
(bulk sediment)			±	0.02	0.14	0.01	0.007	0.015
Mean	8b			0.89	1.65	0.18	0.057	0.167
(17)			±	0.22	0.78	0.06	0.013	0.039
98009	10	-3.88		1.14	1.42	0.23	0.057	0.188
(bulk sediment)			±	0.02	0.14	0.01	0.006	0.015
98004	10	-4.08		0.95	1.21	0.20	0.048	0.159
(bulk sediment)			±	0.02	0.13	0.01	0.004	0.012
RT80den1	10	-4.08		0.35[5]	0.00[5]	< 0.02[5]	0.009[5]	0.031[5]
(dentine)			±	0.02	0.16	0.01	0.002	0.007
RT81den2	10	-4.08		0.27[5]	0.27[5]	0.02[5]	0.009[5]	0.036[5]
(dentine)			±	0.02	0.14	0.01	0.003	0.006
Mean	10			1.05	1.32	0.22	0.053	0.175
(2)			±	0.10	0.11	0.02	0.007	0.016
98055	10-12	-4.44		1.04	1.95	0.30	0.065	0.212
(bulk sediment)			±	0.02	0.13	0.01	0.007	0.016
98056	10-12	-4.44		0.93	–[4]	0.22	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
98072	10-12	-4.44		1.03	–[4]	0.30	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
Mean	10-12			1.03	1.58	0.27	0.060	0.192
(9)			±	0.18	0.35	0.06	0.010	0.027
96002	13	-4.20 –		1.06	0.98	0.07	0.044	0.137
(bulk sediment)		-4.45[4]	±	0.02	0.14	0.01	0.006	0.011
96003	13	-4.20 –		0.81	1.20	0.08	0.040	0.126
(bulk sediment)		-4.45[4]	±	0.02	0.17	0.01	0.006	0.012
96004	13	-4.20 –		0.84	2.13	0.11	0.049	0.169
(bulk sediment)		-4.45[4]	±	0.02	0.14	0.01	0.007	0.013
96006	13	-4.20 –		4.05	2.85	0.13	0.146	0.461
(bulk sediment)		-4.45[4]	±	0.02	0.13	0.01	0.020	0.034
96011a	13	-4.20 –		0.58	< 0.05[6]	0.01	0.018	0.052
(bulk sediment)		-4.45[4]	±	0.02	0.05	0.01	0.003	0.007
96011b	13	-4.20 –		1.81	5.15	0.31	0.119	0.399
(bulk sediment)		-4.45[4]	±	0.02	0.17	0.01	0.009	0.030
96012	13	-4.20 –		1.87	2.66	0.14	0.085	0.279
(bulk sediment)		-4.45[4]	±	0.02	0.17	0.01	0.012	0.021

continued...

Tab 6.2 / *Tab. 6.2*: (nadaljevanje / cont.)

Sediment				Concentrations			External Dose Rates[1]	
Sample (type)	Layer	Depth (m)		U (ppm)	Th (ppm)	K (wt%)	$D_{ext,\beta}(t)$[2] (mGy/y)	$D_{ext,\gamma}(t)$[3] (mGy/y)
98034	13	-4.54		1.10	–[4]	0.29	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
98068	13	-4.54		1.04	–[4]	0.34	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
Mean[4]	13			1.46	2.15	0.16	0.078	0.230
(9)			±	1.00	1.53	0.11	0.043	0.104
98076	14-15	-4.63		1.14	2.06	0.29	0.066	0.223
(bulk sediment)			±	0.02	0.11	0.01	0.007	0.017
98078	14-15	-4.63		-	1.59	0.25	0.047	0.153
(bulk sediment)			±	-	0.11	0.01	0.005	0.013
Mean	14-15			1.14	1.83	0.27	0.057	0.188
(2)			±	0.02	0.24	0.02	0.009	0.035
RT43Bsed1	16a	-5.06		0.81	0.93	0.20	0.037	0.137
(attached sed.)			±	0.02	0.28	0.01	0.004	0.015
RT43Bsed2	16a	-5.06		1.05	1.39	0.18	0.041	0.167
(attached sed.)			±	0.02	0.14	0.01	0.004	0.013
98128	16a	-5.41		1.13	1.09	0.12	0.037	0.156
(bulk sediment)			±	0.02	0.06	0.01	0.004	0.012
Mean	16a			1.00	1.14	0.17	0.039	0.155
(3)			±	0.14	0.20	0.03	0.005	0.019
98132	17a1	-5.48		1.38	1.68	0.18	0.061	0.209
(bulk sediment)			±	0.02	0.08	0.01	0.011	0.030
98101	17	-5.76		1.99	2.05	0.31	0.088	0.296
(bulk sediment)			±	0.02	0.09	0.01	0.010	0.022
98126	17	-5.76		1.65	2.00	0.25	0.073	0.256
(bulk sediment)			±	0.02	0.09	0.01	0.008	0.019
RT5sed	17	-5.76		1.97	2.36	0.25	0.082	0.296
(attached sed.)			±	0.02	0.09	0.02	0.009	0.022
RT5en2	17	-5.76		< 0.02[5,6]	–[6]	–[6]	0.000[5]	0.000[5]
(attached sed.)			±	0.02	–	–	0.001	0.004
RT5den2	17	-5.76		0.46[5]	–[6]	–[6]	0.010[5]	0.038[5]
(dentine)			±	0.02	–	–	0.001	0.004
Mean	17			1.87	2.14	0.27	0.081	0.283
(3)			±	0.16	0.16	0.03	0.009	0.026
98129	17a2	-6.02		1.32	1.66	0.17	0.058	0.202
(bulk sediment)			±	0.02	0.07	0.01	0.007	0.015
98097	17a2	-6.08		1.81	1.92	0.22	0.077	0.261
(bulk sediment)			±	0.02	0.08	0.01	0.013	0.038
98098	17a2	-6.08		1.56	2.07	0.22	0.071	0.245
(bulk sediment)			±	0.02	0.09	0.01	0.012	0.035
RT45sed1[7]	17a2	-6.13		3.10	2.23	0.41	0.131	0.412
(attached sed.)			±	0.02	0.64	0.03	0.022	0.065
98096	17a2	-6.13		1.49	1.80	0.17	0.063	0.221
(bulk sediment)			±	0.02	0.07	0.01	0.011	0.032
98099	17a2	-6.13		1.35	2.08	0.01	0.041	0.191
(bulk sediment)			±	0.02	0.08	0.01	0.007	0.027
98100	17a2	-6.44		1.68	1.86	0.21	0.072	0.245
(bulk sediment)			±	0.02	0.09	0.01	0.012	0.036
98108	17a2	-6.44		2.15	–[4]	0.37	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
98106	17a2	-6.76		2.83	2.18	0.26	0.106	0.362
(bulk sediment)			±	0.02	0.10	0.01	0.010	0.027

continued...

Tab 6.2 / *Tab. 6.2*: (nadaljevanje / cont.)

Sediment				Concentrations			External Dose Rates[1]	
Sample	Layer	Depth		U	Th	K	$D_{ext,\beta}(t)$[2]	$D_{ext,\gamma}(t)$[3]
(type)		(m)		(ppm)	(ppm)	(wt%)	(mGy/y)	(mGy/y)
98107	17a2	-6.76		2.69	1.76	0.20	0.094	0.324
(bulk sediment)			±	0.02	0.09	0.01	0.009	0.024
RT40sed1	17a2	-6.76		1.71	1.41	0.28	0.079	0.244
(attached sed.)			±	0.02	0.22	0.01	0.013	0.037
RT46den1	17a2	-6.76		0.15[5]	< 0.64[5]	–[5]	0.004	0.012
(attached sed.)			±	0.02	–	–	0.001	0.002
98147	17a2	-6.83		2.41	0.84	0.16	0.079	0.259
(bulk sediment)			±	0.02	0.05	0.01	0.013	0.038
96007	17a2	-6.70 –		4.38	1.82	0.10	0.123	0.448
(bulk sediment)		-7.05[4]	±	0.02	0.09	0.01	0.012	0.033
96008	17a2	-6.70 –		3.14	2.17	0.07	0.091	0.354
(bulk sediment)		-7.05[4]	±	0.02	0.10	0.01	0.009	0.026
Mean	17a2			2.26	1.83	0.20	0.084	0.291
(14)			±	0.85	0.36	0.10	0.028	0.084
98109	17/18	-7.06		1.47	1.19	0.11	0.053	0.186
(bulk sediment)			±	0.02	0.07	0.01	0.009	0.027
98143	18	-7.21		2.37	–	0.19	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
98144	18	-7.21		2.64	–	0.29	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
98145	18	-7.21		2.48	–	0.23	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
98146	18	-7.51		1.93	1.07	0.16	0.069	0.228
(bulk sediment)			±	0.02	0.06	0.01	0.012	0.033
Mean	18			2.18	1.13	0.20	0.080	0.258
(5)			±	0.43	0.06	0.06	0.015	0.041
98139	18a	-7.94		2.86	1.23	0.21	0.097	0.320
(bulk sediment)			±	0.02	0.06	0.01	0.015	0.047
98135	19	-8.25		2.54	1.70	0.23	0.094	0.314
(bulk sediment)			±	0.02	0.08	0.01	0.016	0.045
98136	19	-8.25		3.15	–	0.34	–	–
(bulk sediment)			±	0.02	–	0.01	–	–
98137	19	-8.25		3.91	1.75	0.28	0.133	0.438
(bulk sediment)			±	0.02	0.09	0.01	0.023	0.063
Mean	19			3.20	1.73	0.28	0.116	0.379
(3)			±	0.56	0.03	0.04	0.018	0.054
98122	19/20	-8.70		1.96	1.39	0.20	0.087	0.241
(bulk sediment)			±	0.02	0.06	0.01	0.009	0.017
96009	20	-8.60 –		4.87	2.23	0.12	0.162	0.508
(bulk sediment)		-8.90[4]	±	0.02	0.14	0.01	0.017	0.037
96010	20	-8.60 –		5.00	1.53	0.10	0.159	0.488
(bulk sediment)		-8.90[4]	±	0.02	0.14	0.01	0.015	0.036
96013	20	-8.60 –		4.86	2.48	0.14	0.166	0.520
(bulk sediment)		-8.90[4]	±	0.02	0.13	0.01	0.017	0.038
98118	20	-9.05		3.65	2.06	0.33	0.132	0.435
(bulk sediment)			±	0.02	0.10	0.01	0.022	0.063
98120	20	-9.05		2.66	1.74	0.22	0.113	0.324
(bulk sediment)			±	0.02	0.10	0.01	0.012	0.024
98121	20	-9.05		3.17	1.52	0.17	0.101	0.349
(bulk sediment)			±	0.02	0.08	0.01	0.016	0.051
Mean	20			3.73	1.85	0.18	0.104	0.348
(7)			±	1.12	0.38	0.07	0.022	0.073

continued...

Tab 6.2 / *Tab. 6.2*: (nadaljevanje / cont.)

Sediment Sample (type)	Layer	Depth (m)		Concentrations U (ppm)	Th (ppm)	K (wt%)	External Dose Rates[1] $D_{ext,\beta}(t)$[2] (mGy/y)	$D_{ext,\gamma}(t)$[3] (mGy/y)
98116	21	-9.30		3.29	2.33	0.40	0.137	0.410
(bulk sediment)			±	0.02	0.10	0.02	0.035	0.099
	23	-9.58		3.07	3.07	0.34	0.148	0.429
(bulk sediment)			±	0.02	0.12	0.01	0.014	0.032
98114	23	-9.58		2.78	2.46	0.27	0.127	0.370
(bulk sediment)			±	0.02	0.10	0.01	0.013	0.027
98115	23	-9.58		2.61	2.26	0.27	0.121	0.348
(bulk sediment)			±	0.02	0.09	0.01	0.012	0.025
QT74sed	23	-9.58		3.45	3.10	0.29	0.151	0.453
(attached sed.)			±	0.02	0.14	0.02	0.014	0.033
QT74den1	23	-9.58		0.37[5]	0.00[5]	< 0.01[5,6]	0.009[5]	0.031[5]
(dentine)			±	0.02	0.00	0.01	0.002	0.007
Mean	23			2.98	2.72	0.29	0.137	0.400
(4)			±	0.32	0.37	0.03	0.017	0.042
Typical detection			~	0.01	0.10	0.001	0.020	0.050
limits[8]			-	0.02	0.40	0.002	0.050	0.100

[1] Calculated assuming sedimentary water concentration, W_{sed} = 25. ± 5. wt%

[2] Calculated assuming enamel thickness, ϕ_{en} = 574. ± 50. μm
enamel removed, ϕ_{in} = 55. ± 20. μm
enamel removed, ϕ_{out} = 37. ± 20. μm
enamel density, ρ_{en} = 2.95 ± 0.02 g/cm^3
enamel water concentration, W_{en} = 2. ± 2. wt%

[3] Calculated assuming the cosmic dose rate, $D_{cos}(t)$ = 0.000 ± 0.000 mGy/y

[4] More precise data not available.

[5] Not included in mean sediment values.

[6] Assumed to be 0 for calculations.

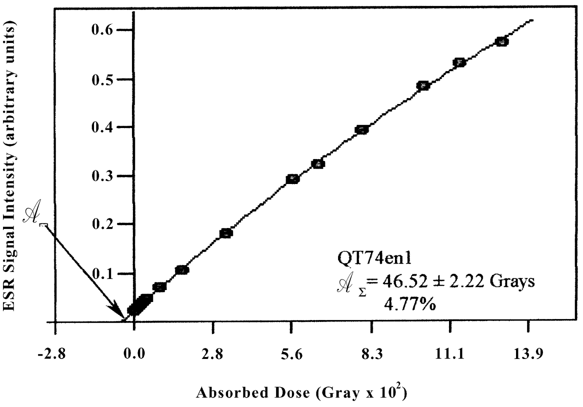
[7] Contained some dentine.

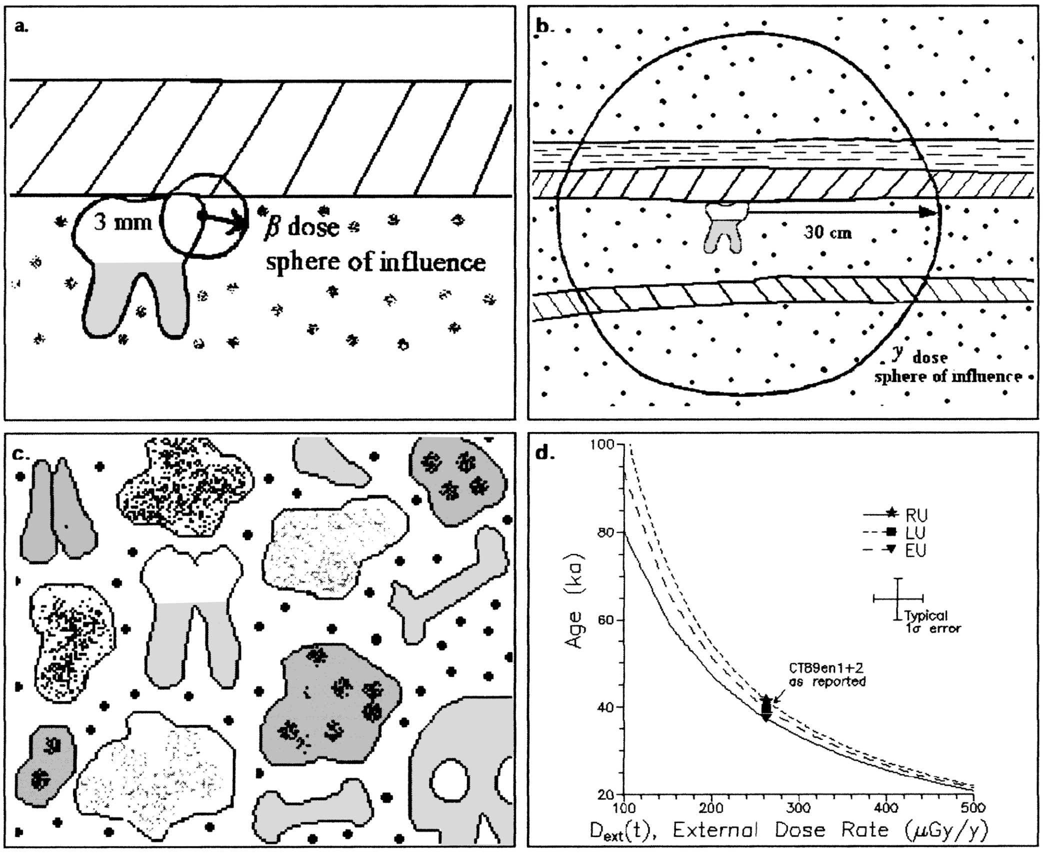
[8] Detection limits depend on sample mass and mineralogy.

teoretičnih izračunov. Za razliko od zob, ki vsebujejo znatno količino U, pri vzorcih z zelo majhnimi uranovimi koncentracijami ne potrebujemo meritev o vnosu U ali modeliranja, če nas zanima ocena ene same ESR-starosti. Pri nizkih uranovih koncentracijah v zobeh tudi ni treba upoštevati oslabitve sevanja zaradi vode v vzorcu, oslabitve doze α in β zaradi gostote snovi, izgube radona (Rn), izluževanja U in sekundarne vključitve urana pri računanju $D_{int}(t)$ (npr. Brennan *et al.* 2000).

Hitrost naraščanja zunanjih doz pa močno vpliva na izračunane ESR-starosti, še posebej pri vzorcih, ki imajo majhno hitrost naraščanja notranjih doz $D_{int}(t)$, kot je tudi primer pri Divjih babah I. Da bi ocenili zunanje dozne hitrosti $D_{ext}(t)$, je bila narejena geokemijska analiza nefrakcioniranega sedimenta (*bulk sediment*), zbranega skupaj z vzorcem. V nefrakcioniranem sedimentu, ki je bil pri postopku zmlet v prah, so bile vzorcem izmerjene koncentracije U, Th in K. Radioizotopske

Sl. 6.3: Določanje prejete doze, $\mathscr{A}_{\Sigma}$.
Metodo dodane doze smo uporabili za izračun prejete (ali γ-ekvivalentne) doze $\mathscr{A}_{\Sigma}$. Po umetnem obsevanju vseh delov vzorca (razen enega) smo na diagram nanesli jakost signala v odvisnosti od dodane doze. Presečišče grafa z abcisno osjo da $\mathscr{A}_{\Sigma}$. Zaradi zelo majhne koncentracije urana v zobu ni mogoče v tem medvedjem zobu iz Divjih bab I zaznati skoraj nič prejete doze.
Fig. 6.3: Determining the accumulated dose, $\mathscr{A}_{\Sigma}$.
The additive dose method was used to calculate the accumulated (or γ-equivalent) dose, $\mathscr{A}_{\Sigma}$. After artificially irradiating all but one aliquot, plotting the signal intensity *versus* the added radiation dose gave a growth curve, whose *x*-intercept yielded $\mathscr{A}_{\Sigma}$. In this bear tooth from Divje babe, almost no accumulated dose can be detected, thanks to the very low U concentrations in the tooth.





Sl. 6.4: Določanje hitrosti zunanje doze, $D_{ext}(t)$.

Sevanje iz radioaktivnega razpada doseže datirani vzorec znotraj vplivnega področja za določen tip sevanja:

a. Žarki β pomembno prispevajo k skupni dozi sevanja, tako notranje kot zunanje. Ker je doseg žarkov β v povprečju 1-2 mm primerljiv z debelino vzorca, morajo izračuni doz upoštevati oslabitev sevanja znotraj vzorca. Vplivno območje za žarke β običajno ne vključuje več kot dve ali tri sedimentacijske enote.

b. Ker žarki γ lahko prodrejo ~ 30 cm, lahko njihovo vplivno območje vključuje več sedimentacijskih enot in več različnih sedimentnih komponent, ki lahko zelo različno prispevajo k dozni hitrosti.

c. V najdiščih z nehomogenimi sedimenti, kot so Divje babe I, lahko različni minerali ali klasti znotraj nehomogenega sedimenta vsebujejo različne koncentracije radioaktivnih elementov. Vsaka sedimentna komponenta lahko prispeva drugačno dozno hitrost. V Divjih babah I so sedimentne komponente kosti, zobje in fragmenti dolomita s stropa jame.

d. Ko se hitrost zunanje doze $D_{ext}(t)$ zmanjšuje, se preračunana starost t_1 za vzorec CT89en1+2 poveča. Razlika v preračunani starosti postane statistično značilna, če hitrost zunanje doze, ki jo zob dejansko prejme, presega 400 μGy/leto ali pade pod 190 μGy/leto.

V vseh primerih mora izračun $D_{ext}(t)$ predstavljati volumensko povprečje dozne hitrosti iz vsakega vira, upoštevaje njegovo pomembnost in lokacijo znotraj vplivnega območja vsake stratigrafske enote ali tipa sedimenta.

Fig. 6.4: Determining the external dose rate, $D_{ext}(t)$.

Radiation can reach the dating sample from radioactive decay occurring within the sphere of influence for the particular radiation type:

a. β particles deliver to a sample a significant, but variable, component in the total radiation dose, both externally and internally. Since the penetration range for a β particle averages 1-2 mm, comparable to the sample thicknesses, dose calculations must consider β attenuation within the sample. The "sphere of influence" for the contributions from β radiation will usually not include more than two or three sedimentary units.

b. Since γ irradiation can penetrate ~ 30 cm, the sphere of influence for the contributions from γ radiation can include several sedimentary units and several different sedimentary components, which may produce very different dose rates.

c. In "lumpy" sites, such as Divje babe I, different minerals or clasts within the inhomogeneous sediment may contain different concentrations of radioactive elements. Each lump can contribute a different dose rate. At Divje babe I, the "lumps" are bones, teeth, and dolomitic rock from the cave roof.

d. As $D_{ext}(t)$, the external dose rate, decreases the calculated age, t_1, increases for CT89en1+2. The difference in its calculated age becomes statistically significant, only if the external dose rate actually experienced by the tooth exceeded 400 μGy/y, or fell below 190 μGy/y.

In all situations, the $D_{ext}(t)$ calculation must volumetrically average the dose rate from each source relative to its importance and location within the "sphere of influence" for each stratigraphic unit or sediment type.

koncentracije so bile uporabljene za matematični izračun sedanjih doznih hitrosti $D_{ext,\gamma}(t_0)$ in $D_{ext,\beta}(t_0)$ pri čemer računi vključujejo popravke za oslabitev doz β in γ zaradi gostote mineralov, koncentracije vode in povratnega sipanja. Ker ima najdišče tanke in nehomogene plasti, sestavljene iz nesortiranega sedimenta, nehomogenost obsevanega polja zahteva volumetrično analizo (Brennan *et al.* 1997a; Guibert *et al.* 1998). Prispevek vsake sedimentne komponente je povprečje glede na velikost njenega volumna in učinka sevanja, tako da lahko izračunamo dejanski prispevek $D_{ext}(t)$ različnih komponent ali plasti znotraj "vplivnih področij" β in γ (npr. *sl. 6.4a-d; tab. 6.2*). V jamah, kjer zobje in kosti vsebujejo malo ali nič U, kot je to v Divjih babah I, pri izračunih $D_{ext}(t)$ ni treba upoštevati možnega vnosa urana, tvorbe dolgoživih uranovih izotopov in potencialne izgube Rn (Blackwell, Blickstein 2000). V jamah, kot je Divje babe I, lahko predvidevamo, da je doza kozmičnih žarkov 0 mGy/leto, ker je dolomitni jamski strop debel več kot 10 m. Zaradi majhne velikosti datiranih zob iz Divjih bab I na nobenem izmed njih ni bilo mogoče izvesti izohrone metode.

V jamah se lahko zaradi kraških procesov in živali, ki kopljejo rove, zobje prestavijo s svoje prvotne lege drugam, običajno v plast z drugačno radioaktivnostjo. Tako se bo njihov $D_{ext}(t)$ razlikoval. Da bi zagotovili, da ne bi naleteli na zobe z drugotnih leg, je potrebnih vsaj 2–3 neodvisnih ESR-analiz za 4–5 zob (Blackwell 1994). V tej raziskavi smo upoštevali možne premike zob, tako da smo za več plasti primerjali datacije za 3–4 zobe na plast.

ANALITIČNE METODE

Za dozimetrijo sedimentov smo z nevtronsko aktivacijsko analizo (NAA) preučili več kot 150 sedimentnih vzorcev (*tab. 6.2*) (Blackwell 1989). Da bi določili $D_{ext}(t)$ v vsebnosti U, Th in K, smo opravili geokemijsko analizo nefrakcioniranega sedimentnega vzorca v zmletem stanju, nabranega v okolici zoba. Več sedimentnih vzorcev, ki niso bili že na začetku pobrani skupaj z zobmi, smo zbrali na novih izkopavanjih, ki so se končala poleti 1999, da bi ocenili $D_{ext}(t)$ v vseh sedimentnih komponentah in plasteh, ki bi lahko prispevale k vzorcu $D_{ext}(t)$ (Blackwell, Blickstein 2000). Obenem smo izmerili tudi prostornino gruščnate frakcije in agregatov v sedimentu. Večje sedimentne vzorce vseh plasti smo nato pregledali za oceno paleovlažnosti in paleotemperature (glej poglavje 5 v tem zborniku).

Z uporabo standardne ESR-metode smo analizirali 52 podvzorcev iz 28 posameznih zob vrste *Ursus spelaeus* iz plasti 2 do 23 v Divjih babah I (*tab. 6.1*). Podvzorci sklenine so bili z manjšimi prilagoditvami pripravljeni po metodi, ki jo opisujejo Blackwell (1989, 2006) in Blackwell *et al.* (1992, 2000). Da bi ohranili vizualno podobo zob tudi po njihovem uničenju, smo vsak zob skicirali in fotografirali iz 4–6 različnih perspektiv. Vse prilepljene sedimente smo odstranili in shranili za NAA. Sklenino, zobovino, morebitni zobni cement in debelino korenine smo izmerili z ročnim digitalnim merilnom in nato uporabili ročni vrtalnik Dremel z diamantno konico za odstranitev 1–4 podvzorcev sklenine, ki so kazali minimalno diagenetsko spremembo. Pri vsakem vzorcu smo sklenino ločili od zobovine in jo shranili za NAA. Po začetnem čiščenju, s katerim smo odstranili morebitno preostalo zobovino in nečistoče, ter po nadaljnjem čiščenju, v katerem smo z vsake strani odstranili 20 μm debelo plast, na katero je vplivalo α obsevanje, smo izmerili debelino vsakega koščka sklenine z mikrometrom Mitutoyo ID-C112E, in sicer v 20–50 točkah pri vsakem podvzorcu. Po ročnem drobljenju na ~ 38–76 μm (mrežica 200–400) z ahatno terilnico in pestilom smo odtehtali približno 20 mg sklenine v vsako od 10–15 alikvot.

Potem ko smo v jederskem reaktorju McMaster obsevali alikvote z žarki γ iz vira ^{60}Co in pri dozni hitrosti 14–126 Gy/s dosegli dodane doze 0,0–2,6 kGy, smo vsak vzorec žarili pri 90°C tri dni, da bi odstranili vsako motnjo v signalu (Skinner *et al.* 2000). Vsak del vzorca smo merili 8 minut pri 25°C s spektrometrom JEOL REIX ESR pri 2,0 mW moči in 5,0 mT velikem polju s središčem v 336 mT ter časovnimi konstantami 0,1–0,3 sekunde. Pri meritvi sklenine je bila mikrovalovna frekvenca naravnana na 9,449 GHz v modulaciji 100 kHz s širino 0,5–1 mT. Ojačanje pri meritvi smo spreminjali, da bi dobili največjo jakost signala. V zbranih ESR-spektrih so bile višine vrhov izmerjene elektronsko s posebnim programom *EPR*.

Za nekaj zob s skrajno majhnimi masami sklenine smo uporabili združevalno (*ramping*) metodo (Blackwell 2006). Ker smo razpolagali samo s 3–8 alikvotami, smo 1–4 alikvote uporabili za kalibriranje ESR-spektrometra pri vsakem setu ponovnega merjenja, 1–5 pa smo jih uspešno obsevali z vedno višjimi dodanimi dozami in nato ponovno izmerili z ESR po vsaki dozi (Blackwell 2006). To smo ponavljali, dokler nismo izmerili vzorcev vsaj za 12–15 neodvisnih dodanih doz, pri čemer je največja dodana doza vsaj 10-krat presegla vrednost zbrane doze, s čimer smo zagotovili največjo natančnost v krivulji rasti (Lee *et al.* 1997; Grün 1996).

Vsak vzorec sklenine, zobovine in sedimenta smo zdrobili v prah in z NNA analizirali U (npr. *tab. 6.2, 6.3*). Približno 0,5–1,0 g vsakega vzorca smo prešteli z zakasnjenim štetjem nevtronov 60 sekund po 60-sekundnem obsevanju ter z10-sekundnim odlogom. V vseh podvzorcih sedimenta in v vsaj enem podvzorcu sklenine ter zobovine pri vsakem zobu smo analizirali Th, K in 12 drugih elementov z 20-minutnim štetjem žarkov γ. Kalij smo analizirali po 60-sekundnem obsevanju in 24-urnem odlogu. Vsak nabor podatkov v NAA smo kalibrirali po standardu NIST, običajno 1633A ali 1633B.

Tab. 6.3: Koncentracije urana v zobeh iz najdišča Divje babe I, Slovenija.
Tab. 6.3: U concentrations in the teeth from Divje babe I, Slovenia.

			U Concentrations			
Sample	Layer		Enamel (ppm)	Dentine (ppm)	Dentine in Root (ppm)	Cementum (ppm)
CT89en1+2	2		< 0.02[1,2]	0.84	0.77	–
CT88en1+3	3		0.12	1.34	2.21	–
CT88en2+4	3		< 0.02[2]	1.01	–	–
mean CT88	3		0.06	1.18	2.21	–
		±	0.06	0.17	0.02	–
CT16en1	3		< 0.02[1,2]	0.44	–	–
CT17en1	3		< 0.02[1,2]	0.06	–	–
CT17en2	3		< 0.02[1,2]	0.06[3]	–	–
mean CT17	3		< 0.02[1,2]	0.06	–	–
		±	0.02	0.02	–	–
RT8en1	8a		0.08	0.41[1]	–	–
RT8en2	8a		< 0.02[2]	0.41[1]	–	–
RT8en3	8a		0.08[1]	0.41	–	–
mean RT8	8a		0.05	0.41	–	–
		±	0.03	0.02	–	–
RT10en1	8a		< 0.10[1]	0.13	–	–
RT11en1	8a		0.01	0.16	–	–
RT12en1	8a		0.10	0.17	0.53	–
CT87en1+3	8c		< 0.02[2,3]	0.17	0.35	–
CT87en2+4	8c		< 0.02[2,3]	0.24	–	–
mean CT87	8c		< 0.02[2]	0.21	0.35	–
		±	0.02	0.04	0.02	–
RT81en1	10		< 0.02[2]	0.32	–	–
RT81en2	10		< 0.02[2,3]	0.27	–	–
RT81den1a	10		–	0.35	–	–
RT81den2a	10		–	0.20	–	–
mean RT81	10		< 0.02[2]	0.29	–	–
		±	0.02	0.06	–	–
RT80en1	10		0.08	0.13	0.58	–
RT80en2	10		0.08[3]	0.14	0.19	–
RT80den1a	10		–	0.35	–	–
RT80den1b	10		–	0.39	–	–
mean RT80	10		0.08	0.25	0.39	–
		±	0.02	0.12	0.20	–
RT76en1+2	10		< 0.01[2]	0.30	0.72	–
RT76en3	10		< 0.01[1,3]	0.25	0.80	–
RT76den1a	10		–	0.38	–	–
mean RT76	10		< 0.01[2]	0.31	0.76	–
		±	0.02	0.05	0.04	–
RT79en1	10-12		0.54	0.13	0.49	–
RT79en2	10-12		< 0.01[2]	0.13[3]	0.82	–
mean RT79	10-12		< 0.01[2]	0.13	0.66	–
		±	0.02	0.02	0.25	–
QT1en1	13		< 0.02[2]	0.13	–	–
QT1en2	13		< 0.02[2]	0.26	–	–
QT1den3	13		–	–	0.52	–
QT1den4	13		–	–	0.74	–
QT1den5	13		–	–	0.59	–
QT1den6	13		–	–	1.03	–
mean QT1	13		< 0.02[2]	0.20	0.72	–
		±	0.02	0.07	0.20	–
RT44en1	13		–	0.30	–	–
		±	–	0.02	–	–

continued....

Tab. 6.3 / Tab. 6.3: (nadaljevanje / cont.)

Sample	Layer		U Concentrations Enamel (ppm)	Dentine (ppm)	Dentine in Root (ppm)	Cementum (ppm)
QT3en1	13		0.05	0.12[3]	0.66	–
QT3en2a	13		< 0.02[2]	0.12	–	–
QT3en2b	13		0.09	0.12	–	–
mean QT3	13		0.05	0.12	0.66	–
		±	0.04	0.02	0.02	–
QT4en1	13		0.06	0.16	–	–
QT4en2	13		0.04	0.10	–	–
QT4den1	13		–	–	0.13	–
QT4den2	13		–	–	0.21	–
QT4den3	13		–	–	0.36	–
QT4den4	13		–	–	0.17	–
QT4den5	13		–	–	0.16	–
mean QT4	13		0.05	0.13	0.21	–
		±	0.02	0.03	0.08	–
RT43Ben1	16a		< 0.02[2]	0.47	0.12	–
RT43Ben2	16a		< 0.02[2]	0.67	0.45	–
RT43Bden1a	16a		–	0.37	–	–
mean RT43B	16a		< 0.02	0.57	0.29	–
		±	0.02	0.10	0.17	–
RT5en1	17		< 0.02[2,3]	0.07	0.31	–
RT5en2	17		< 0.02[2]	0.46	–	–
mean RT5	17		< 0.02	0.28	0.31	–
		±	0.02	0.16	0.02	–
RT42en1	17a2		< 0.02[1,2]	0.83	1.76	–
RT42en2	17a2		< 0.02[1,2]	–	–	–
mean RT42	17a2		< 0.02	0.83	1.76	–
		±	0.02	0.02	0.02	–
RT45en1	17a2		< 0.02[2,3]	0.99	–	–
RT45en2	17a2		< 0.02[2]	1.04	–	–
mean RT45	17a2		< 0.02[2]	1.02	–	–
		±	0.02	0.03	–	–
RT39en1	17a2		< 0.02[2]	0.78	0.74	–
		±	0.02	0.02	0.02	–
RT40en1	17a2		0.10	0.84	1.49	–
RT40en2	17a2		0.17	–	–	–
RT40den1a	17a2		–	0.56	0.87	–
mean RT40	17a2		< 0.02[2]	0.57	0.29	–
		±	0.02	0.10	0.17	–
RT46en1	17a2		< 0.02[2]	0.15	0.52	–
RT46en2	17a2		< 0.02[2,3]	0.10	0.70	–
RT46den1a	17a2		–	–	0.53	–
mean RT46	17a2		< 0.02[2]	0.15	0.58	–
		±	0.02	0.02	0.08	–
QT2en1	17a2		0.04	0.26	0.54	–
QT2en2	17a2		0.09	0.12	–	–
mean QT2	17a2		0.07	0.19	0.54	–
		±	0.03	0.07	0.02	–
QT5en1	20		< 0.02[2]	0.46	–	0.60
QT5en2	20		< 0.02[2]	0.25	0.37	0.67
QT5den3	20		–	0.08	0.32	–
QT5den4	20		–	0.19	0.39	–
mean QT5	20		< 0.02[2]	0.25	0.36	0.64
		±	0.02	0.14	0.03	0.04

continued....

Tab. 6.3 /*Tab. 6.3:* (nadaljevanje / cont.)

Sample	Layer		U Concentrations			
			Enamel (ppm)	Dentine (ppm)	Dentine in Root (ppm)	Cementum (ppm)
QT74en1	23		< 0.02[2,3]	0.37	-	-
QT74en2	23		0.02	0.34	-	-
mean QT74	23		< 0.02[2]	0.36	-	-
		±	0.02	0.02	-	-
Typical errors[4]		±	0.02	0.02	0.02	0.02
Typical detection			0.01	0.01	0.01	0.01
limits[4]		-	0.02	0.02	0.02	0.02
Typical water		~	0.02	0.05	0.05	0.05
concentrations		±	0.02	0.02	0.02	0.02

[1] Value assumed based on nearby teeth.
[2] Below detection limits: Assumed to equal 0 for calculations.
[3] Assumed value equals other subsamples from this tooth
[4] Typical detection limits and errors depend tissue type and subsample mass.

ANALITIČNI IZRAČUNI ZA ESR-DATIRANJA

Čeprav je vrh HAP v spektru razmeroma zapleten, raste enakomerno in ga lahko natančno izmerimo s preprosto oceno njegove višine brez dekonvolucije, saj večkomponentni vrh izhaja z istega mesta v kristalni mreži (Skinner *et al.* 2000). Odvajani ESR-spektri dejansko omogočajo boljšo statistično ločljivost kot integrirani spektri (Lyons, Tan 2000). Zato so bile višine vrhov merjene neposredno iz odvajanega spektra z uporabo programa *EPR* brez dekonvolucije. Prejete doze $\mathcal{A}_{\Sigma}$ in z njimi povezane napake smo izračunali s funkcijo *VFit* (*sl. 6.4*), s tem da smo predpostavili eksponentno približevanje končni vrednosti in upoštevali uteži $1/I^2$.

Starosti, vsa razmerja doz in njihove napake smo izračunali z uporabo programa *Rosy v. 1.4*, ki popravlja oslabitev toka delcev zaradi povratnega sipanja, koncentracije vode, gostote mineralov, debeline vzorcev in vrste tkiva (Brennan *et al.* 1997b). Hitrosti notranje doze smo izračunali s predvidevanjem, da ni bilo nobene izgube Rn in nobenega izluževanja U. Za učinkovitost žarkov α v sklenini smo predpostavili 0,15 ± 0,02 (Grün 1989), za začetno razmerje in aktivnosti urana v zobovini in sklenini $(^{234}U/^{238}U)_0 = 1.2 \pm 0.2$ in za koncentracijo vode v zobovini 5 ± 2 težnih % (Blackwell 2006).

Nehomogeni sediment v Divjih babah I vsebuje kosti, zobe, preperele dolomitne klaste, preperele sige, kamene artefakte, preperino, nastalo z raztapljanjem karbonatov, dolomiten detritus različnih velikosti od gline do peska ter sekundarne fosfatne minerale. Vsaka komponenta je imela drugačne koncentracije radioaktivnih elementov in je tako prispevala različne doze sevanja. Za vsako plast do razdalje 30 cm od datiranih zob smo analizirali več vzorcev nefrakcioniranega sedimenta in posameznih sedimentnih komponent (*tab. 6.2*). $D_{ext}(t)$ smo izračunali iz koncentracij U, Th in K, ugotovljenih z NAA (npr. Adamiec, Aitken 1998), in predpostavili, da ni bilo prispevka kozmičnega sevanja. Trenutne koncentracije vode v najdišču so v povprečju ~ 10–15 težnih % zaradi odlične drenaže, kljub temu pa so izračuni predvidevali 25 ± 5 težnih % vode, ker avtigeni fosfatni cementi povzročajo občasno zastajanje vode v sedimentu v preteklih obdobjih. Sestavo relativnih komponent in delež por smo ocenili iz natančnih stratigrafskih profilov ter fotografij za vsako lokacijo vzorčenja. Te smo potrdili z uporabo enake metode na novih izdanjkih sedimentov z najdbami zob, ki so jim sledile prave volumetrične meritve različnih komponent. Relativni prispevki iz različnih virov so bili ocenjeni glede na volumensko povprečje v "vplivnem območju" za vire γ v polmeru 30 cm ter za vire β v polmeru 3 mm (npr. Blackwell *et al.* 2000; Blackwell, Blickstein 2000).

Velika negotovost pri izračunu starosti izvira iz nezanesljivosti v $D_{ext}(t)$ in $\mathcal{A}_{\Sigma}$. Ko pa ESR primerjamo z drugimi metodami, daje običajno zanesljive rezultate (Blackwell 2006). Vir sevanja v laboratoriju McMaster je bil kalibriran v medlaboratorijskem kalibriranju leta 1992 (Barabas *et al.* 1993), medtem ko je laboratorij ESR v Williamsu sodeloval v medlaboratorijskih kalibracijah 1992 in 2003–2004 (Wieser *et al.* 2006).

REZULTATI

Z metodo ESR smo določili koledarsko starost 44 podvzorcev, ki pripadajo 28 zobem iz Divjih bab I (*tab. 6.4*). Pri vsakem zobu smo analizirali več podvzorcev sklenine in dentina za oceno koncentracije U (*tab. 6.3*). Kjer smo lahko našli dovolj zobnega cementa za analizo, smo ga tudi testirali. Ker se zobje v Divjih babah I

Tab. 6.4: Datacije ESR za najdišče Divje babe I, Slovenija.
Tab. 6.4: ESR dates for Divje babe I, Slovenia.

Subsample		Layer	Accumulated Dose, $\mathcal{A}_\Sigma$ (Grays)	External Dose Rates $D_{ext,\beta}(t)^2$ (μGy/y)	$D_{ext,\gamma}(t)^2$ (μGy/y)	ESR Ages[1] EU (ka)	LU (ka)	RU[3] (ka)
A. CT89, 98231, *Ursus spelaeus* canine								
CT89en1+2		2	11.06	79.1	183.8	37.4	39.7	41.6
	±		0.65	10.5	18.5	4.3	4.7	5.2
			3.52%			11.5%	11.8%	12.5%
B. CT88, 98198, *Ursus spelaeus* molar								
CT88en1+3		3	11.73	91.3	218.1	32.8	35.4	37.4
	±		0.55	13.9	26.0	4.0	4.6	5.1
CT88en2+4		3	12.86	91.3	218.1	36.9	39.2	41.1
	±		0.66	13.9	26.0	4.6	5.2	5.7
Mean CT88		3	12.24	91.3	218.1	34.8	37.3	39.2
(2)	±		0.42	13.9	26.0	3.0	3.5	3.8
			3.46%			8.7%	9.3%	9.7%
C. CT16, 98161, *Ursus spelaeus* incisor								
CT16en1		7	11.78	56.5	160.0	51.9	53.2	54.2
	±		0.78	10.6	24.0	8.7	9.1	9.4
			6.59%			16.8%	17.1%	17.3%
D. CT17, 98162, *Ursus spelaeus* molar								
CT17en1		7	8.08	5.5	160.0	50.1	50.4	50.5
	±		1.31	1.6	24.0	11.0	11.1	11.1
CT17en2		7	7.16	5.5	160.0	44.4	44.5	44.7
	±		0.89	1.6	24.0	8.6	8.6	8.7
Mean CT17		7	7.50	5.5	160.0	46.9	47.1	47.2
	±		0.74	1.6	24.0	6.8	6.8	6.9
						14.5%	14.5%	14.6%
Mean Layer 7		7				49.0	49.6	50.1
(3)	±					5.4	5.5	5.6
						11.0%	11.1%	11.2%
E. RT8, 98216, *Ursus spelaeus* molar								
RT8en1		8a	21.36	74.6	200.7	67.8	72.9	76.6
	±		1.51	10.7	22.7	8.7	9.9	10.8
RT8en2		8a	9.47	72.1	194.5	33.9	34.2	34.4
	±		0.29	10.3	22.5	4.3	4.3	4.4
RT8en3		8a	25.92	72.1	194.5	81.4	87.9	92.9
	±		1.50	10.3	22.5	10.1	11.3	12.5
Mean RT8		8a	14.15	72.1	194.5	61.3	64.2	66.5
	±		0.36	10.3	22.5	4.5	4.8	5.2
			2.53%			7.3%	7.5%	7.8%
F. RT10, 98217, *Ursus spelaeus* canine								
RT10en1		8a	15.41	72.1	194.5	50.0	53.1	55.7
	±		1.45	10.3	22.5	7.4	8.0	8.6
			9.41%			14.8%	15.1%	15.4%
G. RT11, 98215, *Ursus spelaeus* canine								
RT11en1		8a	9.61	72.1	194.5	34.3	34.6	34.8
	±		1.84	10.3	22.5	7.8	7.9	8.0
			18.79%			22.7%	22.8%	22.9%

continued....

Tab. 6.4 / *Tab. 6.4:* (nadaljevanje / cont.)

Subsample	Layer	Accumulated Dose, $\mathscr{A}_\Sigma$ (Grays)	External Dose Rates $D_{ext,\beta}(t)$[2] (μGy/y)	$D_{ext,\gamma}(t)$[2] (μGy/y)	ESR Ages[1] EU (ka)	LU (ka)	RU[3] (ka)
H. RT12, 98214, *Ursus spelaeus* canine							
RT12en1	8a	15.54	72.1	194.5	50.0	53.3	55.8
	±	1.01	10.3	22.5	6.4	7.1	7.7
		6.5%			12.8%	13.3%	13.8%
Mean Layer 8a	8a				55.8	58.6	60.8
(6)	±				3.2	3.4	3.6
					5.6%	5.8%	6.0%
I. CT87, 98224, *Ursus spelaeus* molar							
CT87en1	8c	8.232	65.3	174.7	45.0	46.1	46.9
	±	0.438	9.9	21.3	5.7	5.9	6.2
		5.32%			12.7%	12.8%	13.2%
J. RT81, 98001A, *Ursus spelaeus* molar							
RT81en1	10	16.38	68.1	191.3	80.9	83.4	85.3
	±	0.92	11.7	25.9	11.7	12.0	12.6
RT81en2	10	10.36	11.3	191.3	51.6	52.9	59.3
	±	0.28	2.7	25.9	6.8	7.2	7.5
Mean RT81	10	11.49	39.7	191.3	64.9	67.3	70.3
	±	0.28	7.2	25.9	6.3	6.7	6.8
		2.44%			9.7%	7.2%	9.6%
K. RT80, 98001B, *Ursus spelaeus* molar							
RT80en1	10	12.96	68.1	191.3	59.0	63.5	66.9
	±	0.56	11.7	25.9	7.7	8.5	9.4
RT80en2	10	13.82	68.1	191.3	63.2	67.9	71.2
	±	0.59	11.7	25.9	8.2	9.2	10.2
Mean RT80	10	13.40	68.1	191.3	61.1	65.7	69.0
	±	0.41	11.7	25.9	5.6	6.3	6.9
		3.04%			9.2%	9.5%	10.0%
L. RT76, 98003, *Ursus spelaeus* canine							
RT76en1+2	10	18.93	68.1	191.3	67.6	70.3	72.5
	±	1.13	11.7	25.9	10.0	10.8	11.4
					23.0%	24.0%	25.0%
Mean Layer 10	10				63.7	67.1	72.3
(5)	±				3.9	4.2	4.5
					6.1%	6.3%	6.3%
M. RT79, 98025, *Ursus spelaeus* canine							
RT79en1	10-12	33.55	74.2	208.6	76.6	94.7	112.6
	±	0.89	25.7	58.9	15.3	22.8	31.9
RT79en2	10-12	9.11	74.2	208.6	32.0	32.1	32.2
	±	0.27	25.7	58.9	9.5	9.5	9.6
Mean RT79	10-12	22.68	74.2	208.6	62.7	69.8	74.5
(2)	±	0.45	25.7	58.9	10.4	13.0	15.3
	±	1.98%			16.6%	18.7%	20.5%
N. QT3, 91047a, *Ursus spelaeus* incisor							
QT3en1	13	15.20	7.5	201.3	66.9	71.3	74.6
	±	0.26	2.3	55.2	16.3	18.5	20.3
QT3en2a	13	17.73	7.5	201.3	81.4	84.9	87.3
	±	0.79	2.3	55.2	21.0	22.8	24.1

continued...

Tab. 6.4 / Tab. 6.4: (nadaljevanje / cont.)

			Accumulated	External Dose Rates		ESR Ages[1]		
Subsample		Layer	Dose, $\mathcal{A}_\Sigma$	$D_{ext,\beta}(t)$[2]	$D_{ext,\gamma}(t)$[2]	EU	LU	RU[3]
			(Grays)	(μGy/y)	(μGy/y)	(ka)	(ka)	(ka)
QT3en2b		13	21.46	7.5	201.3	89.1	98.0	104.8
	±		1.08	2.3	55.2	20.9	25.1	28.7
Mean QT3		13	16.04	7.5	201.3	79.3	84.9	88.9
(3)	±		0.24	2.3	55.2	11.2	12.8	14.1
			1.50%			14.1	15.1	15.8
O. QT4, 91047b, *Ursus spelaeus* incisor								
QT4en1		13	15.95	7.5	201.3	71.8	75.7	78.6
	±		0.74	2.3	55.2	18.1	20.1	21.7
QT4en2		13	15.30	7.5	201.3	71.1	73.8	75.6
	±		0.67	2.3	55.2	18.5	19.8	20.8
Mean QT4		13	15.61	7.5	201.3	71.5	74.8	77.1
(2)	±		0.50	2.3	55.2	12.9	14.1	15.0
			3.18%			18.1%	18.9%	19.5%
P. QT1, 91043, *Ursus spelaeus* canine								
QT1en1		13	15.16	7.5	201.3	69.8	72.6	74.8
	±		0.49	2.3	55.2	17.8	19.3	20.6
QT1en2		13	14.60	7.5	201.3	66.4	69.5	71.9
	±		3.22	2.3	55.2	22.1	23.8	25.1
Mean QT1		13	15.14	7.5	201.3	68.5	71.4	73.7
(2)	±		0.49	2.3	55.2	13.9	15.0	15.9
	±		3.21%			20.2%	21.0%	21.6%
Mean Layer 13		13				74.5	78.7	81.6
(7)	±					7.3	8.1	8.7
						9.8%	10.3%	10.7%
Q. RT43B, 98011, *Ursus spelaeus* molar								
RT43Ben1		16a	13.82	5.4	160.8	79.7	83.0	85.2
	±		0.63	1.4	18.5	9.1	9.7	10.2
RT43Ben2		16a	10.11	5.4	160.8	59.3	61.2	62.4
	±		0.48	1.4	18.5	7.2	7.3	7.6
Mean RT43B		16a	12.05	5.4	160.8	70.1	72.3	74.0
	±		0.40	1.4	18.5	5.8	6.0	6.3
	±		3.30%			8.3%	8.4%	8.5%
R. RT5, 98124, *Ursus spelaeus* molar								
RT5en1		17	19.62	4.7	252.0	76.0	76.3	76.4
	±		1.36	2.0	38.2	12.9	13.0	13.0
RT5en2		17	23.01	4.7	252.0	87.6	88.7	89.5
	±		1.39	2.0	38.2	14.3	14.7	14.9
Mean RT5		17	21.55	4.7	252.0	82.0	82.6	83.1
(2)	±		0.98	2.0	38.2	9.7	9.8	9.9
			4.55%			11.8%	11.9%	11.9%
S. RT42, 98094, *Ursus spelaeus* incisor								
RT42en1[4]		17a2	24.68[4]	8.0	262.6	88.2	89.8	90.9
	±		4.25	2.3	64.8	26.0	26.7	27.4
			17.22%			29.5%	29.7%	30.1%
T. RT45, 98095, *Ursus spelaeus* molar								
RT45en1		17a2	24.36	8.5	266.6	77.2	83.2	88.0
	±		0.76	2.5	73.0	18.8	21.7	24.3
RT45en2		17a2	19.18	8.5	266.6	65.4	67.9	69.8
	±		1.78	2.5	73.0	18.0	19.3	20.3
Mean RT45		17a2	23.83	8.5	266.6	72.0	76.2	79.4
	±		0.71	2.5	73.0	13.1	14.6	15.9
			2.97%			18.2%	19.2%	20.0%

continued...

Tab. 6.4 / *Tab. 6.4:* (nadaljevanje / cont.)

		Accumulated	External Dose Rates		ESR Ages[1]		
Subsample	Layer	Dose, $\mathcal{A}_\Sigma$ (Grays)	$D_{ext.\beta}(t)$[2] (μGy/y)	$D_{ext.\gamma}(t)$[2] (μGy/y)	EU (ka)	LU (ka)	RU[3] (ka)
U. RT39, 98102, *Ursus spelaeus* canine							
RT39en1	17a2	26.01	8.6	267.1	84.7	90.0	94.1
	±	1.08	2.9	74.0	21.5	24.2	26.5
		4.15%			25.3%	26.8%	28.1%
V. RT40, 98103a, *Ursus spelaeus* molar							
RT40en1	17a2	13.78	4.5	267.1	49.9	50.4	50.5
	±	0.54	1.2	74.0	13.7	13.9	14.0
		3.94%			28.2%	28.4%	28.5%
W. RT46, 98103b, *Ursus spelaeus* molar							
RT46en1	17a2	32.36	4.5	267.1	116.3	117.8	118.8
	±	3.63	1.2	74.0	34.0	34.8	35.4
RT46en2	17a2	25.77	4.5	267.1	92.6	93.8	94.7
	±	2.63	1.2	74.0	26.7	27.2	27.8
Mean RT46	17a2	28.75	4.5	267.1	104.3	105.6	106.6
	±	2.17	1.2	74.0	21.4	21.9	22.3
		7.55%			20.5%	20.7%	20.9%
X. QT2, 91042a, *Ursus spelaeus* incisor							
QT2en1	17a2	43.93	56.5	361.8	98.3	101.9	104.5
	±	2.51	6.5	30.7	10.0	10.5	11.0
QT2en2	17a2	65.47	56.5	361.8	141.3	149.6	155.0
	±	6.58	6.5	30.7	18.5	19.9	20.9
Mean QT2	17a2	49.20	56.5	361.8	114.5	119.8	123.6
(2)	±	2.44	6.5	30.7	9.2	9.8	10.3
		4.97%			8.0%	8.2%	8.3%
Mean Layer	17a2				101.9	106.5	109.8
(9)	±				6.5	6.9	7.2
					6.3%	6.5%	6.6%
Y. QT5, 91044, *Ursus spelaeus* canine							
QT5en1	20	30.17	6.2	259.2	111.8	114.3	115.6
	±	1.58	1.8	49.3	21.6	22.5	23.0
QT5en2	20	28.35	6.2	259.2	105.4	107.5	109.0
	±	1.22	1.8	49.3	20.2	20.9	21.6
Mean QT5	20	29.08	6.2	259.2	108.6	110.9	112.3
(2)	±	0.99	1.8	49.3	14.8	15.3	15.8
		3.42%			13.6%	13.8%	14.0%
Z. QT74, 98110, *Ursus spelaeus* canine							
QT74en1	23	46.52	104.6	271.5	120.6	122.3	123.6
	±	2.22	15.5	37.3	17.5	18.0	18.4
QT74en2	23	42.05	104.6	271.5	107.7	110.0	111.6
	±	2.00	15.5	37.3	15.5	16.1	16.6
Mean QT74	23	44.27	104.6	271.5	114.1	116.1	117.6
(2)	±	1.49	15.5	37.3	11.7	12.1	12.4
		3.37%			10.2%	10.4%	10.5%

Abbreviations:
EU = assuming early U uptake
LU = assuming linear (continuous) U uptake
RU = assuming recent U uptake

Calculated using
α efficiency factor, κ_α = 0.15 ± 0.02
initial U activity ratio, $(^{234}U/^{238}U)_0$ = 1.20 ± 0.20
enamel water concentration, W_{en} = 2. ± 2. wt%
dentine water concentration, W_{den} = 5. ± 2. wt%
cementum water concentration, W_{cem} = 5. + 2. wt%
enamel density, ρ_{en} = 2.95 ± 0.02 g/cm^3
dentine density, ρ_{den} = 2.85 ± 0.02 g/cm^3
cementum density, ρ_{cem} = 2.75 ± 0.02 g/cm^3

continued...

Tab. 6.4 / Tab. 6.4: (nadaljevanje / cont.)

radon loss from the tooth, Rn_{tooth}	=	0.	±	0.	%
sediment density, ρ_{sed}	=	2.65	±	0.02	g/cm³
cosmic dose rate, $D_{cos}(t)$	=	0.000	±	0.000	mGray/y

[2] Volumetrically averaged external dose rates used assumptions listed in *Table 6.2.*

[3] Calculated assuming the uptake parameter, p = 10

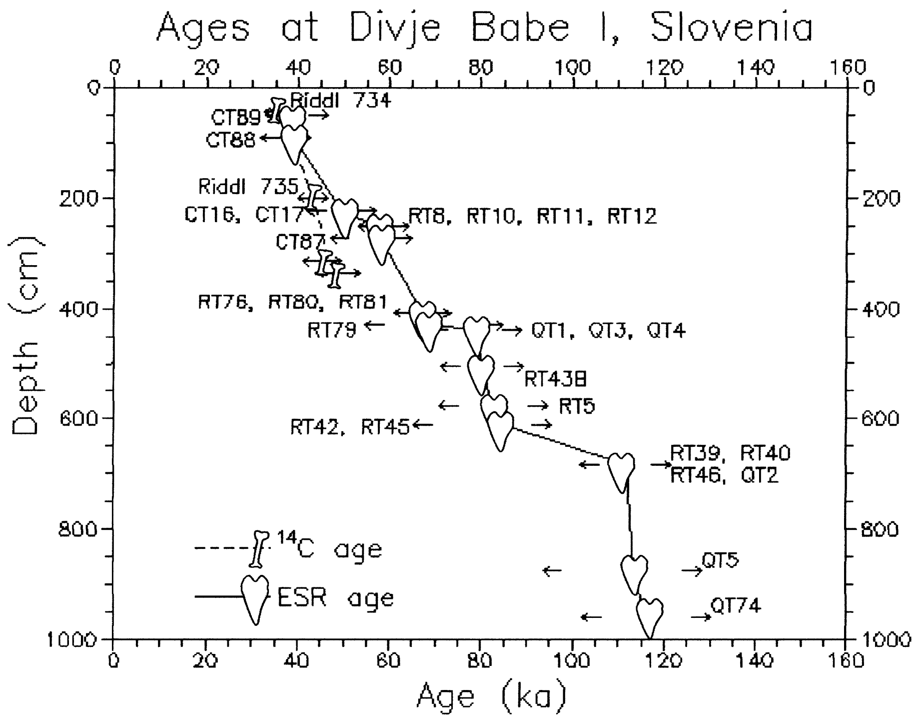
običajno pojavljajo posamič v skupinah, redkeje skupaj v čeljustih, smo zbrali tudi več vzorcev koreninskega dentina za oceno $D_{ext,\beta}(t)$, tj. hitrosti zunanje doze žarkov β (*tab. 6.2*). Pri mnogih zobeh smo za določitev Th in K analizirali tudi vsaj en vzorec sklenine in dentina. Sklenina z zelo malo izjemami ni vsebovala U, ki ga bi bilo mogoče izmeriti. Medtem ko je večina dentina v kronah vsebovala manj kot 0,5 ppm U, pa sta koreninski dentin in cement običajno vsebovala nekoliko več U, a noben več kot 2,5 ppm. Noben vzorec dentina ali sklenine ni kazal merljive vsebnosti Th, prav tako ni noben vseboval več kot 0,02 težna % K (*tab. 6.2*). Ti podatki pomenijo, da izbira modela o vnosu urana ne povzroči kakšne večje spremembe pri izračunanih starostih. Še več, razmišljanje o tem, kako se spoprijeti z izgubo Rn ali sekundarno vključitvijo urana postane odveč in brez pomena. Zato se bo razprava od tod naprej osredotočila izključno na model pozne vključitve urana (LU), ki nam pove povprečne starosti.

Zaradi nizkih uranovih koncentracij in s tem tudi majhnih hitrosti notranje doze $D_{int}(t)$ so starosti močno odvisne od $D_{ext,\gamma}(t)$. Z nevtronsko aktivacijsko analizo (NAA) smo analizirali 146 vzorcev sedimenta (*tab. 6.2*) in nekaj sklenin ter dentinov, da bi tako izmerili dozno hitrost v sedimentu (Blackwell 1989). Večina plasti je imela srednjo vrednost $D_{ext,\beta}(t)$ v povprečju manjšo od 100 μGy/leto, medtem ko je srednja vrednost $D_{ext,\gamma}(t)$ segala od 130 do 410 μGy/leto. Te nizke vrednosti izhajajo iz visoke koncentracije delcev dolomita vseh velikosti v sedimentu (Turk *et al.* 1989b, 2001, 2002b), ki v povprečju vsebujejo zelo malo U, Th in K (povprečje za dolomitne klaste, velikosti 40–60 mm, iz vseh plasti je 1,26 ±0,87 ppm za U, 0,59 ±0,25 ppm za Th, za K pa ni podatka). Čista dolomitna kamnina z jamske stene ima povprečje manj kot 100 μGy/leto. Kosti in fosfatni sedimenti pa vsebujejo nekoliko višje uranove koncentracije, imajo pa malo Th ali K, tako da k $D_{ext,\gamma}(t)$ prispevajo 250 do 300 μGy/leto. Žal pa nehomogena zgradba mnogih plasti (*sl. 6.2*) pomeni, da je bila vrednost $D_{ext,\gamma}(t)$ za marsikateri zob pogosto povezana z znatno negotovostjo (*tab. 6.4*), ki je tako povzročila še večje negotovosti v izračunanih ESR-starostih. Ko $D_{ext}(t)$ zvečuje izračunano starost, se t_1 zmanjšuje. Razlika v izračunani starosti, ki upošteva 2 σ negotovosti, postane pomembna samo, če se $D_{ext}(t)$, ki jo zob dejansko prejme, razlikuje za več kot 100–150 μGy/leto od vrednosti, ki smo jo uporabili pri naših izračunih (npr. *sl. 6.4d*). Ker smo določitev $D_{ext}(t)$ oprli na toliko analiz nefrakcioniranega sedimenta, je takšna napaka malo verjetna, razen za zobe, ki se dotikajo velikih blokov v sedimentu (glej Brennan *et al.* 1997a).

Datirani zobje, ki vsi pripadajo vrsti *Ursus spelaeus*, so bili tako majhni, da nobeden ni dal več kot tri podvzorce, kar nekaj pa jih je omogočilo le enega (*tab. 6.4*). Pri veliko zelo majhnih podvzorcih je bila potrebna metoda združevanja, da bi v zadostni količini alikvota lahko izmerili prejeto dozo. Posledica tega so bili veliko daljši časi analiz, pa tudi večje s tem povezane negotovosti (napake) v prejeti dozi. Zato je napaka pri starosti za vse zobe večja (7–30 %), kot bi jo dobili pri datiranju govejih ali konjskih zob, kjer je običajna 2–8 % napaka.

Starosti pa so pokazale notranjo doslednost, ko smo jih prikazali stratigrafsko (*sl. 6.5*). V razponu od 40 ± 5 tisoč let (*ka*) do 50 ± 6 *ka* za plasti 2–7 (*tab. 6.4*) se ESR-starosti ujemajo znotraj svojih negotovosti s ^{14}C-starostmi za plast 2 in 6 pri 35,3 ± 0,7 in 43,3 ± 1,4 tisoč let (*ky*) pred sedanjostjo (p. s.). Približno enaka razlika med obojnimi starostmi ponuja sklep, da je lahko v tem starostnem razponu kalibracijski parameter za pretvorbo ^{14}C-starosti v koledarske letnice v povprečju ~ 3 *ky*. V necementiranem delu plasti 8a, ~ 0,3 m nad močno cementiranim delom iste plasti, kjer je bila najdena piščal, je pet zob pokazalo povprečno starost 59 ± 3 *ka*, medtem ko je v plasti 8c na isti globini, kot je ležala piščal, vzorec CT87 pokazal starost 54 ± 7 *ka*. V plasti 10, 1,2 m pod piščaljo, so trije zobje pokazali povprečno starost 67 ± 4 *ka*, v plasti 10-12 pa je vzorec RT79 pokazal povprečje 70 ± 13 *ka*. Te datacije dosledno kažejo, da je piščal najverjetneje stara približno 60 *ka*. V plasti 13 so trije zobje pokazali povprečno starost 80 ± 8 *ka*, medtem ko je vzorec RT43B iz plasti 16a pokazal starost 80 ± 7 *ka*. Iz plasti 17 je vzorec RT5 pokazal povprečno starost 83 ± 10 *ka*. Datacije za plast 17a2 so od povprečno 80 ± 13 *ka* na globini 6,1 m do 102 ±11 *ka* na globini 6,8 m, kar nakazuje na nepretrgano in hitro sedimentacijo v tem obdobju. V plasti 20 je vzorec QT5 pokazal povprečno starost 111 ± 15 *ka*, vzorec QT74 v plasti 23 pa 116 ± 12 *ka*. Tako se je sedimentacija v jami nadaljevala skozi večino kisikove izotopske stopnje OIS 4 in 5.

Datacije nakazujejo, da obstajajo štirje sedimentacijski ciklusi v plasteh 2 do 23, ki so bili ugotovljeni tudi sedimentološko (glej poglavje 5 v tem zborniku). Zdi se, da je bila sedimentacija nepretrgana od začetka plasti 23 pred približno 116 *ka* do okoli 102 *ka*, ko je bil odložen spodnji del plasti 17a2. Hitrost sedimentiranja je bila v povprečju 0,02 cm/leto, kar se zdi veliko, ven-



Sl. 6.5: Datacije ESR za Divje babe I, Slovenija.

Od 26 z ESR-metodo tukaj datiranih zob so starosti na začetku ekstremno dosledne kljub negotovostim, ki so nekoliko višje od normalnih (nakazane z razponom med puščicami). Štiri s ^{14}C-metodo uspešno datirane kosti namigujejo, da lahko ^{14}C-starosti v razponu med 40 in 50 *ka* zahtevajo kalibracijo +2 do +5 *ky*, da bi jih izenačili s koledarskimi starostmi, kot jih daje ESR. Datacije ESR kažejo, da se je jama polnila s sedimentom sporadično. Do velike upočasnitve sedimentacije ali vrzeli je prišlo v plasti 17a2 v globini od približno 6,15 do 6,7 m. Ta upočasnitev oz. vrzel datira iz približno 105 do 85 *ka*. Še ena upočasnitev ali vrzel je ugotovljena med plastmi 12 in 13, ta je trajala od ~ 78 do 70 *ka*. Zadnja oz. predzadnja upočasnitev pa datira med ~ 55 in 50 *ka*.

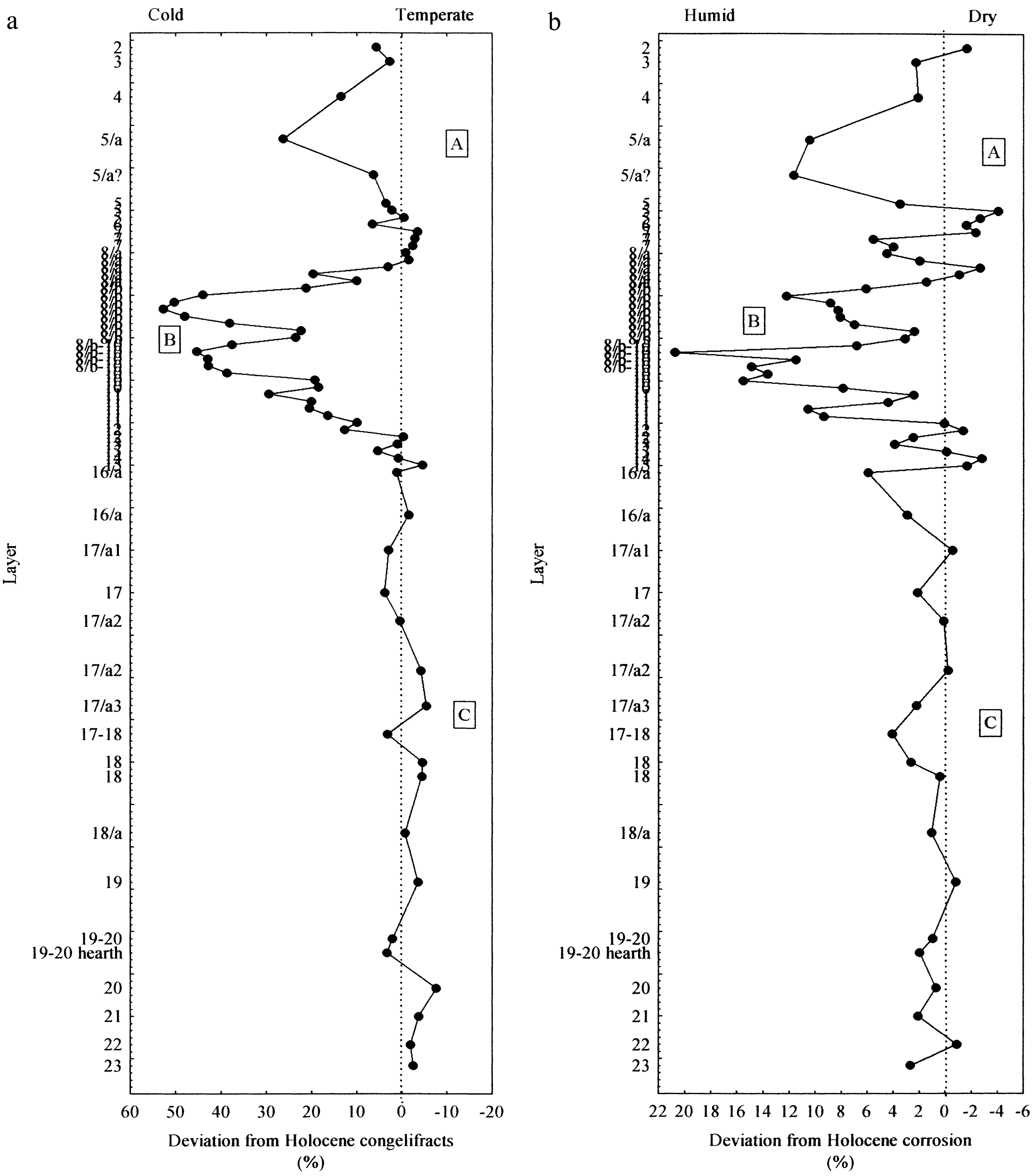
Fig. 6.5: ESR dates at Divje babe I, Slovenia.

From the 26 teeth dated here by ESR, the ages are extremely internally consistent, despite the somewhat larger than normal uncertainties (denoted by the span between the arrows). The four bones successfully dated by ^{14}C hint that ^{14}C ages in the range from 40–50 ka may require a calibration of +2 to +5 ky to bring them into line with calendric ages, like ESR. The ESR dates show the cave filled with sediment episodically. A major depositional slowdown or hiatus occurred within Layer 17a2 between about 6.15 and 6.7 m below datum from approximately 105 to 85 ka. Another slowdown or hiatus occurred between Layers 12 and 13 lasting from ~ 78 to 70 ka. Another slowdown occurs from ~ 55 to 50 ka.

dar je k temu lahko pripomogla zgradba matične kamnine, ki je vplivala na hitrost odlaganja krioklastičnega materiala (*éboulis*). Nato se zdi, da je vrzel v sedimentaciji ali drastično zmanjšanje hitrosti sedimentiranja trajalo do okoli 85 *ka*, ko se je sedimentacija spet ponovila oz. ko se je njena hitrost vrnila na tisto, ugotovljeno med OIS 5d. Od približno 85 *ka* (vrh plasti 17a2) do 80 *ka* (vrh plasti 13) je hitrost sedimentacije v povprečju 0,036 cm/leto. Ta sedimentacijski cikel se ujema z OIS 5a, Dansgaardovim in Öschgerjevim dogodkom 21 (DÖ 21). Nato je sledila še ena vrzel, ki je trajala do približno 70 *ka*, kar se ujema s prvo hladno fazo v OIS 4 v času, ko so bile višje na severu hitre, skrajne klimatske spremembe (Barron *et al.* 2003). Sedimentacija se je obnovila s približno hitrostjo 0,012 cm/leto v plasteh 10-12 do 8a, v obdobju med okoli 70 *ka* in 55 *ka*, ki sovpada z večino OIS 4 in se ujema z nekoliko toplejšo fazo v pelodnih zapisih iz nahajališča Castiglione v Italiji (van Andel 2003), še višje na severu pa se zdi, da je bilo hladno. Sedimentacija se je občutno zmanjšala ali pa je morda za kratko ponovno prenehala od 55 *ka* do 50 *ka*. To se ujema z zgodnjo OIS 3 ter dobro sovpada z zadnjimi datumi za hladno fazo med interstadiali Örel in Glinde-Mörschoofd v severni Evropi in kratko fazo na lokaciji Castiglione z nizkim deležem drevesnega peloda (van Andel 2003). Od okoli 50 *ka* do 40 *ka* se je ponovno začela hitra sedimentacija, ko so nastale plasti 7 do 2, s povprečno hitrostjo ~ 0,04 cm/leto. To obdobje se ujema s toplejšo fazo v srednji OIS 3, interstadiali Glinde-Mörschoofd in Hengelo v severni Evropi ter Dansgaardovimi in Öschgerjevimi dogodki 14–10 (Huntley, Allen 2003).

GLOBALNE KORELACIJE

Štirje na datiranju osnovani sedimentacijski ciklusi se skoraj popolnoma ujemajo z velikimi klimatostrati-



Sl. 6.6a, b: Prikaz paleoklimatskih sedimentarnih značilnosti v Divjih babah I, Slovenija. Pogostnost paleoklimatskih sedimentoloških značilnosti, vključno s talnimi zmrzlinskimi klasti (kongelifrakti), klasti z reliefno korodirano površino in agregati, ki se močno spreminja v profilu (povzeto po Turk *et al.* 2005a):

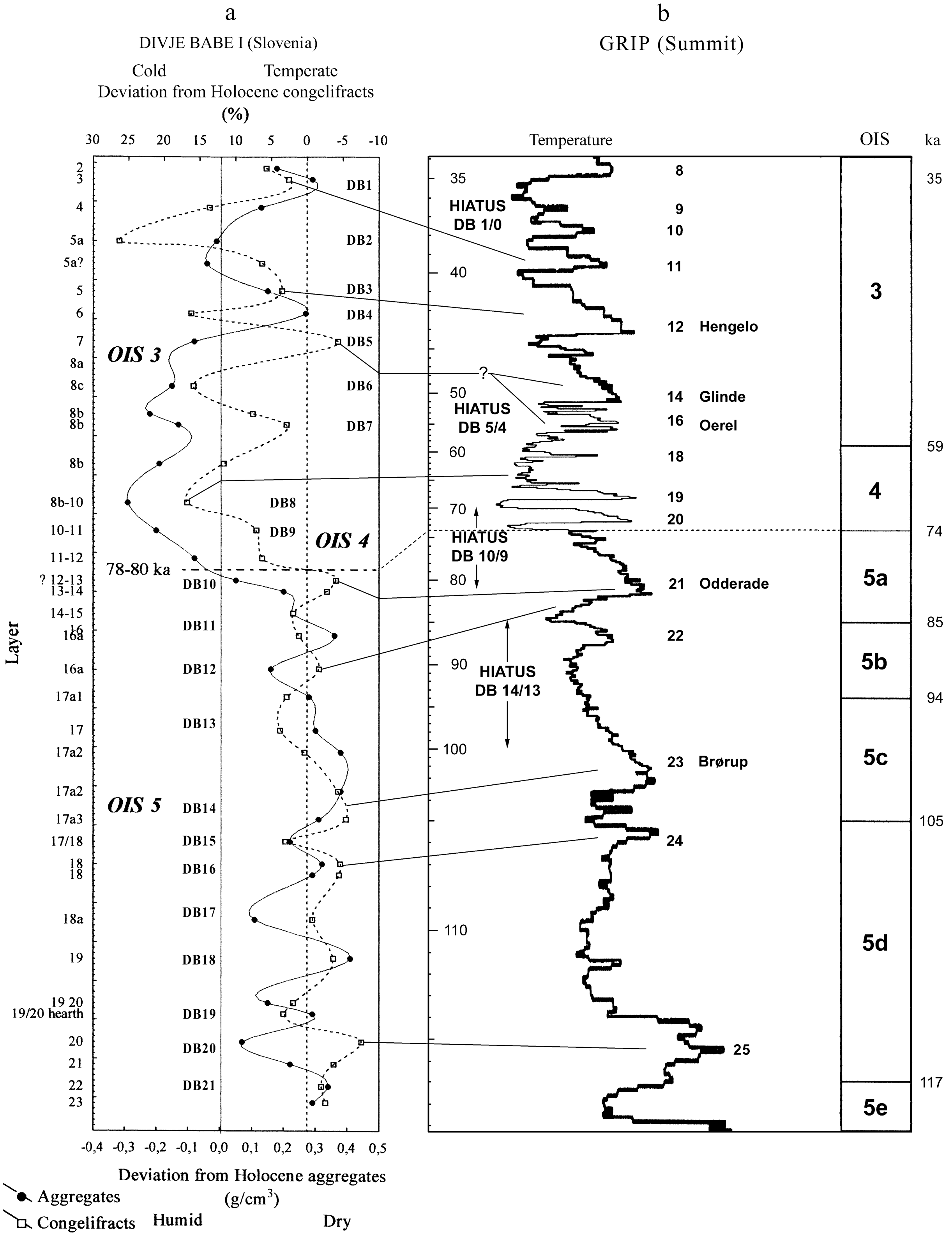
a. Talni zmrzlinski klasti, velikosti med 10 in 40 mm: visok odstotek talnih zmrzlinskih klastov da slutiti hladno podnebje, nizek odstotek pa toplejše.

b. Reliefno korodirani klasti, velikosti >40 mm: visok odstotek reliefno korodiranih klastov da slutiti visoke koncentracije talne vlage in zato bolj vlažno podnebje, nizek pa govori v prid bolj suhi klimi.

Fig. 6.6a, b: Distribution of paleoclimatic sedimentary features at Divje babe I, Slovenia. The frequency of the paleoclimatic sedimentary features, including congelifracts, etched clasts, and aggregates all vary dramatically with depth in the cave (adapted from Turk *et al.*, 2005a):

a. Congelifracts between 10 and 40 mm in size: High percentages of broken clasts suggest cold climates, while low percentages suggest warmer climates.

b. Etched clasts > 40 mm in size: High percentages of etched clasts suggest high soil moisture concentrations, and hence, more humid climates, while low percentages suggest drier climates.



grafskimi fazami in sedimentološkimi facijami, ki so bile ugotovljene s sedimentološkimi analizami. Čeprav je bilo veliko teh analiz opravljenih med izkopavanji in po njih, so samo morfogenetske raziskave dale prepričljive podatke za klimatostratigrafske interpretacije jamskih sedimentov (glej poglavje 5 v tem zborniku). Kronologija in paleotemperaturne krivulje so podlaga za naslednje domnevne korelacije, ki služijo za nadaljnje primerjave:

1. Plast 13 v Divjih babah I smo z ESR-metodo datirali v 79 ± 8 *ka* (*sl. 6.5*). V območju vrzeli med plaste-

◁◁

Sl. 6.7a, b: Paleoklimatski zapis mlajšega pleistocena v Divjih babah I, Slovenija.

Paleoklimatski zapis mlajšega pleistocena v Divjih babah I kaže velika klimatska nihanja, ki se dobro ujemajo z drugimi klimatskimi zapisi mlajšega pleistocena:

a. Če primerjamo pogostnost holocenskih agregatov in talnih zmrzlinskih klastov v jami s tisto v pleistocenskih sedimentih, lahko ustvarimo diagrame, ki prikazujejo relativne temperature in vlažnost. V diagramu pikčasta navpična črta predstavlja holocensko povprečje, sklenjena krivulja pa odstopanje pleistocenskih plasti od holocenskega povprečja.

b. Zapis mlajšepleistocenskih temperaturnih sprememb kot se kaže v ledni vrtini GRIP-vrh. (povzeto po Weismüller 1997).

Velika podobnost med Divjimi babami I in GRIP krivuljo v OIS 3 in 4 daje slutiti relativno kontinuirano sedimentacijo. Na meji med plastema 12 in 13, ki datira v ~ 80 *ka*, se je pojavila kratka sedimentacijska vrzel. Kratka vrzel ali upočasnitev sedimentacije se je morda pojavila tudi med plastema 6 in 7, nekoliko daljša pa morda tudi znotraj plasti 17a2.

Fig. 6.7a, b: The Upper Pleistocene paleoclimatic record at Divje babe I, Slovenia.

The Upper Pleistocene at Divje babe I shows major climatic fluctuations which correlate well with the climatic record in other Upper Pleistocene records:

a. By comparing the Holocene frequency of aggregate and congelifract formation in the cave against that seen in Pleistocene sediment, relative temperatures and humidity profiles can be constructed. For each curve, the dotted line represents the Holocene mean, while the solid line gives deviation in the sedimentary layers.

b. The GRIP (summit) record for Upper Pleistocene climate (adapted from Weismüller, 1997).

This strong correlation in OIS 3 and 4 suggests relatively continuous sedimentation. At the boundary between Layers 12 and 13, dated at ~ 80 ka, a short depositional hiatus occurred. A short hiatus or depositional slowdown may have also occurred between Layers 6 and 7, and possibly, a somewhat longer one within Layer 17a2.

ma 12 in 13 se narava sedimentov popolnoma spremeni, vključno s pogostnostjo agregatov, korodiranih klastov ter talnih zmrzlinskih klastov vseh velikosti (npr. *sl. 6.6a, b* in *6.7a*). Preliminarna analiza peloda je na tem mestu pokazala spremembo, ki je značilna za prehod iz pozne OIS 5a v OIS 4 (Šercelj, Culiberg 1991). Zato je vrh plasti 13 moč povezati z mejo OIS 5a/4 pri približno 74–76 *ka* (*sl. 6,7b*). Ker lahko spremembe v vegetaciji in sedimentaciji na večjih višinah nastopijo prej, bi lahko prišlo do te klimatske spremembe v Divjih babah I že pri 78–80 *ka*.

2. Plast 6 v Divjih babah I so s ^{14}C-metodo datirali v 43,3 ± 1,4 *ky* p. s., plast 7 pa smo z ESR-metodo datirali v 49,6 ± 5,5 *ka* (*sl. 6.5*). Glede na kalibracijski popravek ^{14}C sta plasti 6 in 7 verjetno stari okoli 46–50 *ka*. Plast 6 je domnevno nastala v hladni, suhi klimi (klimatska faza DB 4 na *sl. 6.7a*). Zato jo primerjamo s hladnim obdobjem med interstadialom Hengelo in Glinde pred približno 44–46 *ka* (*sl. 6.7b*). Kronološko tako ustreza tudi najnižjim zimskim temperaturam, ki jih lahko razberemo v pelodnih zapisih v Grand Pile, Les Echets in Lago Grande di Monticchio (Guiot 1990, sl. 12; Allen *et al.* 1999, sl. 3f). Nasprotno pa se v plasti 7 (DB 5) odslikava topla, suha klima.

3. ESR-datumi kažejo, da so bile plasti 8c–7 v Divjih babah I odložene med 52–55 ± 5,5 *ka* in 49,6 ± 5,5 *ka* (*sl. 6.5*). To se je zgodilo v mrzli, vlažni fazi (DB 6 na *sl. 6.7a*), ki je prešla v toplo fazo, vendar je ostala vlažna (DB 5). Toplejša faza DB 5 v plasti 7 je verjetno istovetna z najdaljšim toplim obdobjem v OIS 3, ki je primerljivo s cono 11 v pelodnih zapisih Lago di Monticchio (Allen *et al.* 2000) in dogodki DÖ 14–16 in interstadiali Glinde-Mörschoofd-Örel (*sl. 6.7b*). Zaradi prevladujoče levalvske tehnike (*levallois*), ugotovljene v plasteh 7 in 8a, kaže, da pripadajo artefakti musterjenu. Ker v Evropi v tem obdobju poznamo samo številne ostanke neandertalskih okostij (pribl. 400 primerkov), je najverjetneje, da so te artefakte in z njimi povezano piščal izdelali neandertalci.

Profil iz Divjih Bab I je prvi sedimentološki profil iz slovenskega jamskega najdišča, ki dovoljuje takšne primerjave na regionalni in kontinentalni ravni. Glede na zgoraj navedene povezave lahko tudi druge plasti v Divjih babah I primerjamo z določenimi paleoklimatskimi dogodki:

4. Plast 2 v Divjih babah I, ki vsebuje orinjasjenske najdbe, je bila s ^{14}C-metodo (Nelson 1997) datirana v 35,3 ± 0,7 *ky* p. s., z ESR-metodo pa v 39,7 ± 4,7 *ka*. Plast 3 smo z ESR-metodo datirali v 37,3 ± 3,5 *ka*. Glede na to, da verjetno obstaja odmik več kot 2 *ky* med ^{14}C-starostmi in koledarskimi leti v tem razponu (van Andel *et al.* 2003), se predvideva, da sta bili plasti 2 in 3 odloženi v topli, suhi fazi (DB 1 na *sl. 6.7a*) pred 38–39 *ka* in sta najverjetneje istočasni z dogodki DÖ 8–11 (*sl. 6.7b*). Sodeč po pelodu je dogodek DÖ 8 verjetno povezan z interstadialom Les Cottés (Weissmüller 1997; Bastin *et al.* 1976) na krivulji GISP2-δ^{18}.

5. Plasti 4–5a v Divjih babah I (DB 2 na *sl. 6.7a*), ki sta interpretirani kot predstavnici mrzlega, zmerno vlažnega obdobja, kronostratigrafsko verjetno ustrezata mrzli, vlažni fazi med interstadialoma Hengelo in Les Cottés (*sl. 6.7b*, Dansgaard *et al.* 1993; Weissmüller 1997).

6. Ker se zdi, da sta bili plasti 5a–5 v Divjih babah I odloženi v toplejših in nekoliko bolj suhih razmerah (DB 3 na *sl. 6.7a*), najverjetneje kronostratigrafsko ustrezata dogodku DÖ 12 pred približno 42–44 *ka*, ki ga enačimo z interstadialom Hengelo (*sl. 6.7b*, Dansgaard *et al.* 1993; Weissmüller 1997).

7. V srednji in zahodni Evropi je bil prehod iz srednjega v mlajši paleolitik med interstadialoma Hengelo

in Les Cottés (t.j. ~ 44–34 *ka*, *sl. 6.7b*). Plasti 5–2 v Divjih babah I (DB 3–DB 1 na *sl. 6.7a*) temu obdobju ustrezajo arheološko, kronološko in paleoklimatsko. V Divjih babah I se v arheološkem smislu v tem obdobju ni zgodilo nič posebnega, razen da so s plastjo 4 paleolitski obiskovalci jame prekinili levalvsko tradicijo, ki je, med drugim, zaznamovala starejše arheološke horizonte (Blaser 1999, neobjavljeno). Če predvidevamo enotno hitrost sedimentacije, je bil prehod iz srednjega v mlajši paleolitik v Divjih babah I pred približno 40 *ka*.

8. Zgornji del plasti 8b se je odložil v topli, vlažni klimatski fazi (DB 7 na *sl. 6.7a*), ki kronostratigrafsko lahko ustreza dogodku DÖ 18 pred okoli 60 *ka* (*sl. 6.7b*).

9. Mrzli, zelo vlažni klimatski fazi (DB 8 na *sl. 6.7a*) na meji med plastjo 8b in 10 verjetno ustreza mrzla faza od 62 do 65 *ka* v OIS 4, med dogodkoma DÖ 18 in 19 (*sl. 6.7b*).

10. Plast 10 smo z ESR-metodo datirali v 67,1 ± 4,2 *ka*, plast 10-12 pa v 69,8 ± 13,0 *ka* (*sl. 6.4*). Zato bi lahko hladna, vlažna klimatska faza v zgornjem delu plasti 11 (DB 9 na *sl. 6.7a*) ustrezala dogodku DÖ 19 pred približno 68 *ka* (*sl. 6.7b*), medtem ko bi nekoliko toplejša, a še vedno relativno vlažna faza v plasti 12 verjetno ustrezala dogodku DÖ 20.

11. Plast 13 v Divjih babah I je nastala pred sedimentacijsko vrzeljo, ki jo povezujemo z mejo med OIS 4 in OIS 5a in zgodnjim glacialnim vrhuncem (= zgodnja virmska/ex-Würm I poledenitev, = zgodnja vajkselska/Weichsel poledenitev, = zgodnja viskonsinka/Wisconsin poledenitev) pred pribl. 78 *ka*. Med napredovanjem poledenitve bi na vsaki alpski lokaciji pričakovali, da se sedimentacija ustavi ali znatno upočasni (Campy, Chaline 1993; Bintz *et al.* 1997). Plasti 13-14, ki je bila odložena v topli, relativno suhi klimatski fazi (DB 10 na *sl. 6.7a*), ustreza dogodek DÖ 21 (=interstadial Odderade) v OIS 5a (*sl. 6.7b*).

12. Plasti 13–10 vsebujejo najbogatejši paleolitski horizont E, za katerega so značilni napredni elementi v kameni zapuščini, ki bi načeloma lahko označevali mlajši paleolitik (glej Brodar 1999). Vendar datacije kažejo, da so plasti stare od približno 78 do 67 *ka*, kar, skupaj z drugimi dognanji o najdišču, ne podpira Brodarjeve teze. V tem času, se je podnebje ohlajalo in postajalo bolj vlažno (DB 10–9 na *sl. 6.7a*).

13. Drobtinčasta siga v plasti 17/18 (DB 15 na *sl. 6.7a*) je morala nastati v topli, zmerno vlažni klimatski fazi. Za spodnji del plasti 17a2 (topla, suha faza DB 14), tik nad plastjo 17/18, je ESR-metoda pokazala povprečno starost 112 ± 13,0 *ka*, globlje pa je za plast 20 (topla, zmerno vlažna faza DB 20) pokazala starost 110,2 ±15,3 *ka*. Plast 23 (topla, suha faza DB 21) pa je po tej metodi stara 116,1 ± 12,1 *ka*. Zato plasti 17/18 in plastem od spodnje 17a2 do 23 verjetno najbolje ustrezata ločena klimatska optimuma v OIS 5c in OIS 5d pred približno 100–105 *ka* in 113–117 *ka* oz. dogodki DÖ 23–25. Procesi cementacije, ki se kažejo v prisotnosti breče v plasteh 15/16a (DB 11), 18a (DB 17), 20/21 (DB 19) in 23 (DB 21), so očitno potekali v rahlo hladnejših, a bolj vlažnih obdobjih v OIS 5, vidnih na krivulji GRIP (*sl. 6.7b*). Vendar pa ni nujno, da so ti procesi neposredno pogojeni s temi klimatskimi spremembami (glej Turk 2006).

SKLEPI

Z uporabo ESR-metode smo neodvisno datirali 44 podvzorcev iz 28 zob jamskega medveda (*Ursus spelaeus*), pobranih v plasteh 2 do 23 v Divjih babah I, ter sestavili podrobno in natančno kronostratigrafsko zaporedje (*sl. 6.5*), ki smo ga povezali z izsledki sedimentoloških analiz (npr. *sl. 6.6b*; Turk *et al.* 2001). Paleoklimatske interpretacije, ki sledijo iz tega, smo lahko nato primerjali z drugimi regionalnimi in globalnimi klimatskimi dogodki.

Kronologija Divjih bab I, kot jo trenutno razumemo, predvideva, da so ^{14}C-datacije zanesljive samo za plasti 2 do 6, vendar lahko zahtevajo +2 do +5 *ky* popravka zaradi kalibracije. ESR-datacije so, v okviru svojih negotovosti, zanesljive za vse plasti, tj. 2 do 23. Kronometrične datacije kažejo, da so plasti 2 do 23 nastale v dveh do štirih glavnih sedimentacijskih fazah in v precej številnejših kratkih klimatskih nihanjih.

Sedimentacija v plasti 23 do spodnjega dela plasti 17a2 se je začela pred pribl. 116 *ka* in je trajala do pribl. 102 *ka* v topli klimi, ki se je spreminjala od suhe do zmerno vlažne v kisikovi izotopski stopnji OIS 5d pri hitrosti sedimentacije 0,02 cm/leto. Nato se je sedimentacija drastično upočasnila ali celo ustavila do približno 85 *ka* v OIS 5c in 5b. V obdobju med pribl. 85 *ka* in 80 *ka* v OIS 5a, Dansgaardov in Öschgerjev dogodek 21, se je sedimentacija zopet obnovila in nastali so sedimenti zgornjega dela plasti 17a2 do plasti 13 v topli, a suhi do zmerno suhi klimi pri hitrosti sedimentacije v povprečju 0,036 cm/leto Sedimentacija se je ponovno upočasnila ali ustavila do približno 70 *ka* v prvi mrzli fazi v OIS 4.

Za tem se narava sedimentov močno spremeni, tako da izraža procese, značilne prej za glacialne kot interglacialne razmere. Od okoli 70 do 55 *ka* v pozni OIS 4 do zgodnje OIS 3 se je ponovilo obdobje hitre sedimentacije s hitrostjo ~ 0,012 cm/leto in tako so nastale plasti 12 do 8c v bolj spremenljivih temperaturnih, vendar vlažnih razmerah. V tem obdobju lahko prepoznamo sedimentacijske dogodke, ki kažejo spremenljive klimatske razmere, in za katere se zdi, da so primerljivi s toplimi in hladnimi, a vlažnimi fazami, ki jih prepoznavamo v drugih evropskih in globalnih klimatskih zapisih, vključno z dogodki DÖ 20 do 18. Zatem se hitrost sedimentacije ponovno upočasni od 55 do 50 *ka*, a se zdi, da se ne ustavi popolnoma, saj plasti 7 do 8a kažejo vpliv tople klime, ki, kot kaže, da ustreza dogajanju v drugih globalnih klimatskih zapisih, vključno z najdaljšim toplim obdobjem v OIS 3, dogodki DÖ 14–16, in interstadiali Mörschoofd-Glinde-Örel. Od približno 45 do 38 *ka* se je hitrost sedimentacije povečala in nastale so plasti 6 do 2 pri srednji hitrosti blizu 0,04 cm/leto. Za klimatska nihanja zaznana v teh plasteh se zdi, da dobro ustrezajo klimatskim spremembam od dogodka DÖ 12 do 8 v OIS 3. Vpliv zelo nizkih temperatur v OIS 2 je v jamskih sedimentih viden v obliki globinske krioturbacije v plasteh 5a–2, a je znotraj jame ostalo le malo v tem času odloženega sedimenta razen majhnih leč s krioklastičnim materialom.

Od pribl. 110 do 40 *ka* so musterjenci občasno obiskovali jamo in za seboj puščali številna ognjišča, kamene in koščene predmete. Sodeč po številu ognjišč in drobnih najdb je bila zasedenost ali uporaba jame pogostejša v OIS 3 in 4 kot pa v OIS 5. Izsledki računalniške tomografije in eksperimentalnih arheoloških raziskav na večkrat preluknjanem femurju jamskega medveda ter musterjenskem orodju v najdišču dopuščajo sklep, da so ljudje naredili luknje v femur preden so ga zavrgli in ga prepustili zveri, ki je zglodala konce pred približno 60 *ka* (Turk *et al.* 2005b). Prehod iz srednjega paleolitika v mlajši paleolitk nastopi, arheološko gledano, v plasti 4 v sredini OIS 3 pred približno 40 *ka*, če predvidevamo enakomerno hitrost sedimentacije za plasti 6–2. Orinjasjenci so nato za kratek čas uporabljali jamo od 40 do 38 *ka*, za njimi pa ni bilo več nobenih paleolitskodobnih sedimentov in najdb.

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6. ESR DATING AT DIVJE BABE I, SLOVENIA

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Abstract

At Divje babe I, Slovenia's oldest archaeological site, the thick archaeological sequence housed Mousterian artefacts, including hearths, a perforated ursid femur interpreted as a flute, Mousterian and Aurignacian bone tools, and ~ 200,000 cave bear (*Ursus spelaeus*) skeletal remains (NISP), besides other faunal remains. Eleven archaeologically significant layers were dated by 44 independent standard ESR (electron spin resonance) analyses from 28 teeth. To calculate volumetrically averaged external dose rates, 146 sedimentary component samples were analyzed by NAA.

Numerous sedimentary characteristics indicate that Divje babe I experienced strong climatic fluctuations during the Late Pleistocene, during four distinct interstadials and five stadials in OIS 3-4, and prolonged warm interglacial conditions in OIS 5, during which hominids visited the cave intermittently discarding Mousterian artefacts. From Layers 2 to 23, the ESR dates suggest that at least three, and probably four, periods of rapid sedimentation alternate with depositional hiati. Continuous sedimentation at 0.02 cm/y from approximately 116 ka to 102 ka during Oxygen Isotope Stage (OIS) 5d deposited Layer 23 through the lower Layer 17a2 under warm, dry to moderately humid conditions. During OIS 5b-5c, sedimentation slowed dramatically or ceased until about 85 ka. In early OIS 5a, Dansgaard-Öschger Event 21 (DÖ 21), from approximately 85 ka until 80 ka, sedimentation averages 0.036 cm/y, depositing upper Layer 17a2 through Layer 13 under warm, but dry to moderately dry conditions. The next hiatus spanned the first cold phase in OIS 4 from 80 ka until ~ 70 ka. Deposition at approximately 0.012 cm/y resumed with Layers 10-12 through 8a, from about 70 to 55 ka, during the latter part of OIS 4, under cool to cold, humid conditions. The flute was produced and abandoned at ~ 60 ka. Sedimentation slowed again or stopped from about 55 until 50 ka, during early OIS 3. From about 50 to 38-40 ka during Mörshoofd-Glinde and Hengelo Interstadials, DÖ 14-10 in OIS 3, rapid sedimentation resumed at about 0.04 cm/y, depositing Layers 7 to 2 under conditions that varied widely from very cold to moderately warm, but from dry to moderately humid. The Pleistocene stratigraphic sequence ends with Layer 2, which contains an Early Aurignacian split-based point in sediment suggesting interstadial conditions. During OIS 2, deep cryoturbation disturbs Layers 2-5a. In the Early Holocene, after a 28-30 ky hiatus, modest sedimentation resumed.

At Divje babe I, Slovenia (*Fig. 6.1*), a flute made from cave bear (*Ursus spelaeus*) bone was found associated with Mousterian artefacts. Initially dating analyses by Nelson (1997) and Lau *et al.* (1997) showed the flute to be > 43 ka old. Subsequent research concentrated on producing a more detailed chronology and reliable paleoclimatic determinations for Layer 8, in particular, and for the stratigraphic sequence as a whole, as well as checking to make sure reworking had not affected the dated teeth (*cf.* Blackwell 1994). ESR (electron spin resonance) in tooth enamel was used to determine 44 independent dates for 28 *Ursus spelaeus* teeth for Layers 2 through 20 (*Tab. 6.1; Fig. 6.2a-c*) to enable Divje babe's layers to be correlated with other sites in Europe, and to establish the detailed chronology for paleoenvironmental changes during the Upper Pleistocene in Slovenia (e.g., Turk *et al.* 2001; Turk *et al.* 2002b; Turk 2006).

Several ^{14}C dates were attempted on bone and charcoal from the site (Nelson 1997). Most exceeded the limits for ^{14}C dating, while several others were so close to that limit, that a small amount of modern carbon contamination could skew them significantly. Layer 2, the Aurignacian layer, was dated at 35.3 ± 0.7 ky BP, while Layer 6 contained a bone dated at 43.3 ± 1.4 ky BP. Given the uncertainty of the discrepancy between uncalibrated ^{14}C ages and true calendric dates in the 35-50 ka range (e.g., Conard, Bolus 2003; Conard 2006), the ^{14}C dates, at best, merely confirm the antiquity of the site and the ESR dates below. Lau *et al.* (1997) reported preliminary ESR ages for five teeth for Layers 13, 17a2, and 20, but the dates used relatively few sedimentary analyses. The current study used 146 sedimentary component analyses (*Tab. 6.2*) to improve the precision and accuracy of the external dose rate determinations and ESR dating.

ESR THEORY

ESR can provided chronometric dates for hydroxyapatite (HAP) in tooth enamel ranging in age from as young as 5 ka to as old as 5 Ma, currently with a 2-8%

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[1] The oldest is meant in terms of the calendar age of ESR dating. Since other palaeolithic sites in Slovenia are not adequately dated their real ages are not known.

precision (Blackwell 2006). For mammal teeth, ESR bridges the gap between the ^{14}C maximum dating limit (~ 40–50 ka) and U/Pb methods' minimum limit (1–2 Ma). Standard ESR dating for tooth enamel has now been tested extensively against other dating methods for sites in the age range 30–300 ka (Blackwell 2006).

Radiation-sensitive ESR signals grow in direct proportion to the total accumulated radiation dose (Blackwell 2006), as unpaired electrons accumulate in traps in the crystal lattice. In enamel hydroxyapatite (HAP), the ESR signal at $g = 2.0018$ in the X band has a mean signal lifetime of ~ 10^{19} y with no anomalous fading reported (Skinner *et al.* 2000). HAP signals only zeroes if heated to ≥ 300°C. Grinding and light exposure do not zero the signal. In mammals, its radiation-sensitivity does not depend on species, but does depend on the crystallinity, which is affected by the animal's age and health (Skinner *et al.* 2001 2005). Diagenesis and remineralization reduce ESR peak intensity and the maximum ESR dating limit, but not accumulated dose ($\mathcal{A}_\Sigma$) measurement precision (Skinner *et al.* 2000). If the ESR signal height (intensity) for a radiation-sensitive signal can be converted into an accumulated dose and the radiation dose rate experienced by the sample during its deposition is known or can be modelled, an ESR age is calculated from Equation 1:

$$\mathcal{A}_\Sigma = \mathcal{A}_{\text{int}} + \mathcal{A}_{\text{ext}} = \int_{t_0}^{t_1} D_\Sigma(t)\,\mathrm{d}t = \int_{t_0}^{t_1} (D_{\text{int}}(t) + (D_{\text{ext}}(t))\,\mathrm{d}t$$

where $\mathcal{A}_\Sigma$ = the total accumulated dose in the sample,
$\mathcal{A}_{\text{int}}$ = the internally derived accumulated dose component,
$\mathcal{A}_{\text{ext}}$ = the externally derived accumulated dose component,
$D_\Sigma(t)$ = the total environmental dose rate,
$D_{\text{int}}(t)$ = the dose rate from internal sources: U, its daughters, and any other radioisotopes,
$D_{\text{ext}}(t)$ = the dose rate from external sources: sedimentary U, Th, and K, and the cosmic dose,
t_1 = the sample's age,
t_0 = today.

The accumulated dose $\mathcal{A}_\Sigma$ is calculated using the additive dose method, in which samples are irradiated with increasing radiation doses. $\mathcal{A}$ can be measured with 0.8–5% precision (*Fig. 6.3*) depending on the spectrometer's calibration (Nagy 2000), the radiation source calibration (Wieser *et al.* 2006), the sample's age and diagenetic state (e.g., Blackwell *et al.* 2005; Skinner *et al.* 2001, 2005). The total dose rate is determined by the radioactive element concentrations in the sample and its immediate surroundings. Many factors, including the various particle attenuation, radioactive element concentrations, and U uptake history, affect the internal and external dose rates. If samples experience low radiation dose rates, both the minimum and maximum datable age will be high (Blackwell 2006).

In teeth, U primarily produces the internal dose rate, $D_{\text{int}}(t)$. To calculate $D_{\text{int}}(t)$, the U concentrations in the teeth are measured geochemically, usually using neutron activation analysis (NAA). Then, $D_{\text{int}}(t)$ is derived from theoretical calculations. Unlike teeth, which contain substantial U, those with very low U concentrations do not require U uptake measurement or modelling to assess a single unique ESR age. Low U concentrations in the teeth also reduce the need to consider radiation attenuation by water within the sample, α and β dose attenuation due to mineral density, radon (Rn) loss, U leaching or secondary U uptake for the $D_{\text{int}}(t)$ calculations (e.g., Brennan *et al.* 2000).

The external dose rate $D_{\text{ext}}(t)$ strongly affects the calculated ESR ages, especially for samples that have low internal dose rates $D_{\text{ext}}(t)$, such as those as at Divje babe I. To derive the external dose rates, $D_{\text{ext}}(t)$, bulk geochemical analysis by NAA, using powdered sediment collected in conjunction with the sample was analyzed to measure the U, Th, and K concentrations. The radioisotopic concentrations were used to mathematically calculate the current dose rates, $\mathrm{D}_{\text{ext},\gamma}(t_0)$ and $\mathrm{D}_{\text{ext},\beta}(t_0)$ whose calculation includes corrections for β and γ dose attenuation due to mineral density, water concentration, and backscattering. Since the site has thin and inhomogeneous ("lumpy") layers, the inhomogeneity in the dose field requires volumetric analysis (Brennan *et al.* 1997a; Guibert *et al.* 1998): The contribution from each component is averaged depending on its volumetric abundance and radiation output, in order to calculate the actual contribution to $D_{\text{ext}}(t)$ from different components or layers within the β and γ "spheres of influence" (e.g., *Fig. 6.4; Tab. 6.2*). In caves where the bones and teeth contain little or no U, as here at Divje babe I, the $D_{\text{ext}}(t)$ calculations do not need to consider possible U uptake, U daughter isotope ingrowth, and potential Rn loss (Blackwell & Blickstein 2000). In caves such as Divje babe I, $D_{\text{cos}}(t)$, the cosmic dose rate, can be assumed to be 0 mGy/y, because the cave is roofed by > 10 m of dolomite. Due to their small size, the isochron method could not be performed on any of the teeth dated from Divje babe I.

In caves, karst processes and animal burrowing can easily rework teeth from its original depositional location to its final location, usually in a layer with different radioactivity. Thus, its $D_{\text{ext}}(t)$ will differ. To ensure that reworked teeth do not occur, at least 2–3 independent ESR analyses for 4–5 teeth are needed (Blackwell 1994). This study tested for reworked teeth by comparing dates for 3–4 teeth per layer in several layers.

ANALYTICAL METHODS

Using neutron activation analysis (NAA), > 150 sediment samples (*Tab. 6.2*) were analyzed for sediment dosimetry (Blackwell 1989). To derive $D_{\text{ext}}(t)$, bulk geochemical analysis of a powdered sediment sample collected in conjunction with the tooth was used to measure the U, Th, and K concentrations. More sediment samples were collected from new excavations completed in summer, 1999, to assess $D_{\mathrm{ext}}(t)$ in any sedimentary component or layer which may have contributed to the sample's $D_{\mathrm{ext}}(t)$ that had not been collected initially with the sampled teeth (Blackwell, Blickstein 2000). At the same time, the volume of *éboulis* and aggregates were measured. Larger sediment samples from all layers were then examined to assess paleohumidity and temperature (see Chapter 5 in this volume).

Using standard ESR, 52 subsamples from 28 individual *Ursus spelaeus* teeth collected from Layers 2 through 23 at Divje babe I were analyzed (*Tab. 6.1*). Enamel subsamples were prepared following the techniques outlined by Blackwell (1989, 2006) and Blackwell *et al.* (1992, 2000) with minor modifications. To retain a visual record of the teeth after their destruction, each was sketched and photographed from 4-6 different perspectives. Any attached sediment was removed and saved for NAA. Enamel, dentine, any dental cementum, and root thicknesses were measured using a hand-held digital caliper, before using a hand-held, diamond-tipped Dremel drill to remove 1-4 enamel subsamples showing minimal diagenetic alteration. For each subsample, the enamel was separated from the dentine, which was saved for NAA. After primary cleaning to remove any remaining dentine and impurities, and again following secondary cleaning to remove the outer 20 μm affected by α irradiation from each side of the enamel, the thickness of each enamel piece was measured using a Mitutoyo ID-C112E micrometer for 20-50 points on each subsample. After hand powdering to ~ 38-76 μm (200-400 mesh) with an agate mortar and pestle, approximately 20 mg of enamel was weighed into each of 10-15 aliquots.

After the aliquots were irradiated with ^{60}Co γ radiation with added doses ranging from 0.0 to 2.6 kGy at dose rates of 14-126 Gy/s at the McMaster Nuclear Reactor, each was annealed at 90°C for 3.0 days to remove any unstable interference signals (Skinner *et al.* 2000). Each aliquot was measured for 8 minutes at 25°C with JEOL REIX ESR spectrometer at 2.0 mW power over a 5.0 mT field centered on 336 mT with time constants of 0.1-0.3 sec. The microwave frequency was set to 9.449 GHz under 100 kHz enamel field modulation with a modulation width of 0.5-1 mT. Measurement gain varied to maximize the signal intensity. ESR spectra were collected and peak heights measured electronically using EPRware.

For several teeth with extremely small enamel masses, the ramping technique was used (Blackwell 2006). With only 3-8 aliquots, 1-4 aliquots were used to calibrate the ESR spectrometer with each set of remeasurements, and 1-5 were successively reirradiated to ever higher added doses and then remeasured with the ESR after each dose (Blackwell 2006). This was repeated until at least 12-15 independent added doses were measured, with the maximum added dose at least 10 times the accumulated dose to ensure the best precision for the growth curves (Lee *et al.* 1997; Grün 1996).

Each enamel, dentine, cementum, and sediment subsample was powdered and analyzed for U using NAA (e.g., *Tab. 6.2* and *6.3*). About 0.5-1.0 g of each were counted by delayed neutron counting for 60 s after a 60 s irradiation and 10 s delay. All sediment subsamples, and at least one enamel and dentine subsample per tooth were analyzed for Th, K, and 12 other elements by γ counting for 20 minutes. K was analyzed after a 60 s irradiation and a 24 hour delay. Th was irradiated for 1.0 hour, and counted following a 7-10 day delay. Each NAA data set was calibrated to a NIST standard, usually 1633A or 1633B.

ANALYTICAL CALCULATIONS FOR THE ESR DATES

Although the HAP peak is complex, it grows uniformly and can be accurately measured by a simple peak height measurement without deconvolution, because the multicomponent peak derives from the same lattice site (Skinner *et al.* 2000). Derivative ESR spectra actually provide better statistical resolution than integrated spectra (Lyons & Tan 2000). Therefore, peak heights were measured directly from the derivative spectra using EPRware without deconvolution. The accumulated doses, $\mathscr{A}_{\Sigma}$, and their associated errors were calculated using VFit (*Fig. 6.4*), assuming a saturating exponential regression with $1/I^2$ weighting.

The ages, all dose rates, and their errors were calculated using Rosy v. 1.4, which corrects for particle attenuation due to backscattering, water concentration, mineral density, sample thickness, and tissue type (Brennan *et al.* 1997b). The internal dose rates were calculated by assuming no Rn loss, no U leaching, and an α efficiency for the enamel of 0.15 ± 0.02 (Grün, 1989), an initial U activity ratio in the dentine and enamel, $(^{234}\mathrm{U}/^{238}\mathrm{U})_0 = 1.2 \pm 0.2$, and assumed a dentinal water concentration of 5 ± 2 wt % (Blackwell, 2006).

At Divje babe I, the inhomogeneous sediment contains bones, teeth, weathered dolomitic *éboulis*, weathered calcitic tufa, lithic artefacts, detrital sediment from carbonate dissolution, detrital dolomite particles ranging in size from clay to sand, and secondary phosphate deposits. Each component had different radioactive element concentrations, thereby producing different radiation doses. For each layer within 30 cm of the dated teeth, several bulk sediment samples and individual sedimentary components (i.e., the "lumps") were analyzed (*Tab. 6.2*). $D_{\mathrm{ext}}(t)$ were calculated from the U, Th, and K concentrations determined by NAA (e.g., Adamiec & Aitken, 1998), assuming no cosmic dose rate contribution. Current water concentrations in the site averaged ~ 10–15 wt % due to the excellent drainage in the site, but calculations assumed 25 ± 5 wt % water, because authigenic phosphatic cements suggest sporadically waterlogged conditions in the past. Relative component composition and void percentages were estimated from detailed stratigraphic profiles and photographs for each sampling location. These were confirmed by using the same process for new outcrops followed by actual volumetric measurements of the different components. The relative contributions from the different sources were volumetrically averaged over the "sphere of influence" for the γ sources using a 30 cm radius, and for the β sources with a 3 mm radius (e.g., Blackwell *et al.* 2000; Blackwell, Blickstein 2000).

The major uncertainty in the age calculation stems from uncertainties in $D_{\mathrm{ext}}(t)$ and $\mathscr{A}_{\Sigma}$. When ESR is compared with other methods, however, ESR dating usually gives reliable results (Blackwell, 2006). The irradiation source at McMaster was calibrated in the 1992 Interlaboratory Calibration (Barabas *et al.* 1993), while the ESR lab at Williams participated in the 1992 and 2003–2004 Interlaboratory Calibrations (Wieser *et al.* 2006).

RESULTS

Using ESR, 44 subsamples from 26 teeth from Divje babe I yielded dates (*Tab. 6.4*). For each, several enamel and dentine subsamples were analyzed to assess their U concentrations (*Tab. 6.3*). Where sufficient dental cementum could found to analyze, it was also tested. Because the teeth at Divje babe I usually occurred in pockets with several teeth near each other, and sporadically in intact jaws, several samples of root dentine were also collected to assess the external β dose component, $D_{\mathrm{ext},\beta}(t)$ (*Tab. 6.2*). For several teeth, at least one enamel and one dentine were also analyzed for Th and K. With very few exceptions, the enamels contained no measurable U. While most dentine in the crowns contained < 0.5 ppm U, the root dentine and cementum usually contained slightly more U, but none contained more than 2.5 ppm. No dentine or enamel sample showed any measurable Th nor did any show K > 0.02 wt% (*Tab. 6.2*). These data mean that the selection of U uptake model does not produce any significant change in the calculated ages. Moreover, scenarios about how to deal with Rn loss or secondary U uptake become unnecessary, as these are also unimportant sources of error. Therefore, henceforth, the discussion will focus on the LU ages only, since these provide a median age.

Thanks to the low U concentrations and, hence, the low internal dose rates, $D_{\mathrm{int}}(t)$, the ages do depend strongly on $D_{\mathrm{ext},\gamma}(t)$. Using neutron activation analysis (NAA), 146 sediment samples (*Tab. 6.2*) and several enamels and dentines were analyzed for sediment dosimetry (Blackwell 1989). For most of the layers, the mean $D_{\mathrm{ext},\beta}(t)$ averaged < 100 μGy/y, while the mean $D_{\mathrm{ext},\gamma}(t)$ ranged from 130 to 410 μGy/y. These low values derived from the high concentrations of dolomite particles of all sizes in the sediment (Turk *et al.* 1989b, 2001, 2002b), which contained very little U, Th, and K on average. Pure dolomite wall rock averaged < 100 μGy/y. Bones and phosphate deposits, however, contained somewhat higher U concentrations, but still had little Th or K, producing $D_{\mathrm{ext},\gamma}(t)$ from 250 to 300 μGy/y. Unfortunately, the inhomogeneous nature of many layers (*Fig. 6.2a–c*) means that the $D_{\mathrm{ext},\gamma}(t)$ value for any individual tooth often had a large associated uncertainty (*Tab. 6.4*), which in turn, caused larger uncertainties in the calculated ESR ages. As $D_{\mathrm{ext}}(t)$, increases the calculated age, t_1, decreases. The difference in the calculated age considering the 2 σ uncertainties only becomes significant, if $D_{\mathrm{ext}}(t)$ actually experienced by the tooth differed by more than 100–150 μGy/y from $D_{\mathrm{ext}}(t)$ used here (e.g., *Fig. 6.4d*). Since $D_{\mathrm{ext}}(t)$ here were based on so many bulk sediment analyses, such an error is unlikely, except for the teeth touching large *éboulis* blocks (see Brennan *et al.* 1997a).

Given the small teeth dated here, all *Ursus spelaeus* teeth, none yielded more than three subsamples, and several teeth, only one (*Tab. 6.4*). For several very small subsamples, ramping was necessary to obtain sufficient aliquots to measure an accumulated dose. This resulted in much longer analytical times, as well as higher associated uncertainties in the accumulated doses. Consequently, all the teeth have higher uncertainties in their ages, ranging from 7% to 30%, than would have occurred had bovid or equid teeth been used for dating, normally 2–8%.

Nevertheless, the ages showed internal consistency when plotted stratigraphically (*Fig. 6.5*). Ranging from 40 ± 5 ka to 50 ± 6 ka for Layers 2–7 (*Tab. 6.4*), the ESR ages agree within their uncertainties with the ^{14}C ages for Layers 2 and 6 at 35.3 ± 0.7 and 43.3 ± 1.4 ky BP. The consistent offset suggests that at this age range the calibration factor to convert ^{14}C ages to calendric ages in this time range may average ~ 3 ky. In the uncemented part of Layer 8a, ~ 30 cm above the well cemented portion which yielded the flute, five teeth averaged 59 ± 3 ka, while in Layer 8c at the same depth as the flute, CT87 yielded an age of 54 ± 7 ka. In Layer 10, 1.2 m below the flute, three teeth averaged 67 ± 4 ka, and in Layer 10–12, RT79 averaged 70 ± 13 ka. These dates consistently show that the flute probably dates to about 60 ka. In Layer 13, three teeth yielded a mean age of 80 ± 8 ka, while RT43B from Layer 16a is 80 ± 7 ka. From Layer 17, RT5 averaged 83 ± 10 ka. Dates for Layer 17a2 ranged from a mean of 80 ± 13 ka at 6.1 m to 102 ± 11 ka at 6.8 m, suggesting continuous and rapid deposition during this period. In Layer 20, QT5 averaged 111 ± 15 ka, while QT74 in Layer 23 averaged 116 ± 12 ka. Thus, deposition in the cave continued throughout most of OIS 4 and 5.

The dates suggest that four sedimentation cycles exist in Layers 2 to 23. Sedimentation appears to have been continuous from the initiation of Layer 23 at about 116 ka until approximately 102 ka when the lower part of Layer 17a2 was deposited. This deposition rate averaged 0.02 cm/y, which seems high, but structural properties of host rock might have contributed to higher rates of *éboulis* deposition. Then, a hiatus in sedimentation or a drastic decrease in the sedimentation rate appears to have lasted until about 85 ka, when sedimentation resumed again or when its rate returned to that seen during OIS 5d. From approximately 85 ka (the top of Layer 17a2) until 80 ka (the top of Layer 13), the sedimentation rate averaged 0.036 cm/y. This sedimentation cycle corresponds to OIS 5a, Dansgaard-Öschger Event 21. Another hiatus then followed, that lasted until about 70 ka, which corresponds to the first cold phase in OIS 4, a time that, further north, saw rapid extreme climatic oscillations (Barron *et al.* 2003). Deposition at approximately 0.012 cm/y resumed, with Layers 10-12 through 8a, from about 70 to 55 ka, a period that correlates with most of OIS 4 and matches a somewhat warmer phase in the pollen records seen at Castiglione, Italy (van Andel 2003), but further north appears to have been cold. Sedimentation slowed significantly or may have stopped briefly from 55 until 50 ka. This corresponds to early OIS 3 and correlates well with recent dates for the cold phase between the Örel and Glinde-Mörschoofd Events in Northern Europe and the short phase at Castiglione with low arboreal pollen (van Andel 2003). From about 50 to 40 ka, rapid sedimentation began again, depositing Layers 7 to 2, at a mean rate of ~ 0.04 cm/y. This period correlates with a warmer phase in mid OIS 3, the Mörshoofd-Glinde and Hengelo Interstadials in Northern Europe, and the Dansgaard-Öschger Events 14-10 (Huntley & Allen 2003).

GLOBAL CORRELATIONS

These four sedimentation cycles based upon the dates match almost perfectly with the major climatostratigraphic phases and sedimentological facies determined by the sedimentological analyses. Although many sedimentological analyses were performed during, and after, the excavations, only morphogenic analyses provided conclusive data for climatostratigraphic interpretations of the cave sediment (see Chapter *5* in this volume). From the chronology and the paleotemperature curves, the following correlations are assumed as the basis for further comparisons:

1. Divje babe I Layer 13 was dated by ESR at 79 ± 8 ka (*Fig. 6.5*). At the hiatus between Layers 12 and 13, the sedimentary character completely changes, including the frequency of aggregates, corrosion, and post-depostional cryoclasis of clasts in all size classes (e.g., *Fig. 6.6* and *6.7a*). Preliminary pollen analyses also showed a shift at this point in pollen production, typical of the change from the late OIS 5a to OIS 4 (Šercelj, Culiberg 1991). Therefore, the top of Layer 13 was correlated with the OIS 5a/4 boundary at approximately 74-76 ka (*Fig. 6.7b*). Because the changes in vegetation and sedimentation at higher altitudes may reflect earlier onset of colder conditions, however, this climatic change could have occurred as early as 78-80 ka at Divje babe I.

2. Divje babe I Layer 6 was dated by ^{14}C at 43.3 ± 1.4 ky BP, while Layer 7 dated at 49.6 ± 5.5 ka by ESR (*Fig. 6.5*). Given the ^{14}C calibration offset, Layers 6-7 probably date to about 46-50 ka. Interpreted as having a cold, dry climate (Climatic phase DB 4 on *Fig. 6.7a*), Layer 6 is assumed to correlate with the cold period between the Hengelo and Glinde Interstadials at approximately 44-46 ka (*Fig. 6.7b*). This also corresponds chronologically with the lowest winter temperatures as deduced from the Grand Pile, Les Echets, and Lago Grande di Monticchio pollen records (Guiot 1990, Fig. 12; Allen *et al.* 1999, Fig. 3f). Layer 7 (DB 5), in contrast, is characterized by warm, humid conditions.

3. From the ESR dates, Divje babe I Layers 8c-7 were deposited between 52-55 ± 5.5 ka and 49.6 ± 5.5 ka (*Fig. 6.5*). These beds were deposited during a cold, humid phase (DB 6 on *Fig. 6.7a*) that warmed up, but remained humid (DB 5). In Layer 7, the warmer Phase DB 5 probably correlates directly with the longest warm period in OIS 3, which also corresponds to Zone 11 in the Lago Grande di Monticchio pollen record (Allen *et al.* 2000) and DÖ Event 14-16, the Mörschoofd-Glinde-Örel Interstadials (*Fig. 6.7b*). Given the preponderance of Levallois technique used to make the artefacts in Layers 7 and 8a, they appear to have strong affinities with the Mousterian. Since no non-Neanderthal skeletal evidence occurs in Europe at this time, it suggests that Neanderthals most likely made these tools and the associated flute.

This profile from Divje babe I is the first sedimentological profile from a Slovenian cave to permit such correlations on a regional or continental scale. Given the correlations above, other layers in Divje babe I can be linked with specific paleoclimatic events:

4. Divje babe I Layer 2, containing Aurignacian deposits, dated to 35.3 ± 0.7 ky BP by ^{14}C (Nelson 1997), and by ESR at 39.7 ± 4.7 ka, while Layer 3 dated by ESR at 37.3 ± 3.5 ka. Given that an offset of > 2 ky probably exists between ^{14}C ages in this range (van Andel *et al.* 2003), this suggests that Layers 2 and 3 were deposited in a warm, dry phase (DB 1 on

Fig. 6.7a) at 38–39 ka, and most likely correlate with DÖ Events 8–11 (*Fig. 6.7b*). From the pollen, DÖ Event 8 is probably linked with the Les Cottés Interstadial (Weissmüller 1997; Bastin *et al.* 1976) on the GISP2δ^{18}O curve.

5. Interpreted as a cold, moderately humid period, Divje babe I Layers 4–5a (DB 2 on *Fig. 6.7a*), probably correspond chronostratigraphically to the cold, humid phase between the Hengelo and Les Cottés Interstadials (*Fig. 6.7b*; Dansgaard *et al.* 1993; Weissmüller 1997).

6. Since Divje babe I Layers 5a?–5 appear to have been deposited under warmer and somewhat drier conditions (DB 3 on *Fig. 6.7a*), they probably correspond chronostratigraphically to DÖ Event 12 at about 42–44 ka, which is equated with the Hengelo Interstadial (*Fig. 6.7b*; Dansgaard *et al.*, 1993; Weissmüller, 1997).

7. In central and western Europe, the Middle-Upper Palaeolithic transition occurred during the Hengelo to Les Cottés Interstadial (i.e., ~ 44–34 ka; *Fig. 6.7b*). Divje babe I Layers 5–2 (DB 3–DB 1 on *Fig. 6.7a*) correspond to this period archaeologically, chronologically, and paleoclimatically. At Divje babe I, nothing special in the archaeological sense happened in this interval, except that by Layer 4, the occupants had abandoned the Levallois tradition, which, among other things, characterized the earlier horizons (Blaser 1999, unpublished). Assuming uniform sedimentation rates, the MP-UP transition occurred about 40 ka.

8. The upper part of Divje babe I Layer 8b was deposited during a warm, humid climatic phase (Phase DB 7 on *Fig. 6.7a*), suggesting that it correlates chronostratigraphically with DÖ Event 18 at about 60 ka (*Fig. 6.7b*).

9. The cold, very humid climatic phase (DB 8 on *Fig. 6.7a*) at the boundary between Layers 8b and 10 probably correlates with the cold phase from 62–65 ka in OIS 4, between DÖ Events 18 and 19 (*Fig. 6.7b*).

10. Layer 10 dated at 67.1 ± 4.2 ka, while Layer 10–12 dated at 69.8 ± 13.0 ka by ESR (*Fig. 6.4*). Consequently, the cool, humid climatic phase in upper Layer 11 (Phase DB 9 on *Fig. 6.7a*) could correlate with DÖ Event 19 at about 68 ka (*Fig. 6.7b*), while the slightly warmer, but still relatively humid phase in Layer 12 probably correlates with DÖ Event 20.

11. In the Divje babe I sedimentary profile, the deposition of Layers 13 precedes a hiatus that correlates with the OIS 4/5a boundary and the early glacial maximum (= Würm 1/Early Weichselian/Early Wisconsinan Glaciation) at about 78 ka. During glacial advances, sedimentation in any Alpine location would be expected to stop or slow significantly (Campy, Chaline 1993; Bintz *et al.* 1997). Layer 13-14, which was deposited during a warm, relatively dry climatic phase (Phase DB 10 on *Fig. 6.7a*), correlates with DÖ Event 21 (= Odderade Interstadial), and OIS 5a (*Fig. 6.7b*).

12. Layers 13–10 contain the richest Palaeolithic horizon E, which included advanced elements that normally could characterize the Upper Palaeolithic (see Brodar 1999). The dates, however, indicate that layers range from approximately 78 to 67 ka in age, during a time when climate was cooling and becoming more humid (DB 10–9 on *Fig. 6.7a*).

13. The flowstone in the Layer 17/18 (Phase DB 15 on *Fig. 6.7a*) had to have been deposited in a warm, moderately humid climatic phase. In lower Layer 17a2 (warm, dry phase DB 14), just above the Layer 17/18, ESR dates averaged 112 ± 13.0 ka, while below, Layer 20 (warm, moderately humid phase DB 20) had an ESR age of 110.2 ± 15.3 ka, and Layer 23 (warm, dry phase DB 21) dated at 116.1 ± 12.1 ka. Therefore, the Layer 17/18 and the layers from lower 17a2 to 23 probably correlate best with the climatic optimum in OIS 5c and OIS 5d at about 100–105 ka and 113–117 ka, DÖ Events 23–25. The cementation events that cement the “breccias” in Layers 15/16a (DB 11), 18a (DB 17), 20/21 (DB 19), and 23 (DB 21) appear to correlate with marginally cooler, but more humid periods during OIS 5, which are documented on the GRIP curve (*Fig. 6.7b*). These cementation events, however, may not be directly caused by these climatic shifts.

CONCLUSIONS

Using ESR, 44 subsamples were independently dated from 28 *Ursus spelaeus* (cave bear) teeth found in Layers 2 through 23 to build a detailed and precise chronostratigraphic sequence (*Fig. 6.5*) which allowed other sedimentological analyses to be tied to an absolute time sequence (e.g., *Fig. 6.6b*; Turk *et al.* 2001). The resulting paleoclimatic interpretations could then be correlated with other regional and global climatic events.

The chronology of Divje babe I as currently understood assumes that the ^{14}C dates are reliable for Layer 2 to Layer 6, but may require a +2 to +5 ky shift for calibration, and that the ESR dates are reliable, within their uncertainties, for Layers 2 to 23. The chronometric dates suggest that Layers 2 to 23 record two to four major sedimentation pulses, but several more short-term climatic cycles.

Sedimentation in Layer 23 to the lower part of 17a2 began at about 116 ka and continued until approximately 102 ka under warm climates, that alternated from dry to moderately humid conditions, during OIS 5d at a sedimentation rate of 0.02 cm/y. Then, sedimentation slowed drastically or stopped until about 85 ka, during OIS 5c and 5b. From approximately 85 ka until 80 ka during OIS 5a, Dansgaard-Öschger Event 21, sedimentation resumed, depositing upper Layer 17a2 through Layer 13 under warm, but dry to moderately dry conditions at a sedimentation rate averaging 0.036 cm/y. Sedimentation again slowed or stopped until about 70 ka during the first cold phase in OIS 4.

Then, the character of the sedimentation changes dramatically, reflecting processes more prevalent under glacial rather than interglacial conditions. From about 70 to 55 ka in late OIS 4 to early OIS 3, rapid deposition at ~ 0.012 cm/y resumed, producing Layers 12 through 8c, under more variable temperatures, but humid conditions. During this period, sedimentation events that reflect changing climatic conditions and that appear to correlate with cold and warm, but humid phases, seen in other European and global climatic phases can be recognized, including DÖ Events 20 to 18. Then, the sedimentation slows again from 55 to 50 ka, but does not appear to stop totally, because Layer 7 to 8a show a warm climatic signature that appears to correlate with other global records, including the longest warm period in OIS 3, DÖ Events 14–16, and the Mörschoofd-Glinde-Örel Interstadials. From about 45 to 38 ka, sedimentation sped up, depositing Layers 6 to 2, at a mean rate near 0.04 cm/y. Climatic oscillations recorded in these beds appear to correlate well with fluctuating climates from DÖ Events 12 through 8 during OIS 3. The cave sediment does preserve a record of the effects from OIS 2 in the form of pervasive cryoturbation in Layers 5a–2, but little sediment deposited during this time has survived within the cave, except in small pockets of cryoclastic sediment.

From approximately 110 until 40 ka, Mousterian people visited the cave sporadically leaving behind their hearths, flint and bone artefacts. Judging by the frequency of hearths, cave occupation or utilization became more intense in OIS 3 and 4, than in OIS 5. From computerized tomography and experimental archaeological studies on the perforated cave bear femur and the Mousterian tools in the cave, humans did make the holes in the femur before abandoning it to a carnivore who gnawed off its ends at about 60 ka (Turk *et al.* 2005b). Archaeologically, the MP/UP transition occurs at the cave at Layer 4 during mid OIS 3, at about 40 ka, assuming uniform sedimentation rates for Layers 6–2. Aurignacian peoples then used the cave for a short time from 40 to 38 ka, after which no Palaeolithic deposition occurred.

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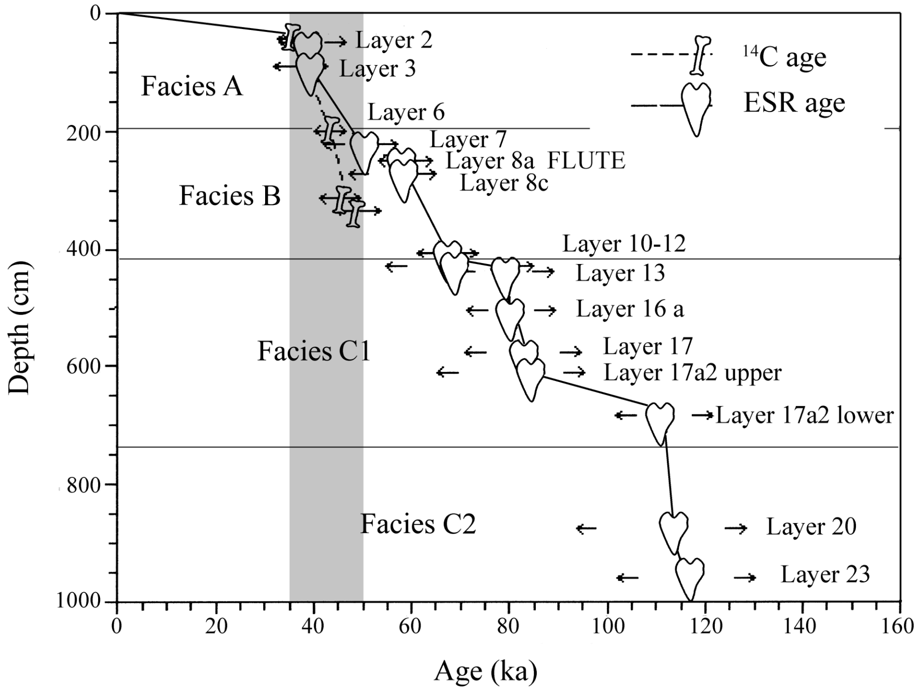
7. KRONOLOGIJA NAJDIŠČA DIVJE BABE I

IVAN TURK

Doslej je bilo več poskusov kronološke interpretacije najdišča (Brodar 1999; Šercelj, Culiberg 1991; Turk *et al.* 1989a, 1989b; Turk 1997c; Turk, Bastiani 2000). Vse razlage so bile dvomljive vrednosti glede na način, kako so bile izpeljane. To žal drži tudi za kronologijo ^{14}C AMS (Nelson 1997; Turk 1997c), ki ne predstavlja koledarska leta in kot taka ni primerljiva z drugimi izotopskimi kronologijami, ki v enem profilu obsegajo celoten zadnji interglacialno-glacialni ciklus. Zato predlagam popolnoma novo kronologijo, ki temelji na novi, večstransko preverjeni metodologiji.

Nova kronološka interpretacija sloni na koledarskih letnicah ESR (*sl. 7.1*) (glej poglavje 6 v tem zborniku), ki opredeljujejo klimatske dogodke, predstavljene z neodvisno pridobljenim parom krivulj, sestavljenem iz približkov paleotemperature in paleovlažnosti (*sl. 7.2*) (glej podpoglavji 5.2 in 5.3 v tem zborniku), in na ujemanju s koledarsko opredeljenimi klimatskimi dogodki v zadnjem interglacialno-glacialnem ciklusu na izotopskih in pelodnih krivuljah, izraženimi s približki temperature (*sl. 7.3*) (Turk *et al.* 2006, sl. 30). Ključna pri tem je dobro opredeljena meja med toplejšim zgodnjim gla-

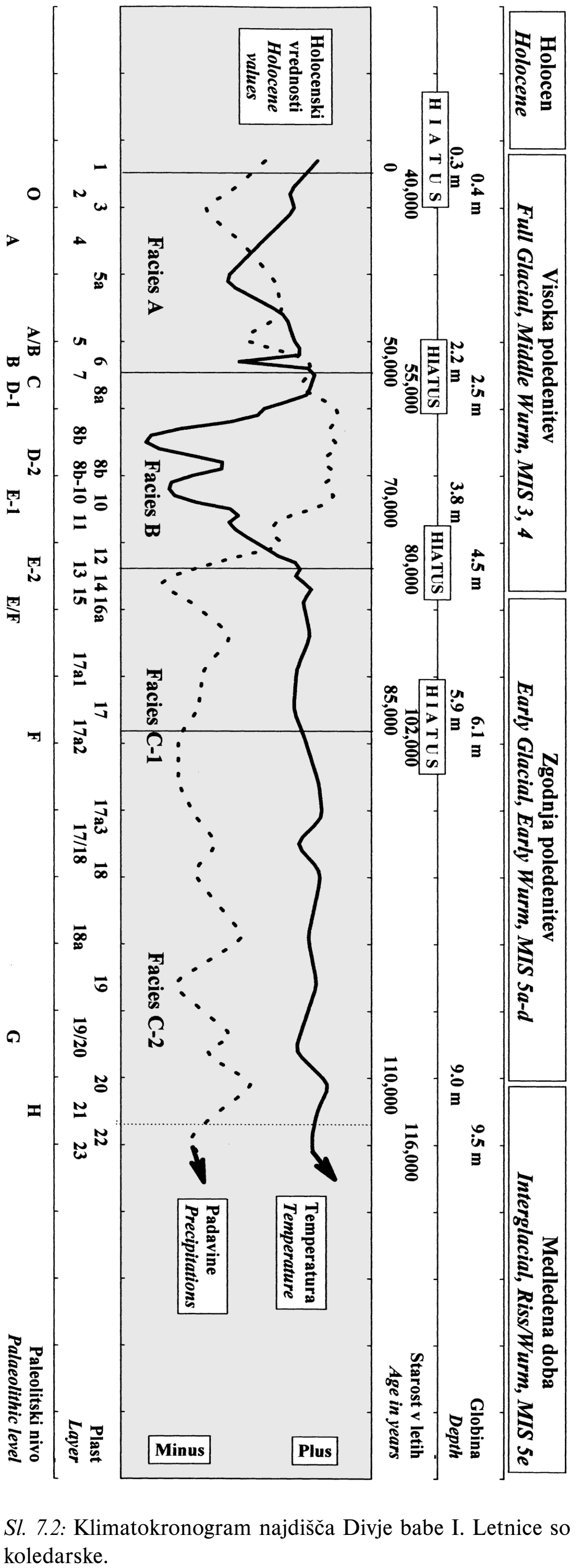


Sl. 7.1: Diagram plasti in izbranih datacij AMS ^{14}C (Nelson 1997) ter ESR (poglavje 6 v tem zborniku) profila Divjih bab I. Stopnice predstavljajo kronološke in sedimentacijske vrzeli, ki se v grobem ujemajo z mejami med sedimentnimi facijami A/B, B/C-1 in C-1/C-2. V sivem navpičnem pasu so vse AMS ^{14}C-datacije za plasti 2–20. Datacije AMS ^{14}C so bile izvedene na aminokislinah v kosteh jamskega medveda, ESR pa na sklenini zob. Prevzeto po Blackwell *et al.*, v tisku, in Turk *et al.* 2006.
Fig. 7.1: Diagram of layers and selected AMS ^{14}C (Nelson 1997) and ESR (Blackwell et al., in print) dates of the Divje babe I profile. The steps represent chronological and sedimentary hiatuses, which roughly correspond to the boundaries between sedimentary facies A/B, B/C-1 in C-1/C-2. In the grey vertical belt are all the AMS ^{14}C dates for layers 2–20. AMS ^{14}C was done on aminoacids in cave bear bones, and ESR on tooth enamel. Taken from Blackwell *et al.*, in print and Turk *et al.* 2006.

cialom (zgodnji virm) in hladnejšim srednjim glacialom (srednji virm) med 70 *ka* in 80 *ka* na vseh krivuljah. Ta meja predstavlja, poleg tipične interglacialne favne in flore, najzanesljivejšo oporno točko pri povezovanju različnih regionalnih kronologij s trenutno veljavno t. i. globalno kronologijo izotopskih stopenj[1].

V Divjih babah I je meja med zmerno klimo in hladno, med suho in vlažno sedimentološko dobro določena, slabše pa paleontološko. Radiometrično je postavljena med 70.000 in 80.000 let pred sedanjostjo oz. med sedimentni faciji C in B (*sl. 7.2*). Pod to mejo je zgodnji glacial ali MIS 5 – *marine isotope stage* (= sedimentni facies C), nad njo »visoki glacial« (»full glacial« oz. »pleniglacial«) oz. MIS 4–2 (= sedimentni faciji A in B), pri čemer manjka večji del MIS 4 in celotna MIS 2.

Spodnji del profila Divjih bab I pripada topli in suhi klimi kronocone zgodnjega glaciala oz. MIS 5a–d oz. zgodnjega virma alpske poledenitve (= sedimentni faciji C-1 in C-2, plasti 13–19/20). Ker v profilu sedimentne facije C ni bilo zaznati nobene mrzle klimatske faze[2], ki so sicer značilne za to kronocono in zgodnji glacial v Evropi (Preusser 2004), je zgodnji glacial težko ločiti od interglaciala (plasti 20 in podležne plasti). Tik za zgodnjeglacialno-srednjeglacialno mejo je daljša vrzel (*sl. 7.2*), ki obsega zgodnji glacialni vrhunec, ki je v Vzhodnih Alpah (Samerberg, Mondsee) slabo izražen (Preusser 2004). Onstran zgodnjeglacialno-srednjeglacialne meje je slabo izražena kronocona MIS 4, 70–60 *ka* pred sedanjostjo (= facija B, plasti 8b in 8b–10?) in bistveno bolje zastopan starejši del kronocone MIS 3 oz. srednjega virma, 60–40 *ka* pred sedanjostjo (= faciji A in B, plasti 2–8b? ali 2–12). Ti kronoconi sta v Divjih babah I in drugje sestavljeni iz toplih in hladnih klimatskih faz, tj. interstadialov in stadialov. Začneta se z mrzlo in vlažno klimatsko fazo, prekinjeno z neizrazito toplim, vendar izrazito vlažnim dogodkom, in se nadaljujeta z dolgo toplo in vlažno klimatsko fazo, ki jo lahko primerjam s severnoevropskim pelodnim interstadialom Glindeja oz. Moershoofda (glej poglavje 6 v tem zborniku). Poleg omenjene tople dobe sta v profilu sedimentne facije B zabeleženi še dve, od katerih starejša lahko ustreza severnoevropskemu pelodnemu interstadialu Hengela, mlajša pa pelodnemu interstadialu Denekampa. Vsaj dve od naštetih toplih obdobij (interstadialov) sta evidentirani tudi v tipskih profilih Gossaua in Dürntena v območju Alp (Preusser 2004). Mrzlih klimatskih faz je zabeleženih več (*sl. 7.2, 7.3*). Najizrazitejša je bila od 70 *ka* do 60 *ka*. Koreliram jo z. zgodnjim glacialnim maksimumom. Med 40 *ka* in 50 *ka* sta bili dve ne tako



Sl. 7.2: Klimatokronogram najdišča Divje babe I. Letnice so koledarske.

Fig. 7.2: Climatochronogram of the site Divje babe I. Ages are in calendar years.

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[1] Pod regionalno kronologijo razumem vsako kronologijo, ki temelji na regionalnih podatkih, kar pa ne pomeni, da so bile med posameznimi regijami bistvene razlike v razvoju klime, ki se je spreminjala globalno. Potrditev za to vidim v klimatokronogramu najdišča Divje babe I.

[2] Takšna faza je zabeležena v klimatskem zapisu *GISP2* ok. 90 ka in kronološko gledano ustreza daljši vrzeli v sedimentnem profilu Divjih bab I (glej *sl. 7.2* in Van Andel, Davies 2003, 33, sl. 4.1).

izraziti mrzli fazi. Prva, ok. 46 *ka*, je morala biti kratka in zelo mrzla, druga je bila verjetno daljša.

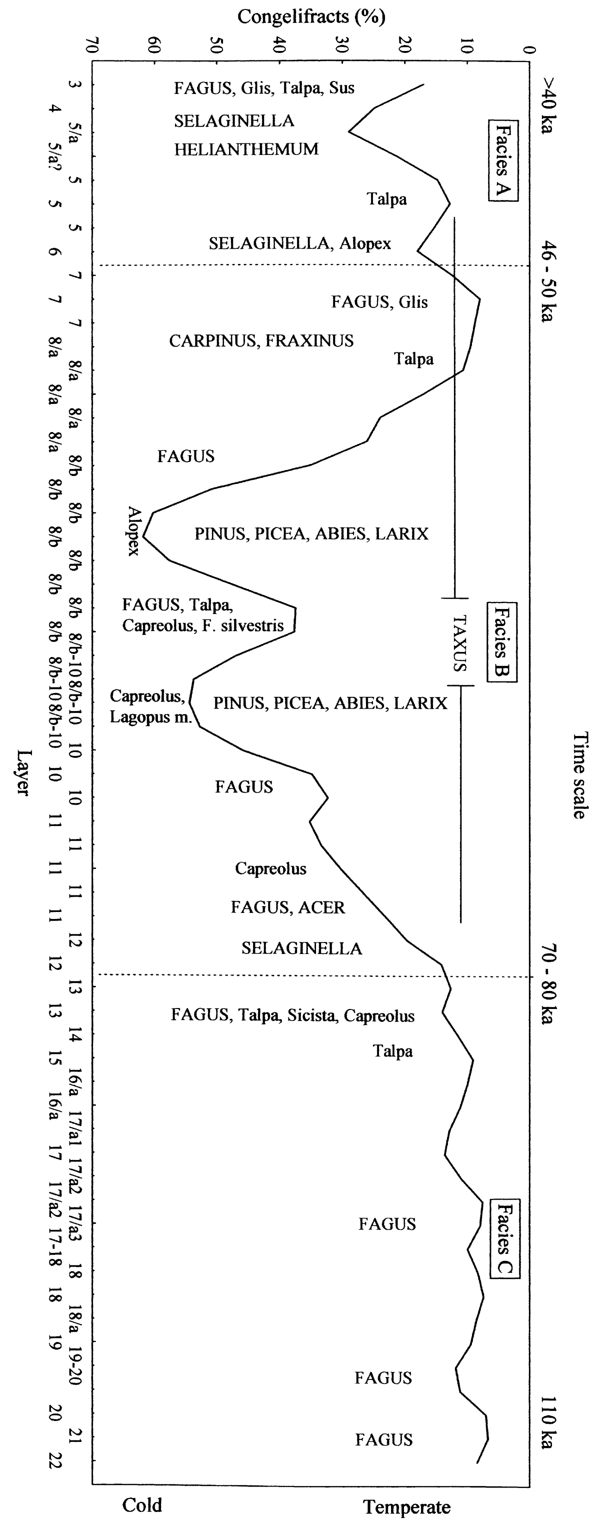
Kronocona MIS 2 oz. mlajšega virma, s poznim glacialnim vrhuncem ali vrhuncem zadnjega glaciala (LGM = *Last* ali *Late Glacial Maximum*) vred, v profilu Divjih bab I ni zastopana. To je značilno za vrsto profilov v Sloveniji in drugje. S poznim glacialnim vrhuncem med 27.000 in 16.000 pred sedanjostjo je mogoče domnevno povezati krioturbacijo v najmlajših plasteh profila in leče krioklastičnega grušča v plasti 2, ki pa so praktično brez najdb.

Klimatokronogram Divjih bab I je neverjetno podoben klimatskemu zapisu *GISP Summit* ledne vrtine, kakor tudi referenčnim pelodnim diagramom, ki kažejo razvoj klime v zadnjem glacialu. O tem sem oz. smo večkrat poročali (Turk *et al.* 2001, Blackwell *et al.*, v tisku). Podobnost je še večja, če ga primerjam z zglajeno krivuljo *GISP2*, ki kaže splošen trend klimatskih sprememb v MIS 5 in MIS 3, ki ima manjšo časovno ločljivost in je tako bolje primerljiva s klimatokronogramom Divjih bab I z majhno časovno ločljivostjo (prim. *sl. 7.3* in Van Andel, Davies 2003, 33, sl. 4.1). Manjša odstopanja tako v časovni lestvici kot v približkih paleotemperature med obema klimatokronogramoma so pričakovana glede na različno metodologijo.

Če v novo klimato-kronološko shemo najdišča Divje babe I vključim neodvisne paleookoljske približke, osnovane na ostankih flore in favne (glej poglavja 8-11 v tem zborniku), dobim dodatno potrditev, ali pa tudi ne, za zanesljivost nove klimato-kronološke interpretacije najdišča (*sl. 7.3*). Paleoklimatski približki na podlagi posameznih ostankov flore in favne, najdenih v Divjih babah I, so bolj vprašljivi kot približki na podlagi izbranih sedimentoloških podatkov. Medtem ko slednji ločujejo med temperaturo in padavinami, pri flori in favni to ni mogoče, tako da običajno ne vemo, kaj je dejansko vplivalo na spremembo v sestavi flore in favne. Zaradi majhne časovne ločljivosti in mobilnosti najdb so se lahko pomešale najdbe iz različnih obdobij. Posledica so neobičajne kombinacije najdb, ki pripadajo različnim paleookoljem. Razen tega je samo na podlagi florističnih in favnističnih najdb ter analogij praktično nemogoče izdelati dovolj zanesljivo kronologijo. V razlagi paleookoljskih približkov bom upošteval vse navedeno. Zato se interpretacija ne bo vedno ujemala s podrobnim dejanskim stanjem v stratigrafsko domnevno zaokroženih celotah.

Za zgodnji glacial (115-80 *ka*) so značilni pelod bukve in drugih listavcev (Šercelj, Culiberg 1991) ter najdbe krta, ki ne prenese globoko zamrznjenih tal oz. potrebuje debel sloj tal, kakršen na obstoječi kamninski podlagi ni mogoč (*sl. 7.3*). Tako bukev kot krt sta interglacialna relikta.

Kratek, mrzel dogodek v začetku zgodnjega glacialnega maksimuma (70-60 *ka*) označuje pelod alpske drežice. Ta rastlina je značilen arkto-alpinski element. Sledi izboljšanje klime, ki jo označuje oglje bukve in javorja. Za naslednjo, izrazitejšo mrzlo fazo so značilni skoraj izključno pelod in oglje iglavcev (bora, smreke,



Sl. 7.3: Korelacija med izbranimi biostratigrafskimi podatki in približki paleotemperature v profilu Divjih bab I.
Fig. 7.3: Correlation between selected biostratigraphical data and palaeotemperature proxis in the profile of Divje babe I.

jelke, tise, macesna, brina) ter najdba belke. Najdba srne in odsotnost krta kažeta na normalno debelino snežne odeje kljub večji vlažnosti. Odsotnost krta v vseh mrzlih in vlažnih fazah je dokaz, da snežna odeja ni bila dovolj debela, da bi preprečila globoko zamrzovanje tal[3]. Na ponovno otoplitev kažeta oglje bukve in drugih listavcev (jesena, gabra) ter najdba krta. Značilni najdbi sta tudi srna in divja mačka. Kombinacija srne in krta kaže na mile zime z normalno debelino snežne odeje. Sledi najhladnejše obdobje zgodnjega glacialnega vrhunca tik pred 60 ka, za katerega so značilni izključno pelod in oglje iglavcev (bora, smreke, jelke, tise, macesna, brina), spore alpske drežice in najdba polarne lisice. Gre za kombinacijo izrazito glacialnih elementov, kar se odlično ujema s približki paleotemperature na podlagi talnih zmrzlinskih klastov. Zgodnji glacialni maksimum evidentno ni bil ves čas mrzel, temveč so ga vsaj na začetku prekinjala krajša, toplejša obdobja, za katera so značilni interglacialni relikti favne in flore. Gozd ni nikoli popolnoma izginil. Značilna je bila velika vlažnost, ki je potrjena z veliko količino oglja tise.

Ponovno močno in dolgo otoplitev (60–50 *ka*), tokrat po glacialnem vrhuncu, označujejo oglje in pelod bukve ter drugih listavcev (jesena, gabra, bresta in javorja) in najdbe krta ter polha. Gre za edino zanesljivo glacialno najdbo polha, za katerega vemo, da živi v plodonosnih listnatih gozdovih. Da se polh skupaj s številnimi listavci pojavi proti koncu najdaljšega in najtoplejšega interstadiala srednjega virma, ki je ekvivalent severnoevropskih interstadialov Moershoofda in Glindeja, ne preseneča. Sledi kratka in zelo mrzla faza ok. 46 *ka*, s katero se konča dolgo, zelo vlažno obdobje, za katero je značilna takorekoč stalna prisotnost tise[4]. To kratko, mrzlo fazo označujejo spore alpske drežice, oglje izključno iglavcev (bora, smreke, jelke, tise, macesna, brina) in najdba polarne lisice. Naslednje toplejše obdobje, ki kronostratigrafsko ustreza severnoevropskemu interstadialu Hengelo, označuje najdba krta. Oglje in pelod pripadata v glavnem iglavcem (boru, smreki, cemprinu). Prežitek vlažne predhodne faze je tisa. Cemprin se verjetno prvič pojavi v zgodnjem glacialnem vrhuncu. Sledi nova mrzla faza, ki jo označujejo spore alpske drežice in pelod sončeca. Oglje se ni ohranilo. Zadnje toplo obdobje lahko označujejo oglje bukve in drugih listavcev (jesena, navadnega in črnega gabra, javorja) ter najdbe krta, polha in divje svinje. Vendar gre lahko v vseh primerih za poznejšo, predvsem holocensko kontaminacijo, ki je bila potrjena za oglje z dvema ^{14}C-datacijama (glej poglavje 8 v tem zborniku). V zvezi s tem je zgovorno tudi dejstvo, da divja svinja kot tipična predstavnica interglacialne favne ni zastopana v nobeni plasti, starejši od plasti 2–5, vključno z interglacialnimi plastmi, čeprav bi lahko bila v vseh plasteh z najdbami krta. Enako velja za črni gaber. Najdbe belke, ki je arkto-alpinska vrsta, v plasti 2, lahko služijo kot dodaten dokaz za mešanje najdb iz različnih obdobij zaradi evidentnega zastoja(jev) v sedimentaciji.

Za čas po 50 *ka* je značilno progresivno ohlajevanje podnebja, kar se v Divjih babah I odslikava predvsem v približkih za paleotemperaturo in do neke mere tudi v flori in favni, če upoštevam možnost kontaminacije najmlajših sedimentov.

Šercelj in Culiberg (1991) sta pelodni profil Divjih bab I razdelila na tri odseke: A, B in C. Odseka A in B sta razdelila še na pododseke. Pri razlagi profila sta se delno oprla na datacije ^{14}C, za katere smo sedaj ugotovili, da so napačne (glej poglavje 6 v tem zborniku). Pelodni odsek C, ki je najstarejši, obsega plasti, ki jih v tem zborniku ne obravnavamo. Danes bi jih preliminarno razvrstil v zadnji interglacial na podlagi ESR-datumov. Pelodni pododsek B_2 naslednjega, mlajšega odseka obsega iste plasti kot sedimentna subfacija C-2. Pelodna pododseka B_1 in A_3 obsegata skoraj iste plasti kot sedimentna subfacija C-1. Glede na poudarjeno razliko med pelodnim odsekom A in B in dejstvom, da meja med njima poteka v neposredni bližini plasti 17, bi mejo lahko utemeljil tudi z zastojem v sedimentaciji, ki je trajal skoraj 20.000 let (*sl. 7.1* in *7.2*). Pelodni pododsek A_2 obsega plasti 13–10 oz. spodnji del sedimentne facije B, pelodni pododsek A_1 pa plasti 8–4 oz. zgornji del sedimentne facije B in večji del facije A. Med pelodnimi odseki oz. pododseki in sedimentnimi facijami je v zgornjem delu profila očitno neskladje. Ker gre za členitvi, ki sta osnovani na podatkih izkopavanj, pri katerih so bile uporabljene različne terenske tehnike in metode, bi bila vsaka revizija v smislu prilaganja pelodnih odsekov sedimentnim facijam in obratno nesmiselna početje. Rešitev bi bil pelod v jamski notranjosti. Tega pa kljub intenzivnemu vzorčevanju tamkajšnih profilov, žal, nismo našli v količinah, potrebnih za izdelavo pelodnega diagrama.

Neodvisni paleookoljski približki potrjujejo, da je nova klimatokronološka razlaga, kot je prikazana v klimatokronogramu (*sl. 7.2*), najzanesljivejša in najbolje utemeljena med vsemi doslej podanimi razlagami. Zato sem profil Divjih bab I predlagal za stratotip srednjega virma v Sloveniji (Turk 2006).

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[3] Ta ugotovitev dopolnjuje predvidevanje o trajanju snežne odeje (Turk *et al.* 2005a) in da slutiti, kakšna je bila sezonska razporeditev padavin. Po vsemu sodeč takšna, kot je danes z vrhuncem padavin jeseni.

[4] Dolgo vlažno obdobje v sedimentni faciji B karakterizirajo tudi najdbe rdečezobe rovke in relativno velikega deleža travniške voluharice znotraj skupine *M. agrestis/arvalis* in veliko gozdne voluharice, ki kaže tudi na prisotnost gozda (glej poglavje 11 v tem zborniku).

7. CHRONOLOGY OF THE DIVJE BABE I

IVAN TURK

There have been a number of attempts to date at a chronological interpretation of the site (Brodar 1999; Šercelj, Culiberg 1991; Turk *et al.* 1989a, 1989b; Turk 1997; Turk, Bastiani 2000). All the interpretations were of doubtful value in view of the way that they were produced. Unfortunately this is also true of the ^{14}C AMS chronology (Nelson 1997; Turk 1997), which does not represent calendar years and, as such, is not comparable with other isotope chronologies, which embrace the entire last interglacial-glacial cycle in a single profile. I therefore propose a completely new chronology that is based on a new methodology proved by cross-checking at the site and between sites.

The new chronological interpretation relies on calendar years ESR (*Fig. 7.1*) (see Chapter 6 in this volume), which are defined by climatic events presented with independently obtained pairs of curves consisting of approximations of palaeotemperature and palaeohumidity (*Fig. 7.2*) (see sub-chapters 5.2 and 5.3 in this volume), and correspondence with calendar defined climatic events in the last interglacial-glacial cycle on isotope and pollen curves, expressed by approximations of temperature (*Fig. 7.3*) (Turk *et al.* 2006, Fig. 30). Crucial in this is the well defined boundary between the warmer Early Glacial (Early Würm) and the colder Middle Glacial (Middle Würm) between 70 ka and 80 ka on all curves. This boundary represents, in addition to typical interglacial fauna and flora, the most reliable support point for connecting various regional chronologies with the currently valid, global chronology of isotope stages[1].

In Divje babe I, the boundary between the moderate and cold climates, between dry and humid ones, is sedimentologically well defined, but more poorly palaeontologically. Radiometrically it is set between 70,000 and 80,000 years ago or between sedimentary facies C and B (*Fig. 7.2*). Below this boundary is the Early Glacial or MIS 5 – marine isotope stage (= sedimentary facies C), above the »full glacial« or »pleniglacial«, or MIS 4–2 (= sedimentary facies A and B), whereby the major part of MIS 4 and the whole of MIS 2 are missing.

The lower part of the profile of Divje babe I belongs to the warm and dry climate of the chronozone of the Early Glacial or MIS 5a-d or the Early Würm of the alpine glaciation (= sedimentary facies C-1 and C-2, layers 13–19/20). Because there were no cold climatic phases to be perceived in the profile of sedimentary facies C[2], which are otherwise characteristic for this chronozone and the Early Glacial in Europe (Preusser 2004), the Early Glacial is difficult to distinguish from the Interglacial Riss-Würm (Layer 20 and layers below). Immediately after the Early Glacial-Middle Glacial (»full glacial«) boundary is a prolonged gap (*Fig. 7.2*), which extends to the Early Glacial Maximum, which is poorly expressed in the Eastern Alps (Samerberg, Mondsee) (Preusser 2004). On the other side of the Early Glacial-Middle Glacial boundary is a poorly expressed chronozone MIS 4, 70–60 ka (= Facies B, layers 8b and 8b-10?) and essentially better represented older part of chronozone MIS 3 or Middle Würm, 60–40 ka (= Facies A and B, layers 2–8b? or 2–12). These chronozones, in Divje babe I and elsewhere, are composed of warm and cold climatic phases, i.e., interstadials and stadials. They start with a cold and damp climatic phase, broken with an unpronounced warm but explicitly humid event and continue with a long warm and humid climatic phase, which can be paralleled with the northern European pollen interstadial of Glinde and/or Moershoofd (see Chapter 6 in this volume). In addition to the mentioned warm periods in the profile of sedimentary facies B, two further warm periods are recorded, of which the older may correspond to the northern European Hengelo pollen interstadial, and the younger to the Denekamp

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[1] By regional chronology I understand any chronology that is based on regional data, but this does not mean that there were essential differences among individual regions in the development of climate, which changed globally. I see confirmation of this in the climatogram of the Divje babe I site.

[2] Such a phase is recorded in the climatic records *GISP2* ca. 90 ka and corresponds chronologically to the extended hiatus in the sedimentary profile of Divje babe I (see *Fig. 7.2* and Van Andel, Davies 2003, 33, Fig. 4.1).

pollen interstadial. At least two of the enumerated warm periods (interstadials) are also recorded in the type profiles of Gossau and Dürnten in the region of the Alps (Preusser 2004). A number of cold climatic phases are recorded (*Fig. 7.2, 7.3*). The most pronounced was from 70 ka to 60 ka. I correlate it with the Early Glacial Maximum. Between 40 ka and 50 ka there were two not so pronounced cold phases. The first, around 46 ka, must have been short and very cold, and the second was probably longer.

Chronozone MIS 2 or the Late Würm, including the Last or Late Glacial Maximum *(*LGM), is not represented in the profile of Divje babe I. This is typical of a series of profiles in Slovenia and elsewhere. It is presumably possible to link the cryoturbation in the youngest layers of the profile and the pockets of cryoclastic rubble in Layer 2 with the Late Glacial Maximum between 27,000 and 16,000 BP.

The climatochronogram of Divje babe I is strikingly similar to the climatic record of the *GISP Summit* ice core, as well as reference pollen diagrams, which show the development of climate in the last glacial. I, or we, have reported on that several times (Turk *et al.* 2001, Blackwell *et al.*, in print). The similarity is still greater if I compare it with smoothed *GISP2* curve showing the general trend of the MIS 5 and MIS 3 climate changes, which have a lower temporal resolution and thus better approximate to the climatochronogram of Divje babe I with low temporal resolution (see *Fig. 7.3* and Van Andel, Davies 2003, 33, Fig. 4.1). Minor deviations both in the time scale and in approximations of palaeotemperature between the two climatochronograms are to be expected in view of the various methodologies.

If I include independent palaeoenvironmental approximations in the new climato-chronological scheme of the Divje babe I site, based on the remains of flora and fauna (see Chapters 8–11 in this volume), I obtain additional confirmation, or not, of the reliability of the new climato-chronological interpretation of the site (*Fig. 7.3*). Palaeoclimatic approximations on the basis of individual remains of flora and fauna found in Divje babe I are more suspect than approximations on the basis of selected sedimentological data. While the latter distinguish between temperature and precipitation, this is not possible with flora and fauna, so that we do not normally know what actually influenced changes in the composition of the flora and fauna. Because of low temporal resolution and the mobility of finds, finds from various periods can be mixed. The result is unusual combinations of finds belonging to various palaeoenvironments. In addition, it is practically impossible only on the basis of floristic and faunistic finds and analogies to produce a reliable enough chronology. In the interpretation of palaeoenvironmental approximations, I will take all the aforementioned into account. So the interpretation will not always correspond to the detailed actual situation in stratigraphically presumed closed totalities.

Pollen of beech and other deciduous trees is characteristic of the Early Glacial (115–80 ka) (Šercelj, Culiberg 1991), together with finds of moles, which do not survive deeply frozen soil (*Fig. 7.3*). Both beech and mole are interglacial relicts.

A short, cold event at the start of the Early Glacial Maximum (70–60 ka) is marked by pollen of lesser clubmoss (*Selaginella selaginoides*), which is a typical arcto-alpine element. It is followed by an improved climate marked by charcoal of beech and maple. The following, more explicitly cold phase is characterised by pollen and charcoal of almost exclusively conifers (pine, spruce, fir, yew, larch, juniper) and finds of rock ptarmigan (*Lagopus mutus*). Finds of deer and the absence of mole indicate a normal thickness of snow cover, despite the greater humidity. The absence of mole in all cold and humid phases is evidence that the snow cover was not sufficiently thick to prevent the creation of deeply frozen soil[3]. Charcoal of beech and other deciduous trees (ash, hornbeam) and finds of mole indicate a new warming. Deer and wildcat are also characteristic finds. The combination of deer and mole indicates mild winters with a normal thickness of snow cover. The coldest period of the Early Glacial Maximum follows immediately before 60 ka, for which exclusively pollen and charcoal of confers are characteristic (pine, spruce, fir, yew, larch, juniper), spore of lesser clubmoss and finds of polar fox. This is a combination of explicitly glacial elements, which excellently correspond to approximations of palaeotemperature on the basis of congelifracts. The Early Glacial Maximum evidently was not cold throughout but was broken at least at the start by shorter, warmer periods, for which interglacial relicts of flora and fauna are characteristic. Forest never completely disappeared. High humidity was characteristic, which is confirmed by the amount of yew charcoal.

A new strong and long warming (60–50 ka), this time after the glacial maximum, is marked by charcoal and pollen of beech and other deciduous trees (ash, hornbeam, birch and maple) and finds of mole and dormouse. It is the only reliable glacial find of dormouse, which is known to live in productive broadleaf forests. Dormouse, together with numerous deciduous trees, appears towards the end of the longest and warmest interstadial of the Middle Würm, which is the equivalent of the northern European Moershoofd and Glinde interstadials. It is followed by a short and very cold phase around 46 ka, which ends the long, very humid period

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[3] This finding supplements forecasts of the duration of the snow cover (Turk *et al.* 2005a) and allows conjecture as to the seasonal distribution of rainfall; judging from everything, similar to today, with the peak in autumn.

characterised by the constant present of yew[4]. This short cold phase is marked by spore of lesser clubmoss, charcoal of exclusively conifers (pine, spruce, fir, yew, larch, juniper) and finds of arctic fox. The next warmer period, which corresponds chronostratigraphically with the northern European Hengelo interstadial is marked by finds of mole. Charcoal and pollen belong mainly to conifers (pine, spruce, Arolla pine). A survivor of the humid transitional phase is yew. Arolla pine (*Pinus cembra*) probably appears first in the Early Glacial Maximum. A new cold phase follows, marked by spore of lesser clubmoss and pollen of rock rose (*Helianthemum*). Charcoal has not been preserved. The last warm period can be characterised by charcoal of beech and other deciduous trees (ash, hornbeam and hop hornbeam, maple) and finds of mole, dormouse and wild boar. However, in all cases it may be later, mainly Holocene contamination, which has been confirmed by two ^{14}C-datings (see Chapter 8 in this volume). In this connection, the fact is also revealing that there is no wild boar, as a typical representative of interglacial fauna, represented in any layer older than layers 2–5, including interglacial layers, although mole can be found in all layers. The same applies to hop hornbeam. Finds of *Lagopus mutus*, which is an arctic-alpine species, in Layer 2, may serve as additional evidence of the mixing of finds from various periods because of the evident gap(s) in sedimentation.

For the time after 50 ka, a progressive cooling of the climate is characteristic, which is illustrated in Divje babe I mainly in approximations for palaeotemperature and, to some extent, also in the flora and fauna, if I take into account the possibility of contamination of the most recent sediments.

Šercelj and Culiberg (1991) divided the pollen profile of Divje babe I into three sections: A, B and C. Sections A and B are further divided into sub-sections. In interpretation of the profile, they relied partially on ^{14}C dates, which we then discovered were mistaken (see Chapter 6 in this volume). Pollen section C, which is the oldest, covers the layers that are not dealt with in this volume. Today, I would preliminarily place them in the last interglacial on the basis of ESR datings. Pollen sub-section B_2 of the following, youngest section covers the same layers as sedimentary subfacies C-2. Pollen subsections B_1 and A_3 cover almost the same layers as sedimentary subfacies C-1. In view of the pronounced difference between pollen sections A and B and the fact that the boundary between them runs in the direct vicinity of Layer 17, the boundary could be based on a gap in sedimentation which lasted almost 20,000 years (*Fig. 7.1* and *7.2*). Pollen sub-section A_2 covers layers 13–10 or the lower part of sedimentary facies B, and pollen sub-section A_1 layers 8–4 or the upper part of sediment facies B and the greater part of facies A. There is clear discordance between the pollen sections or subsections and sedimentary facies. Since they are articulations based on data of excavations in which various fieldwork techniques and methods were used, any revision in the sense of adapting the pollen sections to sedimentary facies or the reverse was senseless. The solution would be pollen found in the cave interior. In spite of intensive sampling of the profile there, we did not find this in sufficient quantities required for the production of a pollen diagram.

Independent palaeoenvironmental approximations confirm that the new climatochronological interpretation as shown in the climatochronogram (*Fig. 7.2*) is the most reliable and best based of all interpretations given to date. I have therefore proposed the profile of Divje babe I as a stratotype of the Middle Würm in Slovenia (Turk 2006).

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[4] Long humid periods in sedimentary facies B are also characterised by finds of red-tooth shrew, a relatively large share of field voles within the group of *M. agrestis/arvalis* and a lot of forest voles, which also indicates the presence of forest (see Chapter 11 in this volume).

8. PALEOBOTANIČNE RAZISKAVE V DIVJIH BABAH I

METKA CULIBERG

Izvleček

Analizirali smo več kot 2.300 primerkov oglja iz najmanj 20 ognjišč. Oglje je bilo bodisi zgoščeno v ognjiščih oz. ognjiščnih jamah bodisi razpršeno po plasteh. Ugotovili smo stalno prisotnost gozda v srednjem glacialu (virmu) v obdobju od pribl. 80.000 do 40.000 let pred sedanjostjo. Poleg različnih iglavcev (*Pinus*, *Pinus* cf. *cembra*, *Abies*, *Picea*, *Larix*, *Taxus*, *Juniperus*) so v okolici najdišča uspevali tudi različni listavci (*Quercus*, *Acer*, *Ulmus*, *Carpinus*, *Carpinus-Ostrya*, *Fraxinus*, *Alnus*, *Sorbus, Clematis*), med njimi tudi bukev (*Fagus*). Prisotnost listavcev je omejena predvsem na toplejša obdobja glaciala, medtem ko so nekateri iglavci uspevali tudi v najhladnejših obdobjih, med drugim tudi v zgodnjem glacialnem vrhuncu. Poleg oglja smo v dveh ognjiščnih nivojih našli tudi nezoglenele in mineralizirane koščke lesa nedoločljivih iglavcev.

Ves čas arheoloških izkopavanj v jami Divje babe I, od leta 1980 pa do leta 1999, ko so bila ta končana, so vzporedno potekale tudi paleobotanične raziskave. Temeljile so predvsem na analizi oglja iz najmanj 20. ognjišč, plasti iz vhodnega dela jame pa so bile tudi palinološko analizirane[1]. Rezultate teh analiz predstavljata dva pelodna diagrama (Turk *et. al.* 1989–1989; Šercelj, Culiberg 1991). Drugih paleobotaničnih podatkov iz neposredne okolice najdišča ni.

Skupno je bilo analiziranih več kot 2.300 primerkov oglja, kar pa ni celotna vsebina zbranega oglja. Rezultate antrakotomskih analiz smo ves čas izkopavanj dopolnjevali in jih večji del tudi objavili (Turk *et al.* 1989; Šercelj, Culiberg 1985; 1991; Culiberg, Šercelj 1997; Paunović *et al.* 2002), vendar paleoekoloških razmer, kolikor jih je bilo mogoče razpoznati iz ugotovljenih taksonov, kronološko ni bilo mogoče opredeliti, ker stratigrafija in kronologija celotnega jamskega profila tedaj še nista bili dokončno izdelani. Sedaj je to mogoče in oglje bomo obdelali po plasteh (razpršeno oglje) in ognjiščih oz. ognjiščnih jamah (zgoščeno oglje). Oglja iz plasti 2–7, ki je že bilo obravnavano v knjigi "Moustérienska koščena piščal" (Culiberg, Šercelj 1997), ne bomo upoštevali. Natančnejši stratigrafski pregled drevesnih vrst, katerih les je služil za kurjavo, bomo podali na podlagi bloka sedimentov s prostornino 95 m^3 in sedimentacijskih nivojev (glej poglavje 1 v tem zborniku). Ognjišča in njihovo celotno vsebino bomo podrobneje obdelali v drugem delu monografije.

OGLJE V PLASTEH IN OGNJIŠČIH OZ. OGNJIŠČNIH JAMAH

Pregled razpršenega in zgoščenega oglja podajamo na konvencionalen način po plasteh, pri čemer se moramo zavedati, da je razvrščanje oglja, zlasti razpršenega, po plasteh močno odvisno od subjektivne presoje. Temu primerno je lahko nezanesljiva razlaga razvoja vegetacije in paleookolja na podlagi najdb oglja.

Oglje v plasteh 2–5

Analize oglja iz teh plasti so bile v glavnem objavljene že v monografiji o koščeni piščali (Culiberg, Šercelj 1997). Ker je bilo oglja iglastega drevja le nekaj primerkov, prevladovalo pa je oglje listavcev, predvsem jesena (*Fraxinus*) in bukve (*Fagus*), je bil že tedaj izražen dvom, da bi bilo to oglje pleistocenske starosti. Po pripovedovanju (sedaj že pokojnega) Ivana Pavšiča z Reke 13, naj bi bilo leta 1943 v jamo odneseno več kubičnih metrov bukovih desk, namenjenih za gradnjo partizanske bolnišnice, vendar so Nemci to opazili in deske v jami zažgali. Pri tem je nastalo precej bukovega oglja, ki je lahko kontaminiralo pleistocenske sedimente. Poznejša ^{14}C AMS datacija spornega bukovega oglja je to potrdila. Oglje iz plasti 2–3 (kv. 37, gl. –54 cm) je dalo starost 141 ± 27 BP (KIA19850), iz plasti 3–4 (kv. 31, gl. –54 cm) pa 103 ± 21 BP (KIA 19849). Ta rezultat se dobro približa omenjenemu dogodku, če upoštevamo še rastno dobo bukve. Do kontaminacije teh plasti z recentnim ogljem pa je prišlo zaradi bioturbacije oz. kopanja rovov, ki si jih delajo polhi v sedimente plasti 2 in 3 (glej Kryštufek 1997, 94 s).

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[1] Vzorci, ki so bili vzeti za pelodne analize v osrednjem delu jame (izkopavanja J. Dirjeca in I. Turka), večinoma niso dali zadovoljivih rezultatov. Zato jih ne bomo obravnavali v celoti, ampak zgolj posamič.

Oglje v plasti 4

Plast 4 je temneje obarvana, verjetno tudi zaradi velike količine mikroskopskih drobcev oglja, ki bi bili lahko sprani s površja, saj v njej ni bilo zoglenelih kosti, značilnih za vsa odkrita ognjišča in ognjiščne nivoje (glej *tab. 8.1*). Šlo bi torej za oglje, ki je nastalo zaradi požara v naravi. V celotni plasti 4 je bilo najdenih le 12 določljivih koščkov oglja, največ v kv. 48 in 48c. Od teh jih 5 pripada bukvi (*Fagus*) in 7 jelki (*Abies*). Listavci (bukev in jesen) so bili ugotovljeni tudi pri vhodu v jamo v Brodarjevem vzorcu (Šercelj, Culiberg 1991). Na podlagi sedimentnih analiz naj bi ta plast nastala v zmerno hladni in ne preveč vlažni klimi (glej podpoglavje 5.3 v tem zborniku, *sl. 5.3.6*), vendar se kljub temu postavlja vprašanje, ali ne gre morda tudi tu še za kontaminacijo z recentnim ogljem, kar bi lahko potrdili ali ovrgli s ^{14}C analizo spornega oglja listavcev.

Ognjišče v plasti 5 (kv. 28, 31. 39 in 40, gl. –165 cm)

To ognjišče je bilo obdelano v knjigi "Moustérienska koščena piščal" (Culiberg, Šercelj 1997; Turk, Kavur 1997).

Oglje v plasti 6

Tudi plast 6 je bila podobno kot plast 4 izrazito temneje obarvana, le da je v tem primeru temno siva barva verjetno posledica redukcijskega okolja in znatne količine organskih ostankov. V plasti je bilo več ognjišč, vendar njihovega števila in točne lokacije ni bilo mogoče ugotoviti zaradi slabe ohranjenosti, domnevno povezane s počasno sedimentacijo[2]. Oglje je bilo razpršeno okoli mest, kjer se je kurilo, poleg oglja pa je bilo najdenih tudi več kot 500 ožganih in kalciniranih kostnih fragmentov, ki so nesporen dokaz za kurjenje v jami. Brodarjeva izkopavanja so dala v tej plasti le dva drobca oglja jesena, lahko zaradi drugačne terenske tehnike, mogoče pa je tudi, da so se ljudje zaradi mraza zadrževali globlje v jami in ne pri vhodu, kot je bilo to običajno. Na podlagi zmrzlinskih klastov, agregatov in korozijskih tvorb Turk s sodelavci (poglavje 5 v tem zborniku) predvideva za plast 6 kratkotrajno mrzlo in suho klimo stadialnega značaja.

Oglje v plasti 6:

Pinus 35, *Picea* 21, *Abies* 53, *Larix* 6, *Taxus* 62, *Juniperus* 3, iglavec 24;

Fraxinus 2 (?), *Ulmus* 3, *Acer* 3, listavec 3.

Ognjišče v plasti 6 ali 7 (kv. 34a in 41a, gl. –249 cm do –261 cm)

Ognjišče v kvadratu 34a in delno 41a je bilo sicer slabo ohranjeno, vendar je pomembno, ker leži tik nad drugim ognjiščem sosednjega kvadrata 41a. Zbrana je bila le manjša količina oglja, v kateri so bili zastopani izključno iglasti taksoni. Od 19 analiziranih primerkov jih 11 pripada smreki (*Picea*). Ker je to iglavec, ki razmeroma dobro prenaša nizke temperature, po drugi strani pa je precej zahteven tako glede zračne vlage kot tudi letnih padavin, smemo sklepati na hladno, vendar vsaj nekoliko vlažnejšo klimo. Zelo verjetno pa je smreka tedaj uspevala v nižjih legah, morda celo blizu tekoče vode.

Oglje iz ognjišča:

Pinus 1, *Picea* 11, *Taxus* ? 1, *Juniperus* 2, iglavec 4, 18 ml ogljenih drobcev.

Ognjišče v zgornjem delu plasti 8 (kv. 41a, 48a in 41, gl. –273 cm)

Ognjišče s središčem v kv. 41a je bilo točno na nivoju piščali in od nje oddaljeno le 3 m. Zato ga lahko najzanesljiveje časovno povežemo z najdbo piščali. Na podlagi sedimentnih analiz bi lahko sklepali, da je bilo podnebje tedaj toplo in vlažno. Tudi generična sestava oglja iz tega ognjišča kaže na ugodnejše klimatske razmere. Prevladovali so iglavci, bilo pa je tudi nekaj primerkov oglja navadnega gabra (*Carpinu*s), jesena (*Fraxinus*), jerebike in/ali mokovca (*Sorbus*) in tudi bukve (*Fagus*). Čeprav gre za en sam primerek oglja bukve, je kontaminacija po mnenju I. Turka (ustno sporočilo) skorajda izključena, njeno prisotnost v tem času pa potrjuje tudi pelodna analiza (Culiberg, neobjavljeno). Pelod bukve je bil ugotovljen v treh vzorcih (gl. –257 cm, –272 cm in –283 cm) v dobrih 4 m oddaljenem profilu y = 2 m (x = 17 m) v neposredni bližini ESR-vzorcev RT8, RT10, RT11, RT12 in CT87, ki opredeljujejo starost ognjišča in piščali med 47.000 (necementirana plast 8, –272 cm) in 61.000 (cementirana plast 8, –257 cm)[3] pred sedanjostjo (glej poglavje 6 v tem zborniku, *tab. 6.4* in *sl. 6.2a*).

Oglje iz tega ognjišča je bilo močno impregnirano – mineralizirano, nekateri primerki so bili celo popolnoma okamneli in zato nedoločljivi. Bela snov, s katero je bila impregnirana večina oglja je zelo verjetno sekundarni kalcit, ki se je izločil v procesu cementacije sedimentov, kajti ognjišče je, čeprav necementirano, ležalo na cementiranem kompleksu plasti 8 (glej podpoglavje 5.3 v tem zborniku).

Oglje iz ognjišča:

Pinus 19, *Picea* 2, *Picea/Larix* 1, *Abies* 11, *Larix* 3, *Taxus* 10, *Juniperus* 1, iglavec 28; *Fagus* 1, *Carpinus* 1, *Fraxinus* 2(?), *Sorbus* 2, listavec 1.

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[2] Edino bolje ohranjeno ognjišče smo odkrili pri jemanju vzorcev za ESR-analize v profilu y = 2 m pri x = 17 m. Za ognjišče so značilni oglje smreke (6 koščkov) in macesna (6 koščkov) ter nezogleneli rastlinski ostanki.

[3] Do inverzne datacije in velikega odstopanja starosti je lahko prišlo zaradi zastoja v sedimentaciji in posamičnih navpičnih premikov izoliranih zob, ki so služili za določitev ESR-starosti.

Ognjišče v plasti 8a (kv. 20, gl. –261 cm do –273 cm)

Ob tem ognjišču je bila v breči najdena piščal. V ostanku ognjišča, ki je bilo prostorsko omejeno na en kvadratni meter, je bilo poleg več kot 500 ožganih kostnih fragmentov tudi oglje, za katerega je bila ugotovljena skoraj identična generična sestava s tisto v ognjišču v kvadratih 41a, 48a in 41 na globini –273 cm. Tudi tu so zastopani vsi iglasti taksoni, nekaj manj je bilo listavcev, prav tako pa je bil ugotovljen en primerek bukve. Več o ognjišču lahko bralec zve v knjigi "Moustérienska koščena piščal" (Culiberg, Šercelj 1997; Turk, Kavur 1997).

Oglje iz ognjišča:

Pinus 64, *Picea* 9, *Abies* 4, *Larix* 3, *Taxus* 11, *Juniperus* 1? (košček vgrajen v sigo), iglavec 33; *Fagus* 1, *Carpinus-Ostrya* 1.

Ognjišče v plasti 8b (kv. 13, 16 in 35, gl. –345 cm do –357 cm)

To je bilo najbolje ohranjeno paleolitsko ognjišče od vseh, ki so bila odkrita v Divjih babah I in sploh v Sloveniji (glej podpoglavje 12.5 v tem zborniku, *sl. 12.5.1*). Pomembno je, da je bilo v ognjišču in tudi okoli njega najdeno izključno oglje iglavcev. Oglje listavcev pa je bilo ugotovljeno v ognjiščih nad in pod njim. Precej primerkov oglja je bilo močno kalciniranih. Ognjišče pripada sedimentacijskima nivojema –333 cm in –345 cm, v katerih je bilo tudi več kot 1.800 zoglenelih in prav tako kalciniranih kostnih fragmentov (*tab. 8.1*). Na podlagi sedimentne analize se to ognjišče klimatostratigrafsko ujema z zelo mrzlo in vlažno klimatsko fazo. Tudi vegetacija na podlagi oglja kaže na takšne klimatske razmere. Podoben rezultat za ta del plasti 8 so dali že vzorci oglja Brodarjevih izkopavanj v vhodnem predelu (Šercelj, Culiberg 1991). Uspevala naj bi predvsem bor in smreka. Morda je nekoliko vprašljiva prisotnost jelke, vendar bi bila v tem primeru mogoča tudi napačna determinacija, saj je bilo oglje v veliko primerih težko določljivo zaradi močne kalcinacije. Pelod zeliščne vegetacije iz sedimenta, ki sestavlja tla ognjišča, pa kaže tudi na odprte travniške površine (Culiberg, neobjavljenao). Še posebej zanimivo je, da so bili v kemično obdelanem vzorcu ognjiščnih tal za pelodno analizo množično prisotni tudi mikroskopski drobci nezoglenelih rastlinskih tkiv in lesnih vlaken iglavcev. To zagotovo pomeni vnos svežega rastlinja v jamo, vprašanje je le, ali od človeka ali medveda. Ognjišču pripada tudi eden od skupno 10 koščkov nezoglenelega mineraliziranega lesa iglavca, v velikosti približno 1 x 0,5 x 0,5 cm, ki so bili najdeni v plasteh 8 in 6. Glede na ugotovljena dejstva in bližino izjemno ohranjenega ognjišča (glej podpoglavje 12.5 v tem zborniku, *sl.12.5.1*) so nezogleneli rastlinski ostanki zelo verjetno povezani z dejavnostjo človeka (prim. Kaminská *et al.* 2005).

Oglje iz ognjišča, vključno s sosednjimi kvadrati 10, 11, 14, 17, 19, 34 in 36:

Pinus 337, *Pinus* cf. *cembra* 6, *Picea* 111, *Larix* 72, *Larix-Picea* 5, *Abies* 30, *Taxus* 20, *Juniperus* 2, iglavec 196, nezogleneli iglavec 1.

Oglje v spodnjem delu plasti 8b

V spodnjem delu plasti 8b je bilo kar nekaj razpršenega oglja, za katerega se ni dalo ugotoviti, kateremu ognjišču pripada. Enako velja za redke zoglenele kostne odlomke. Prevladuje oglje iglavcev, in sicer bora, jelke, smreke, macesna in brina (*Pinus*, *Abies*, *Picea*, *Larix* in *Juniperus*), pojavlja pa se tudi oglje listavcev, in sicer bukve, jesena, jerebike in/ali mokovca (*Fagus*, *Fraxinus* in *Sorbus*), kar kaže na relativno toplo klimo. To se ujema z rezultati analize sedimentov, ki kažejo na tem odseku toplo in zelo vlažno klimo.

Oglje v spodnjem delu plasti 8b:

Pinus 17, *Picea* 20, *Abies* 17, *Larix* 10, *Juniperus* 3, *Fagus* 2, *Fraxinus* 2, *Sorbus* 4.

Oglje v plasti 8b-10

Plast 8b-10 predstavlja sediment na meji plasti 8b in 10[4], ki se ju ni dalo zanesljivo ločiti. V njej je bilo več razpršenega oglja, za katerega se ni dalo ugotoviti, kateremu ognjišču pripada. Zogleneli kostni odlomki so izjemno redki. Ker gre izključno za oglje iglavcev, in sicer bora, jelke, smreke, tise in brina (*Pinus*, *Abies*, *Picea*, *Taxus* in *Juniperus*), sklepamo na mrzlo klimatsko fazo, ki so jo predvidele tudi sedimentološke analize (glej podpoglavje 5.3, *sl. 5.3.6*). Kar je pri tem moteče, je močna prisotnost jelke.

Oglje v plasti 8b-10:

Pinus 4, *Picea* 2, *Abies* 20, *Taxus* 2, *Juniperus* 1, iglavec 3.

"Ognjišče" v plasti 10 (kv. 22, 23,25, 26 in 28, gl. –381 cm do –405 cm)

Med velikimi podornimi bloki je bila izrazita koncentracija oglja s središčem v kvadratu 25, za katero pa ni gotovo, ali predstavlja ostanek ognjišča *in situ* ali gre za presedimentirane ostanke. Mogoče bi bilo celo, da gre za dve ognjišči eno vrh drugega. To "ognjišče" pripada začetni fazi kisikove izotopske stopnje OIS 3 (= MIS 3), saj je le nekaj 10 cm globlje dobro določena meja med kisikovo izotopsko stopnjo OIS 4 (= MIS 4) in OIS 5 (= MIS 5), kjer se konča zgodnji glacial (virm) in se prične srednji.

Po sestavi oglja bi lahko sklepali, da to oglje pripada toplejši in vlažnejši klimatski fazi, na kar kaže oglje listavcev, še posebno bukve (*Fagus*), razmeroma dobro pa je bila zastopana tudi jelka (*Abies*). Podoben sestav

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[4] Plast 9 je bila ugotovljena samo pri vhodu v jamo.

oglja poznamo iz plasti 10 v vhodnem predelu jame (Šercelj, Culiberg 1991).

Oglje iz ognjišča:
Pinus 21, *Picea* 29, *Abies* 53, *Larix* 8, *Taxus* 3, *Juniperus* 2, iglavec 3, *Fagus* 2, *Acer* 1, *Sorbus* 3.

Oglje v plasteh 13–24

Ognjišča v plasteh 13–24, odkrita izključno v vhodnem predelu jame, datirajo v zgodnji glacial oz. zgodnji virm (glej poglavji 6 in 7 v tem zborniku). Meja med zgodnjim glacialom (virmom) in srednjim glacialom (virmom) je nekako med plastjo 12 in 13. V jami je v tem času prišlo do velikega udora stropa. Zato notranjost jame ni bila tako intenzivno poseljena kot vhodni del, kjer so bila tedaj in pred tem glavna ognjišča. Verjetno je bil vzrok za to tudi bolj blaga klima. Nasprotno pa so bila v hladnejšem in vlažnejšem srednjem glacialu ognjišča pretežno globlje v notranjosti jame.

Skoraj vse oglje so dala izkopavanja M. Brodarja, kajti le ta so segla globlje od plasti 13, žal pa so vzorci številčno skromni. Iz plasti 13 do 26 je bilo zbranih in opredeljenih le okoli 200 koščkov oglja (Šercelj, Culiberg 1991).

Izkopavanja v osrednjem delu jame so razkrila v plasteh iz končnega dela facije C (= konec zgodnjega virma) izključno oglje bora (*Pinus*), smreke (*Picea*) in macesna (*Larix*).

V ognjišču v plasti 19/20, ki smo ga odkrili pri jemanju vzorcev za ESR-analizo, je bilo oglje tako zdrobljeno, da ga ni bilo mogoče opredeliti.

Oglje v plasti 13:
Pinus 16, *Picea* 21.

Oglje v plasti 15:
Larix 2

NEZOGLENEL IN MINERALIZIRAN LES

V plasteh 6 (kv. 48a, 48b in 55b) in 8b (ognjišče v kv. 13, 16 in 35) je bilo skupaj najdenih tudi 10 nezoglenelih koščkov lesa, večinoma manjših od 1 cm (Paunović *et al.* 2002). Ker od vsega začetka nismo bili pozorni na takšne najdbe, ki so pričakovane v fosfatnem okolju (glej Pacher *et al.* 2004; Kaminská *et al.* 2005), smo zelo verjetno spregledali veliko nezoglenelega lesa, ki je zelo podoben večjim fosfatnim agregatom, ki jih je v sedimentih veliko. Zaradi močne mineralizacije je lesna struktura nerazločna, le v prečnem prerezu se dobro vidi, da les sestavljajo izključno traheide. Pri posameznih primerkih je bilo v tangencialni ravnini po obarvanju mogoče zaznati tudi nekaj krajših žarkov (2–3 celice), tu in tam tudi s smolnim kanalom. Križišča traheid in žarkov so bila večinoma poškodovana, v nekaj primerih bi bila lahko pinoidna. Vsi ti anatomski znaki kažejo, da gre izključno za les iglastega drevja, v nobenem primeru pa ni bilo mogoče zanesljivo determinirati genusa.

OGLJE V SEDIMENTACIJSKIH NIVOJIH

Za lažjo primerjavo različnih vrst podatkov in objektivnejšo prostorsko stratigrafijo je bil večinski del analiziranega oglja razvrščen tudi v t. i. sedimentacijske nivoje (*tab. 8.1*), ki so bili na predlog I. Turka združeni v dva večja sklopa, imenovana facija A in facija B (glej poglavje 1 in 5 v tem zborniku). Obe faciji skupaj zajemata kisikovo izotopsko stopnjo OIS 3 (= MIS 3), vendar jo delita na dva dela z različno klimatsko dinamiko (glej poglavja 5 do 7 v tem zborniku). Delitev sedimentov na prostorninsko utežene sedimentacijske nivoje je pokazala, da je pestrost drevesnih vrst v statistično značilni korelaciji s prostornino in kvadraturo raziskanega prostora. Več ko je kvadratov z ogljem, večja je pestrost drevesnih vrst ($r = 0,76$, $p < 0,05$).

Štirje sedimentacijski nivoji (–177 cm, –201 cm, –333 cm in –405 cm) pripadajo dobro ohranjenim ognjiščem, odkritim v različnih plasteh v bloku sedimentov s prostornino 95 m^3. Od teh ognjišč je samo ognjišče v sedimentacijskem nivoju – 177 cm (plast 5) brez satelitskih ognjišč. Ognjišča v drugih nivojih (plasti 6, 8 in 10) imajo svoje satelite bodisi v osrednjem predelu jame bodisi pri vhodu, kar skupaj s številčnejšimi paleolitskimi najdbami kaže na daljše ali pogostejše obiske jame. Razlika med naravo ognjiščnih nivojev se odslikava tudi v odnosu paleolitskih obiskovalcev do ostankov jamskega medveda, ki je v plasti 5 nekoliko drugačen kot v drugih plasteh z ognjišči (glej podpoglavje 12.5 v tem zborniku, *sl. 12.5.3b*).

Med facijama A in B obstajajo poleg kvantitativnih tudi kvalitativne razlike v vsebini oglja. Oglje v faciji B odslikava domnevno hladnejše in predvsem vlažnejše okolje. Tega prekinja faza, ki kaže toplejše okolje. V začetnem delu facije B so še vedno prisotni elementi (tople in suhe) zgodnjeglacialne klime (primerjaj oglje iz ognjišča v plasti 10 izkopavanj J. Dirjeca in I. Turka ter v plasti 13 Brodarjevih izkopavanj – Šercelj, Culiberg 1991).

Oglje v plasteh 2 do 4 je bilo močno razpršeno, v plasteh 5 do 8 pa v glavnem zgoščeno v ognjiščih oziroma v njihovi neposredni bližini. Zato je v teh plasteh tudi več oglja.

Značilna je odsotnost ognjišč oz. oglja v večjem delu facije A, ki tudi sicer ni ravno bogata z ogljem, vsebuje pa kar nekaj kosov paleolitskih artefaktov, ki so zgoščeni v plasti 4. Podobna slika je značilna za ves raziskani del jame (glej Turk, Kavur 1997). Oglja iz ognjišč dejansko ni od vključno plasti 4 (sedimentacijska nivoja –106 cm do –118 cm) do ognjišča v plasti 5 (sedimentacijski nivo –177 cm).

VEGETACIJA IN KLIMA

Večinski del paleobotaničnega materiala izhaja iz zgornjih plasti 2–13, ki so bile odkopane v precej večjem obsegu in tudi temeljiteje raziskane. Spodnje plasti so bile odkopane le v predelu vhodnega dela jame, oglje pa se je pobiralo brez spiranja in flotiranja sedimentov.

S spiranjem vsega odkopanega materiala zgornje serije plasti, predvsem pa s flotiranjem ognjiščnih sedimentov je bila v osrednjem predelu jame pridobljena velika količina oglja, kar neposredno dokazuje obstoj drevesne vegetacije v okolici jame, hkrati pa omogoča natančneje stratigrafsko opredeliti prisotnost človeka v jami in s tem povezanih drobnih paleolitskih najdb. In prav ognjišča so tista, ki dajo najverodostojnejšo sliko in časovno opredelitev vegetacije kakega krajšega časovnega obdobja. Ugotovljeni taksoni gotovo ne predstavljajo kakšne preference človeka do določene vrste lesa za kurjavo, saj je verjetno porabil vse, kar je našel v bližini. Nekatere vrste lesa, med katerimi sta bila zelo verjetno tudi les tise (*Taxus*) in brina (*Juniperus*), pa je najbrž uporabljal tudi v druge namene, o čemer bomo razpravljali v drugem delu monografije.

Drugače pa je z ogljem, ki je bilo razpršeno po površini plasti in izvira bodisi iz razkopanih ognjišč, morda pa tudi od požara v okolici jame. Zlasti tedaj, ko je bilo to oglje dalj časa na površju zaradi zastoja sedimentacije v domnevno najhladnejših obdobjih, je zaradi skeletnih tal in/ali krio- ter bioturbacijskih procesov lahko zašlo tudi do 50 cm pod površje. Zanesljivo to velja za plasti 2–5, ki so močno nagubane, pa tudi za nekatere druge plasti, kot kaže zastopanost zoglenelih kostnih drobcev v ognjiščnih in podognjiščnih sedimentacijskih nivojih (*tab. 8.1*). Zgornje, srednjeglacialne plasti so kontaminirane z recentnim ogljem listavcev, v tem primeru zaradi bioturbacije, kar je potrjeno tudi s ^{14}C-analizo. Zato natančnejša opredelitev klimatskih razmer glede na vsebino ugotovljenega rastlinskega materiala (tako oglja kot tudi peloda) v teh plasteh oziroma v sedimentacijskih nivojih gotovo ni povsem zanesljiva.

Sedimenti v vhodnem in osrednjem predelu jame so bili tudi pelodno analizirani (Šercelj, Culiberg 1991; Culiberg neobjavljeno) in kljub večinoma le sporadično ugotovljenemu pelodu, se rezultati pelodnih in antrakotomskih analiz večji del dobro ujemajo in dopolnjujejo. V nekaterih primerih pelodna analiza sicer kaže večjo vrstno pestrost, vendar je to razumljivo, saj oglje izvira predvsem od drevja, ki je uspevalo v bližini jame v zelo kratkem času, ko so ljudje kurili, medtem ko pelodna vsebina daje sliko vegetacije širšega in tudi bolj oddaljenega območja v bistveno daljšem obdobju.

V nadaljevanju bomo paleobotanično interpretirali profil od spodaj navzgor, tako kot so se odlagale plasti in si sledili posamezni dogodki. Pri tem se bomo oprli predvsem na oglje v t. i. sedimentacijskih nivojih (*tab. 8.1*), pomagali pa si bomo tudi z ogljem neposredno iz ognjišč.

Sedimentacijski nivoji v bloku sedimentov omogočijo objektiven in utežen količinsko-kakovostni pregled oglja v času na omejenem prostoru. Pomanjkljivost takega pregleda je, da ne upošteva vseh ugotovljenih taksonov, ker lahko izpadejo predvsem najredkejše najdbe oglja. V bloku sedimentov tako ni zastopano oglje hrasta (*Quercus* 1), topola in/ali vrbe (*Populus-Salix* 3) in srobota (*Clematis* 2). Oglje hrasta in srobota bi pripadalo sedimentacijskemu nivoju –249 cm, kjer so bili sicer ugotovljeni samo iglavci. Oglje topola in/ali vrbe je bilo najdeno v plasti 13 v vhodnem predelu jame in bi pripadalo sedimentacijskima nivojema –441 cm in –453 cm. Zaradi gravitacijskih premikov oglja in stopničenja, s katerim smo v sedimentacijskih nivojih sledili naklonu plasti, se oglje v t. i. ognjiščnih sedimentacijskih nivojih ne ujema povsem z ogljem v zaprtih ognjiščnih celotah. Paleoekološka razlaga, ki temelji izključno na najdbah oglja, bi bila najzanesljivejša, če bi upoštevala samo oglje, najdeno v ognjiščih. Žal se je ohranilo in našlo premalo ognjišč v različnih stratigrafskih nivojih, da bi bila takšna razlaga mogoča. Razlaga je nezanesljiva predvsem zaradi gravitacijskih premikov razpršenega oglja.

Najstarejši raziskani sedimenti v najdišču pripadajo kronoconi zgodnjega virma (würm) oz. zgodnjega glaciala. Predstavljajo jih plasti facije C od vključno plasti 13 navzdol. Sedimentološke raziskave so za facijo C ugotovile razmeroma toplo in suho klimo (glej poglavje 5 v tem zborniku). Ta facija klimatsko in kronološko nedvomno ustreza kisikovi izotopski stopnji OIS 5a–d (=MIS 5a–d) in njenim korelatom (glej poglavje 7 v tem zborniku). Interglacialni in starejši sedimenti za zdaj niso ustrezno raziskani.

Sicer skromne paleobotanične najdbe v plasteh facije C tako oglja kot peloda kažejo, da je v drevesni vegetaciji ves čas prevladoval bor (*Pinus*), v tem primeru ne zaradi hladne, temveč zaradi aridne klime. V obdobjih nekoliko večje vlažnosti se je boru najprej pridružila smreka (*Picea*) in tudi drugi iglavci (npr. *Larix*) ter listavci: jesen (*Fraxinus*), breza (*Betula*), jelša (*Alnus*), lipa (*Tilia*), topol (*Populus*) in drugi. Večkrat se pojavi tudi oglje ali pelod bukve (*Fagus*).

Kronocono srednjega virma predstavljata faciji A in B (plasti 2–12), ki se vzporejata s kisikovo izotopsko stopnjo OIS 3 (=MIS 3), za katero so značilna znatna klimatska nihanja, povezana s spremembami temperature in padavin (glej poglavji 6 in 7 v tem zborniku). Sedimenti, ki bi jih lahko pripisali kisikovi izotopski stopnji OIS 4 (=MIS 4) oz. zgodnjemu glacialnemu vrhuncu v začetku srednjega virma so slabo zastopani oz. prepoznavni. Medtem ko so sedimentološke raziskave za

Tab. 8.1: Določeni koščki oglja in zažgani kostni fragmenti, razvrščeni po sedimentacijskih nivojih na površini B (21 m^2, skupno 83 m^3 ali 33 nivojev po 2,5 m^3). Prvi štirje nivoji so s površine A (25 m^2, skupno 12 m^3 ali 4 nivoji po 3 m^3).
Tab. 8.1. Charcoal and burned bone fragments classified by sedimention level in area B (21 m^2, total 83 m^3 or 33 levels of 2.5 m^3 of sediment). The first four levels are from area A (25 m^2, total 12 m^3 or 4 levels of 3 m^3 of sediment).

Sedimentation level (cm)	Facies	Species representation
-20	A	***Ostrya***, ***Fraxinus*** **cf.** ***ornus***, ***Fagus***
-32	A	***Fraxinus***, ***Fagus***, *Pinus*
-44	A	***Carpinus***, ***Fraxinus***, ***Fagus***, *Picea*, *Abies*
-56	A	
-68	A	***Ostrya***, ***Fraxinus***, ***Fraxinus*** cf. ***ornus***, ***Fagus***, ***Acer***, *Pinus*
-81	A	***Fraxinus, Acer,*** Abies
-94	A	
-106	A	
-117	A	
-129	A	
-141	A	
-153	A	
-165	A	
-177***	A	**Deciduous**, *Pinus*, *Pinus cembra*, *Picea*, *Taxus*, *Juniperus*, conifer
-189	A	
-201***	A	***Ulmus***, **deciduous,** *Pinus*, *Picea*, *Abies*, *Taxus*?, *Juniperus*, conifer
-213	A	***Fraxinus***, ***Ulmus***, ***Acer***? **deciduous**, *Pinus*, *Picea*, *Abies*, *Taxus*, conifer
-225	A	*Pinus*, *Abies*, *Taxus*, conifer
-237	B	*Pinus*, *Picea*, *Taxus*, conifers
-249	B	*Pinus*, *Picea*, *Abies*, *Taxus*, conifers
-261	B	*Pinus*, *Picea*, *Abies*, *Taxus*, conifers
-273	B	***Carpinus-Ostrya***, *Pinus*, *Abies*, conifers
-285	B	**Deciduous**? *Pinus*, *Abies*
-297	B	*Abies*
-309	B	***Carpinus***, ***Fraxinus, Fagus,*** *Pinus*
-321	B	***Carpinus***, ***Fraxinus***, ***Fagus***
333***	B	***Carpinus*** **(3)**, ***Fagus*** **(1)**, *Pinus*, *Pinus* cf. *cembra*, *Picea*, *Larix*, *Abies*, *Taxus*, *Juniperus*, conifers
-345	B	***Alnus viridis*** **(3)**, *Pinus*, *Picea*, *Larix*, *Abies*, *Taxus*, conifers
-357	B	*Pinus*, *Pinus* cf. *cembra*, *Picea*, *Larix*, *Abies*, *Taxus*, *Juniperus*, conifer
-369	B	***Fraxinus***, *Pinus*, *Abies*
-381	B	***Sorbus***, ***Fagus***, *Pinus*, *Picea*, *Larix*, *Abies*
-393	B	*Pinus*, *Picea*, *Abies*, *Taxus*, *Juniperus*
405***	B	***Acer***, *Pinus*, *Picea*, *Larix*, *Abies*, *Taxus*, *Juniperus*
-417	B	***Sorbus***, *Pinus*, *Picea*, *Larix*
-429	B	*Pinus*, *Picea*, *Larix*
-441	C-1	***Sorbus***, ***Sorbus-Crataegus***, ***Alnus***, **deciduous**, *Pinus, Larix*
-453	C-1	
SUM	*A–C1*	***Sorbus***, ***Alnus***, ***Ostrya***, ***Carpinus***, ***Fraxinus***, ***Acer***, ***Ulmus***, ***Fagus***, *Pinus*, *Pinus cembra*, *Larix*, *Picea, Abies*, *Taxus*, *Juniperus*

*** Sedimentacijski nivo z ostanki ognjišča.
*** Sedimentation level with the remains of a hearth.

Tab. 8.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Determined pieces	Species (count)	Quadrats containing charcoal	Quadrat (count)	Burned bones (count)
-20	A	4	3	?	?	0
-32	A	4	3	42	1	0
-44	A	12	5	34, 35, 41	3	3
-56	A	0	0		0	0
-68	A	50	5	25, 28, 29, 31, 32, 40	6	0
-81	A	12	3	19, 22, 31, 39	4	1
-94	A	0	0		0	2
-106	A	0	0		0	1
-117	A	0	0		0	1
-129	A	0	0		0	1
-141	A	0	0		0	0
-153	A	0	0		0	0
-165	A	0	0		0	0
-177***	A	54	6	28, 31, 39, 40	4	2
-189	A	0	0		0	11
-201***	A	19	6	19, 20	2	222
-213	A	92	7	19, 20, 22, 23, 26, 31, 36, 37, 38	9	193
-225	A	22	3	36, 37	2	101
-237	B	4	3	13, 36, 38	3	53
-249	B	15	4	17, 34, 36	3	32
-261	B	93	4	20, 22, 36, 37	4	73
-273	B	23	3	20, 36	2	17
-285	B	7	2	17, 36, 37	3	15
-297	B	1	1	17	1	5
-309	B	18	4	**31***, 32, 37, 40	4	2
-321	B	3	3	31, 32	2	1
333***	B	261	9	13, 14, 16, 17, 19, 23, **31***, **32***, 34, 35	10	1467
-345	B	377	6	13, 14, 16, 17, **28***, 34, 35, 36, 37	9	349
-357	B	45	7	14, 16, 19, 34, 35, 36	6	103
-369	B	6	3	29, 31, 34, 36	4	2
-381	B	54	6	25, 26, 36, 38	4	0
-393	B	29	5	23, 25	2	1
405***	B	68	7	22, 23, 25, 28, 38	5	13
-417	B	64	4	22, 29, 37, 38	4	0
-429	B	25	3	13, 16, 25	3	0
-441	C-1	27	5	17, 19, 29, 36, 37	4	0
-453	C-1	0	0		0	1
SUM	*A–C1*	*1389*	*15*	*13, 14, 16, 17, 19, 20, 22, 23, 25, 26, 28, 29, 31, 32, 34, 35, 36, 37 , 38, 39, 40, 42*	*104*	*2672*

* Kvadrati, v katerih je bilo najdeno samo oglje listavcev.
* Quadrats where only charcoal of deciduous trees was found.

facijo B ugotovile večinoma zelo mrzlo in vlažno klimo, je bila klima v faciji A manj mrzla in bolj suha (glej poglavje 7 v tem zborniku, *sl. 7.2*).

Na meji facije C in B nakazuje kratko hladno in vlažno fazo prisotnost nekaterih iglavcev, kot so bor (*Pinus*), smreka (*Picea*) in macesen (*Larix*) (*tab. 8.1*). Morda je to le končna faza močnejšega hladnega sunka na prehodu zgodnjega virma v srednji virm, ko je v celoti izostala sedimentacija (glej poglavje 6 v tem zborniku). Kot kažejo raziskave sedimentov, se je temperatura postopno zniževala, vendar je razmeroma vlažna klima, ki je značilna za celotno obdobje facije B, ob rahlih otoplitvah še omogočala obstoj listavcev, celo bukve. Oglje bukve je bilo namreč ugotovljeno tudi v plasti 10, tj. nedvomno za zelo dobro določeno mejo med kronocono zgodnjega in srednjega virma, ki je nekako med plastema 12 in 13.

Zelo mrzlemu obdobju v času nastajanja plasti 8b-10, za katero je značilno izključno oglje iglavcev, kot so bor (*Pinus*), smreka (*Picea*), jelka (*Abies*), macesen (*Larix*) in tisa (*Taxus*) je sledila kratkotrajna, neizrazita otoplitev v spodnjem delu plasti 8b, v kateri se med ogljem ponovno pojavi bukev (*Fagus*), skupaj s še nekaterimi listavci, kot sta jesen (*Fraxinus*) in jerebika (*Sorbus*). Omenjena mrzla in toplejša faza sta osnovani predvsem na ugotovitvah analize sedimentov in bi ju bilo zelo težko prepoznati zgolj na podlagi ostankov oglja in favne (glej poglavje 7 v tem zborniku, *sl. 7.3*).

Sledilo je najhladnejše obdobje, ki mu pripada ognjišče v kvadratih 13,16 in 35 v sredini plasti 8b.

Tedaj sta uspevala pretežno bor in smreka. Morda je nekoliko vprašljiva prisotnost jelke, vendar bi bila v tem primeru mogoča tudi napačna determinacija, saj je bilo oglje v veliko primerih težko določljivo zaradi močne kalcinacije. Pelod zeliščne vegetacije pa kaže tudi na odprte travniške površine. Predvsem je zanimiva pelodna vsebina vzorca sedimenta iz steptane površine neposredno ob ognjišču (Culiberg neobjavljeno), kjer je bilo sicer malo peloda drevesne vegetacije (le po nekaj pelodnih zrn bora, smreke, macesna in brina ter pelod breze). Razmeroma veliko pa je peloda zeliščne vegetacije iz družin trav, nebinovk, ščetičevk, klinčnic, ostričevk, kobulnic in pelinov (Gramineae, Compositae, Dipsacaceae, Caryophyllaceae, Cyperaceae, Umbelliferae, *Artemisia*) ter spor praproti.

Sledila je dolgotrajna otoplitev, ki kronološko (60.000 – 50.000 let pred sedanjostjo) in drugače ustreza najdaljšemu interstadialu v srednjem virmu, prvemu izrazitemu interstadialu po mrzlem začetku srednjega virma (glej poglavji 6 in 7 v tem zborniku, *sl. 6.6b*; *7.2* in *7.3*). Tudi generična sestava oglja iz pripadajočih ognjišč v plasti 8a in zgornjem delu plasti 8 kaže na ugodnejše klimatske razmere. Prevladovali so iglavci, bilo pa je tudi nekaj primerkov oglja listavcev, kot so navadni gaber (*Carpinus*), navadni ali črni gaber (*Carpinus-Ostrya*), jesen (*Fraxinus*) in jerebika (*Sorbus*), posebej pa je treba omeniti bukev (*Fagus*). Čeprav gre za po en primerek oglja bukve v obeh ognjiščih, je kontaminacija po mnenju Turka (ustno sporočilo) skorajda izključena[5]. Prisotnost bukve v tem času pa potrjuje tudi pelodna analiza (Culiberg, neobjavljeno). Pelod bukve je bil ugotovljen v treh vzorcih v bližnjem profilu med –257 cm in –283 cm, poleg njega pa še pelod jelše (*Alnus*), leske (*Corylus*) in lipe (*Tilia*). Pomembno je tudi to, da je bil med favnističnimi najdbami v teh plasteh ugotovljen tudi polh (*Glis glis*) (glej poglavje 10 v tem zborniku). Te živali pa so zlasti vezane na listaste gozdove, saj so poglavitni del njihove prehrane prav semena in plodovi, med katerimi je gotovo dobrodošel tudi žir bukve.

Na koncu facije B in v začetku facije A je v štirih zaporednih sedimentacijskih nivojih (od –261 cm do –225 cm), ki predstavljajo najmanj 2.700 letno obdobje, izključno oglje iglavcev, in sicer bora (*Pinus*), smreke (*Picea*), jelke (*Abies*) in tise (*Taxus*), kar bi lahko kazalo na relativno hladno in vlažno klimo. To se ne ujema z razlago klime na podlagi raziskav sedimentov. Sredi tega kompleksa je bilo v sedimentih, ki stratigrafsko ustrezajo sedimentacijskemu nivoju –249 cm, najdeno oglje hrasta (*Quercus*) in srobota (*Clematis*), ki sta značilna za toplo klimo.

Najdaljše toplo obdobje srednjega virma v Divjih babah I se je končalo s kratko mrzlo in suho klimatsko fazo, vsaj tako kažejo raziskave sedimentov. To mrzlo fazo predstavlja plast 6 oz. sedimentacijski nivo –201 cm. Malo pred tem so se začeli odlagati sedimenti facije A.

Iz plasti 6 je bilo analiziranih 215 primerkov oglja, od katerih jih je zelo malo zajetih v sedimentacijskem nivoju. Od tega jih 95 odstotkov pripada iglastim taksonom, med katerimi je zastopanih večina indigenih vrst (*Pinus*, *Picea*, *Abies*, *Larix*, *Taxus* in *Juniperus*). Največ oglja pripada jelki (*Abies*) in tisi (*Taxus*), vendar je prav v tem primeru treba poudariti, da število primerkov oglja posameznih taksonov v plasteh ali v ognjiščih ni v nikakršni korelaciji s pogostnostjo dreves teh taksonov.

Ob tako pestri iglasti vegetaciji pa naj bi uspevali tu vsaj še listavci, kot so jesen (*Fraxinus*), brest (*Ulmus*) in javor (*Acer*). Te vrste, tako iglaste kot listaste, razmeroma dobro prenašajo hladnejše podnebne razmere, zagotovo pa ne, vsaj večina od njih, ekstremno hladne (stadialne) in še posebno ne suhe klime, kot jo kažejo rezultati sedimentološke analize (glej podpoglavje 5.3, *sl. 5.3.6*). Predvsem jelka in tudi smreka sta med zahtevnejšimi vrstami, kar zadeva vlago. Zato se postavlja vprašanje, ali je ugotovljena vsebina oglja sočasna, ali gre morda tudi tu za kontaminacijo iz sosednjih plasti zaradi zastoja v odlaganju sedimentov (glej poglavji 6 in 7 v tem zborniku) ali pa bi bile morda lahko vzrok težave

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[5] Pred najdbo bukovega oglja v ognjišču so med izkopavanji leta 1994 odstranili 4 režnje (16–19) sedimentov, debele skupaj 48 cm. Razdalja do najbližjega profila, iz katerega bi lahko padlo oglje, je znašala 3 m.

z umeščanjem oglja v plasti. Kajti takšna vegetacija bi bila značilnejša za nekoliko toplejše in vlažnejše podnebje, kakršno naj bi bilo, ko se je odlagala bodisi plast 5, bodisi plast 7.

Verodostojnejšo sliko, tako rekoč trenutno stanje vegetacije, pa nam pokaže vsebina oglja iz edinega relativno dobro ohranjenega ognjišča v kv. 34a in kv. 41a na meji plasti 6 in 7. V njem skoraj izključno prevladuje oglje iglavcev, kar . kaže izključno iglasto vegetacijo, ki povsem ustrezno mrzlim klimatskim razmeram med pribl. 50.000 in 46.000 leti pred sedanjostjo. Pomembno je, da smo v plasti 6 (=sedimentacijski nivo -201 cm in -213 cm) v neposredni bližini ognjišča našli 7 manjših močno mineraliziranih koščkov nezoglenelega lesa (velikosti približno 1 x 0,5 x 0,5 cm). Več kot to, da je les iglavcev, ni bilo mogoče določiti. Da se je les ohranil in mineraliziral, je moralo biti vlažno okolje, kakršno je verjetno tudi bilo v tistem času.

Ognjišče v spodnji polovici plasti 5 (= 5b) in pripadajoči sedimentacijski nivo -177 cm sta dala predvsem oglje iglavcev (*Pinus*, *Pinus cembra*, *Picea*, *Taxus*, *Juniperus*) in enega nedoločljivega listavca, kar kaže na relativno hladno in vlažno podnebje, ki smo ga z analizo sedimentov ugotovili šele za zgornji del plasti, medtem ko naj bi za čas ognjišča prevladovalo toplo in prej suho kot vlažno podnebje (glej podpoglavje 5.3, *sl. 5.3.6*).

V preostalih plasteh facije A je oglja in drugih makroostankov malo, ponekod sploh nič, kot je razvidno iz stratigrafskega pregleda najdb oglja v sedimentacijskih nivojih (*tab. 8.1*). Da so nekateri zaporedni sedimentacijski nivoji popolnoma brez oglja ni kriva odsotnost drevja, saj pelodna analiza kaže na obstoj iglavcev, bora in smreke. Tudi arheološki material kaže na prisotnost človeka v jami, ni pa sledov o kurjenju. Da 4.725 let (če en nivo predstavlja 675 let) sploh ne bi bilo drevesne vegetacije, je malo verjetno. V času nastanka plasti 4 je okolico jame prizadel velik požar, ki pa je lahko samo za krajši čas uničil gozd.

V zgornjih plasteh facije A med ogljem prevladujejo listavci, predvsem jesen (*Fraxinus*) in bukev (*Fagus*), bili pa so tudi redki primerki iglavcev. Radiokarbonska datacija oglja bukve je potrdila, da je recentno. Žal ni bilo datirano oglje nobenega iglavca. kajti pelodna analiza kaže drugačno sliko. V dveh pelodno analiziranih profilih, in sicer iz vhodnega dela jame (Šercelj, Culiberg 1991) in iz notranjosti (Culiberg neobjavljeno), je ves čas sicer sporadično prisoten pelod bora (*Pinus*) in smreke (*Picea*), izjemno veliko pa je peloda zeliščne vegetacije, predvsem nebinovk (Compositae) in trav ter spor alpske dresžice (*Selaginella selaginoides*), kar nedvomno kaže na odprto alpinsko vegetacijo, zagotovo pa je bilo prisotno tudi drevje. Alpinska vegetacija v plasti 4 se dobro ujema s hladno klimo pred pribl. 40.000 in več leti pred sedanjostjo, ugotovljeno na podlagi raziskav sedimentov in potrjeno z globalnim razvojem glacialne klime (glej poglavje 6 v tem zborniku, *sl. 6.7a, b*).

SKLEP

Vsekakor je najpomembnejša ugotovitev antrakotomskih in pelodnih raziskav v Divjih babah I, da je v srednjem virmu obstajal na območju najdišča gozd tudi v najbolj mrzlih klimatskih fazah. V ugodnejših klimatskih razmerah pa so uspevali različni listavci, vključno z bukvijo. Ugotovljene so bile skoraj vse glavne drevesne vrste, ki še danes uspevajo na tem območju. Zaprte najdbe oglja v ognjiščih kažejo sočasno rast različnih drevesnih vrst, predvsem iglavcev na območju najdišča. Razvoju gozdne in zeliščno-travniške vegetacije lahko prvič v Sloveniji dosti zanesljivo sledimo v 40.000 let dolgem obdobju srednjega virma (= OIS/MIS 3), od pribl. 80.000 do 40.000 let pred sedanjostjo. Rekonstrukcija paleookolja na podlagi rastlinskih ostankov se dokaj dobro ujema s sliko, ki so jo dale v istem najdišču raziskave sedimentov in favne (glej poglavja 5, 10 in 11 v tem zborniku). Posamezna neskladja lahko razložimo z naravo virov, ki je različna od vira do vira.

ZAHVALA

Hvaležna sem kolegu Ivanu Turku, ki mi je dal v uporabo izjemno bogato in dobro dokumentirano zbirko oglja iz najdišča Divje babe I. Zahvaljujem se mu tudi za izdatno pomoč pri stratigrafskem razporejanju vzorcev oglja in za koristne napotke pri pisanju tega poglavja, ki je plod najinega dolgoletnega sodelovanja na področju arheobotaničnih raziskav.

8. PALAEOBOTANICAL RESEARCH IN DIVJE BABE I

METKA CULIBERG

Abstract

We analysed more than 2,300 specimens of charcoal from at least 20 hearths. The charcoal was either concentrated in hearths or hearth hollows or scattered through the layers. We found a permanent presence of forest in the Middle Glacial (Middle Würm) in the period from approximately 80,000 to 40,000 years ago. In addition to different conifers (*Pinus*, *Pinus* cf. *cembra*, *Abies*, *Picea*, *Larix*, *Taxus*, *Juniperus*) various deciduous species grew in the vicinity of the site (*Quercus*, *Acer*, *Ulmus*, *Carpinus*, *Carpinus-Ostrya*, *Fraxinus*, *Alnus*, *Sorbus, Clematis*), including beech (*Fagus*). The presence of deciduous species is restricted mainly to the warmer periods of the glacial, while some conifers also thrived in the coldest periods, including during the early glacial maximum ("first pleniglacial"). In addition to charcoal, in two of the hearth levels we found non-carbonised and mineralised pieces of wood of unidentified conifers.

Parallel palaeobotanical research took place throughout the period of archaeological excavations in the cave Divje babe I, from 1980 to 1999, when they were completed. Investigations were based above all on the analysis of charcoal from at least 20 hearths, and the layers from the entrance part of the cave were also analysed palynologically[1]. The results of these analyses are presented in two pollen diagrams (Turk *et. al.* 1988–1989; Šercelj, Culiberg 1991). There is no other palaeobotanical data from the immediate vicinity of the site.

Altogether, we analysed more than 2,300 specimens of charcoal, although this was not all the charcoal that was collected. The results of anthracotomic analyses were supplemented throughout the period of excavation, and for the most part also published (Turk *et al.* 1989; Šercelj, Culiberg 1985, 1991; Culiberg, Šercelj 1997; Paunović *et al.* 2002), but palaeo-ecological conditions, insofar as it was possible to identify them from the identified taxa, could not be chronologically determined because the stratigraphy and chronology of the entire cave profile have not yet been completed. This is now possible and we will process the charcoal by layers (dispersed charcoal) and hearths or hearth hollows (concentrated charcoal). The charcoal from layers 2–7, which has already been dealt with in the book "Mousterien bone flute" (Culiberg, Šercelj 1997), will not be considered. A more exact stratigraphic review of tree species whose wood served for firewood, will be given on the basis of a block of sediments with a volume of 95 m^3 and sedimentation levels (see Chapter 1 in this volume). Hearths and their entire content will be covered in more detail in part 2 of this monograph.

CHARCOAL IN LAYERS AND HEARTHS OR HEARTH HOLLOWS

Examination of the scattered and concentrated charcoal was done in a conventional way by layers, whereby it is important to be aware that classification of charcoal, especially dispersed charcoal, by layers greatly depends on subjective judgment. An explanation of the development of vegetation and the palaeo-environment on the basis of finds of charcoal can thus be unreliable.

Charcoal in layers 2–5

Analyses of charcoal from these layers have for the most part already been published in the monograph on the bone flute (Culiberg, Šercelj 1997). Because there were only a few specimens of charcoal of coniferous trees, with charcoal of deciduous species predominating, mainly ash (*Fraxinus*) and beech (*Fagus*), the doubt was expressed that this could be charcoal of Pleistocene age. According to the late Ivan Pavšič from Reka 13, several cubic metres of beech planks were taken to the cave in 1943, intended for building a partisan hospital, but the Germans noticed it and burnt the planks in the cave. A considerable amount of beech charcoal was then created which could have contaminated the Pleistocene sediment. Later ^{14}C AMS dating of the contentious beech confirmed this. The charcoal from layers 2–3 (quad-

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[1] Samples that were taken for pollen analysis in the central part of the cave (excavations of J. Dirjec and I. Turk) did not for the most part give satisfactory results. We will not therefore discuss them in entirety but only individually.

rat 37, depth –54 cm) gave an age of 141 ± 27 BP (KIA19850), and from layers 3–4 (quadrat 31, depth –54 cm) 103 ± 21 BP (KIA 19849). This result well approximates to the aforementioned event if the growth period of beech is taken into account. Contamination of these layers with recent charcoal occurred because of bioturbation, or dormice excavating tunnels in the sediment of layers 2 and 3 (see Kryštufek 1997, 94 s).

Charcoal in Layer 4

Layer 4 is darkly coloured, probably also because of the large amount of microscopic particles of charcoal, which may have been washed from the surface above the cave since there were no charred bones in it characteristic of all hearths and hearth levels (see *Table 8.1*). It would therefore have been charcoal created because of fires in nature. In the entire Layer 4, only 12 identifiable pieces of charcoal were found, most in quadrats 48 and 48c. Of these, 5 belong to beech (*Fagus*) and 7 to fir (*Abies*). Deciduous species (beech and fir) were also found by the entrance to the cave in Brodar's sample (Šercelj, Culiberg 1991). On the basis of sediment analyses, this layer would have been formed in a moderately cold and not very humid climate (see sub-chapter 5.3 in this volume, *Fig. 5.3.6*), but this nevertheless raises the question of whether this was perhaps also contamination with recent charcoal, which ^{14}C analysis of the doubtful deciduous charcoal could confirm or refute.

Hearth in Layer 5 (quadrats 28, 31. 39 and 40, depth –165 cm)

This hearth was discussed in ”Mousterian bone flute” (Culiberg, Šercelj 1997; Turk, Kavur 1997).

Charcoal in Layer 6

Layer 6, like Layer 4, was specifically darker coloured, except that in this case the dark grey colour is probably a result of chemical reduction and a significant quantity of organic remains. There were several hearths in the layer, but their number and exact locations could not be established because of the poor state of preservation, presumably linked with low sedimentation rate[2]. The charcoal was dispersed around the places where they burnt and, in addition to charcoal, more than 500 charred and calcified bone fragments were found, providing indisputable evidence of the use of fire within the cave. Brodar's excavations gave only two fragments of charcoal of ash, perhaps because of the different fieldwork technique, but also possible to conclude that people kept deep in the cave because of the cold, and not at the entrance as was normal. On the basis of phosphate aggregates, frost shattered and corroded stones Turk *et al* (see Chapter 5 in this volume) envisage for Layer 6 a brief cold and dry climate of stadial character.

Charcoal in Layer 6:

Pinus 35, *Picea* 21, *Abies* 53, *Larix* 6, *Taxus* 62, *Juniperus* 3, coniferous 24;

Fraxinus 2 (?), *Ulmus* 3, *Acer* 3, deciduous 3.

Charcoal in Layer 6 or 7 (quadrats 34a and 41a, depth –249 cm to –261 cm)

The hearth in quadrat 34a and partially 41a was poorly preserved but it is important because it is located immediately above another hearth of neighbouring quadrat 41a. Only a small quantity of charcoal was collected, in which exclusively coniferous taxa were represented. Of the 19 analysed specimens, 11 belong to spruce (*Picea*). Since this is a conifer that withstands low temperatures relatively well, but is fairly demanding in terms of both air humidity and annual precipitation needs, a cold and at least slightly damper climate can be concluded. Spruce probably grew then at lower locations, perhaps even close to running water.

Charcoal from hearth:

Pinus 1, *Picea* 11, *Taxus* ? 1, *Juniperus* 2, coniferous 4, 18 ml charcoal fragments.

Hearth in upper part of Layer 8 (quadrats 41a, 48a and 41, depth –273 cm)

The hearth with centre in quadrat 41a was exactly on the level of the flute and only 3 m distant from it. We can therefore most reliably link it chronologically to the find of the flute. On the basis of sediment analyses, it can be concluded that the climate was then warm and humid. The generic composition of the charcoal from this hearth also indicates more favourable climatic conditions. Conifers predominated, and there were also some specimens of charcoal of hornbeam (*Carpinus*), ash (*Fraxinus*), rowan and/or whitebeam (*Sorbus*) as well as beech (*Fagus*). Although there is only a single specimen of beech charcoal, I. Turk (oral communication) believes that contamination can be almost entirely ruled out and its presence at this time is also confirmed by pollen analysis (Culiberg, unpublished). Beech pollen was found in three samples (depths –257 cm, –272 cm and –283 cm) in a good 4 m distant profile y = 2 m (x = 17 m) in the immediate vicinity of ESR-samples RT8, RT10, RT11, RT12 and CT87, which put the age of the hearth and flute between 47,000 (uncemented Layer 8, –272 cm) and 61,000 (cemented Layer 8, –257 cm)[3] years ago (see Chapter 6 in this volume, *Table 6.4* and *Fig. 6.2a*).

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[2] The only better preserved hearth was discovered when taking samples for ESR analysis in the profile y = 2 m at x = 17 m. The hearth is characterised by charcoal of spruce (6 pieces) and larch (6 pieces) and uncharred plant remains.

[3] Inverse dating and major deviation of age can occur because of a break in sedimentation and individual vertical movements of isolated teeth which served for determining ESR age.

The charcoal from this hearth was strongly impregnated – mineralised, some specimens were even fully fossilised and so unidentifiable. The white substance with which the majority of the charcoal was impregnated was probably secondary calcite, which was precipitated in the process of cementation of the sediments, since although the hearth is uncemented it lies just above the cemented complex of Layer 8 (see sub-chapter 5.3 in this volume).

Charcoal from hearth:
Pinus 19, *Picea* 2, *Picea/Larix* 1, *Abies* 11, *Larix* 3, *Taxus* 10, *Juniperus* 1, coniferous 28; *Fagus* 1, *Carpinus* 1, *Fraxinus* 2(?), *Sorbus* 2, deciduous 1.

Hearth in Layer 8a (quadrat 20, depth –261 cm do –273 cm)

The flute was found in brecchia beside this hearth. The remains of the hearth, which was spatially restricted to a single square meter, contained charcoal in addition to 500 charred bone fragments, for which an almost identical generic composition was found as that in quadrats 41a, 48a and 41 at a depth of –273 cm. All coniferous taxa are represented, there were slightly fewer deciduous species and, similarly, a single specimen of beech was found. There is more about the hearth in "Mousterian bone flute" (Culiberg, Šercelj 1997; Turk, Kavur 1997).

Charcoal from the hearth:
Pinus 64, *Picea* 9, *Abies* 4, *Larix* 3, *Taxus* 11, *Juniperus* 1? (piece inserted in flowstone), coniferous 33; *Fagus* 1, *Carpinus-Ostrya* 1.

Hearth in Layer 8b (quadrats 13, 16 and 35, depth –345 cm to –357 cm)

This was the best preserved Palaeolithic hearth of all discovered at Divje babe I and in Slovenia in general (see sub-chapter 12.5 in this volume, *Fig. 12.5.1*). It is significant that exclusively coniferous charcoal was found in and around the hearth. Deciduous charcoal was found in hearths above and below it. A considerable number of specimens of charcoal were strongly calcified. The hearth belongs to sedimentation levels –333 cm and –345 cm, in which more than 1,800 charred and also calcified bone fragments were found (*Table 8.1*). On the basis of sedimentation analysis, this hearth corresponds climatostratigraphically with a very cold and humid climatic phase. The vegetation, too, on the basis of charcoal indicates such climatic conditions. Samples of charcoal from Brodar's excavations at the entrance to the cave (Šercelj, Culiberg 1991) gave similar results for this part of Layer 8. Mainly pine and spruce grew. Perhaps the presence of fir is slightly doubtful, and mistaken identification could have occurred since in many cases the charcoal was difficult to identify because of strong calcification. Pollen of herbal vegetation from sediment which composed the living-floor around the hearth also indicates open grassland areas (Culiberg, unpublished). It is particularly interesting that the sample of hearth soil chemically processed for pollen analysis also contained large numbers of microscopic fragments of uncharred plant tissues and wood fibres of conifers. This certainly means the introduction of fresh plants into the cave, the only question is whether by people or cave bears. One out of a total 10 pieces of uncharred mineralised coniferous wood, approximately 1 x 0.5 x 0.5 cm in size which were found in layers 8 and 6, belongs to the hearth. In view of the established facts and the proximity of the extremely well preserved hearth (see sub-chapter 12.5 in this volume, *Fig.12.5.1*) the uncharred plant remains are probably connected with human activities (see Kaminská *et al.* 2005).

Charcoal from hearth, including neighbouring quadrats 10, 11, 14, 17, 19, 34 and 36:
Pinus 337, *Pinus* cf. *cembra* 6, *Picea* 111, *Larix* 72, *Larix-Picea* 5, *Abies* 30, *Taxus* 20, *Juniperus* 2, conifers 196, uncharred conifer 1.

Charcoal in the lower part of Layer 8b

There was quite some dispersed charcoal in the lower part of Layer 8b, which could not be assigned to a particular hearth. The same applies to the occasional charred bone fragments. Charcoal of conifers predominated: pine, fir, spruce, larch and juniper (*Pinus*, *Abies*, *Picea*, *Larix* and *Juniperus*), and charcoal of deciduous species also appears: beech, ash, rowan and/or whitebeam (*Fagus*, *Fraxinus* and *Sorbus*), which indicates a relatively warm climate. This corresponds with the results of sediment analysis, which show a warm and very humid climate in this segment.

Charcoal in lower part of Layer 8b:
Pinus 17, *Picea* 20, *Abies* 17, *Larix* 10, *Juniperus* 3, *Fagus* 2, *Fraxinus* 2, *Sorbus* 4.

Charcoal in Layer 8b-10

Layer 8b-10 represents sediments on the boundary between layers 8b and 10[4], which cannot be reliably distinguished. There was a good deal of dispersed charcoal in it which could not be assigned to particular hearths. Charred bone remains are extremely rare. Since this is exclusively coniferous charcoal, pine, fir, spruce, yew and juniper (*Pinus*, *Abies*, *Picea*, *Taxus* and *Juniperus*), we conclude a cold climatic phase, which is also suggested by sedimentological analysis (see sub-chapter 5.3, *Fig. 5.3.6*). What is not in accordance in this is the strong presence of fir.

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[4] Layer 9 was only found at the entrance to the cave.

Charcoal in Layer 8b-10:
Pinus 4, *Picea* 2, *Abies* 20, *Taxus* 2, *Juniperus* 1, coniferous 3.

"Hearth" in Layer 10 (quadrats 22, 23,25, 26 and 28, depth –381 cm to –405 cm)

Among large rockfall blocks there was an explicit concentration of charcoal centred on quadrat 25, for which it was uncertain whether it was the remains of a hearth *in situ* or re-sedimented remains. It is possible even that it is two hearths, one on top of the other. This "hearth" belongs to the start of OIS 3 (= MIS 3), since only some 10 cm deeper there is a well defined boundary between OIS 4 (= MIS 4) and OIS 5 (= MIS 5), where the Early Glacial (Early Würm) ends and the Middle Glacial (Middle Würm) commences.

In terms of composition, this charcoal can be concluded to have belonged to a warmer and more humid climatic phase, as is indicated by the charcoal of deciduous species, especially beech (*Fagus*), and fir (*Abies*) was also relatively well represented. A similar composition of charcoal was found in Layer 10 at the entrance part of the cave (Šercelj, Culiberg 1991).

Charcoal from hearth:
Pinus 21, *Picea* 29, *Abies* 53, *Larix* 8, *Taxus* 3, *Juniperus* 2, coniferous 3, *Fagus* 2, *Acer* 1, *Sorbus* 3.

Charcoal in layers 13–24

Hearths in layers 13–24, discovered exclusively in the entrance part of the cave, date to the Early Glacial or Early Würm (see Chapters 6 and 7 in this volume). The boundary between the Early Glacial (Würm) and Middle Glacial (Würm) is somewhere between layers 12 and 13. A major collapse of the roof occurred in the cave at that time. The interior of the cave was not therefore as intensively settled as the entrance part, where then and previously the main hearths were located. The milder climate was also probably a contributory factor. In contrast, the hearths were mainly deeper within the cave during the colder and damper Middle Glacial.

Almost all the charcoal came from M. Brodar's excavations, since only these went deeper than Layer 13, but unfortunately samples were numerically modest. Only around 200 pieces of charcoal were collected and identified from layers 13 to 26 (Šercelj, Culiberg 1991).

Excavations in the centre of the cave revealed exclusively charcoal of pine (*Pinus*), spruce(*Picea*) and larch (*Larix*) in layers from the final part of facies C (= end of the Early Würm).

In a hearth in Layer 19/20, which we discovered when taking samples for ESR analysis the charcoal was so pulverised that it could not be identified.

Charcoal in Layer 13:
Pinus 16, *Picea* 21.

Charcoal in Layer 15:
Larix 2

UNCHARRED AND MINERALISED WOOD

In layers 6 (quadrats 48a, 48b and 55b) and 8b (hearth in quadrats 13, 16 and 35), a total of 10 uncharred pieces of wood was found, for the most part smaller than 1 cm (Paunović *et al.* 2002). Since we had not been attentive from the very start to such finds, which are expected in a phosphate environment (see Pacher *et al.* 2004; Kaminská *et al.* 2005), we probably overlooked a great deal of uncharred wood, which is very similar to larger phosphate aggregates, of which there are a lot in the sediments. Because of the strong mineralization, the wood structure is indistinct, only in transverse cross-section can it be well seen that the wood consists exclusively of tracheids. It was also possible in the case of individual specimens to make out some short rays (2–3 cells) by means of the colouring on the tangential section, here and there also with resin channel. The crossing points of tracheids and rays were for the most part damaged, in some cases they could have been pinoid. All the anatomical signs indicate exclusively coniferous wood, but in no case can the genus be reliably determined.

CHARCOAL IN THE SEDIMENTATION LEVELS

For easier comparison of the different types of data and more objective spatial stratigraphy, the majority of the analysed charcoal was also classified into 'sedimentation levels' (*Tab. 8.1*) which, at the suggestion of I. Turk, were combined into two larger complexes, called facies A and facies B (see Chapter 5 in this volume). The two facies together embrace OIS/MIS 3, but they divide it into two parts with very different climatic dynamics (see Chapters 5 to 7 in this volume). The division of the sediments into volumetrically weighted sedimentation levels showed that the variety of tree species is in statistically characteristic correlation with the volume and area of the investigated space. The more quadrats with charcoal, the greater the diversity of tree species ($r = 0.76$, $p < 0.05$).

Four sedimentation levels (–177 cm, –201 cm, –333 cm and –405 cm) have well preserved hearths discovered in various layers in a block of sediments with a volume of 95 m^3. Of these hearths, only the one in sedimentation level – 177 cm (Layer 5) is without satellite hearths. Hearths in other levels (layers 6, 8 and 10) have their own satellites either in the central part of the cave or at the entrance, which together with the more numerous Palaeolithic finds indicates longer or more frequent visits to the cave. The difference between the nature of hearth levels is also reflected in the relation of Palaeolithic visitors to the remains of cave bear, which is slightly different in Layer 5 than in other layers with hearths (see sub-chapter 12.5 in this volume, *Fig. 12.5.3b*).

There are qualitative as well as quantitative differences in the charcoal content between facies A and B. Charcoal in facies B reflects a presumed colder and above all damper environment. This is broken by a phase which indicates a warmer environment. At the beginning part of facies B, elements of the (warm and dry) early glacial climate are still present (compare charcoal from the hearths in Layer 10 of the excavations of J. Dirjec and I. Turk and in Layer 13 of Brodar's excavations – Šercelj, Culiberg 1991).

Charcoal in layers 2 to 4 was strongly dispersed, and in layers 5 to 8 for the most part concentrated in hearths or in their immediate vicinity. There is therefore more charcoal in these layers.

The absence of hearths or charcoal in the greater part of facies A is characteristic, which although not very rich in charcoal contains several specimens of Palaeolithic artefacts, which are concentrated in Layer 4. A similar picture is characteristic of all the investigated central part of the cave (see Turk, Kavur 1997). There is actually no charcoal from hearths from Layer 4 inclusive (sedimentation levels –106 cm to –118 cm) to the hearth in Layer 5 (sedimentation level –177 cm).

VEGETATION AND CLIMATE

The majority of the palaeobotanical material came from the upper layers 2–13, which were excavated to a considerably greater extent and also thoroughly investigated. The lower layers were only excavated in the entrance part of the cave, and the charcoal collected without rinsing and floating the sediments. By washing all the excavated material of the upper series of layers, and above all floating the hearth sediments, a large quantity of charcoal was obtained in the central part of the cave, which directly shows the existence of tree species in the vicinity of the cave and, at the same time, enables more precise stratigraphic determination of the presence of humans in the cave and the associated Palaeolithic artefacts. Precisely hearths provide the most authentic picture of the vegetation and its chronological position in a short time period. The taxa found certainly do not suggest any kind of human preference for certain types of wood for burning, since they probably used everything found in the vicinity. Some species of wood, including yew (*Taxus*) and juniper (*Juniperus*), was probably also used for other purposes, which will be discussed in part 2 of this monograph.

It is different with charcoal that was dispersed over the surface of the layer and derives either from reworked hearths or perhaps from fires in the vicinity of the cave. Especially when this charcoal was on the surface for an extended period because of a break of sedimentation in the presumed coldest periods, it could penetrate up to 50 cm below the surface because of the skeletal soil and/or cryo- and bioturbation processes. This certainly applies to layers 2–5, which are strongly folded, as well as for some other layers, as is shown by the representation of charred bone fragments in hearths and below hearth sedimentation levels (*Tab. 8.1*). The upper, Middle Glacial layers are contaminated by recent deciduous charcoal, in this case because of bioturbation, which is also confirmed by ^{14}C-analysis. More precise determination of climatic conditions in relation to the content of the plant material found (both charcoal and pollen) in these layers or in sedimentation levels is certainly not entirely reliable.

Sediments in the entrance and central part of the cave were also subjected to pollen analysis (Šercelj, Culiberg 1991; Culiberg unpublished) and despite the mostly only sporadically found pollen, the results of pollen and anthracotomical analyses for the most part well corresponded and complemented each other. In some cases pollen analysis shows greater species variety, which is understandable since the charcoal comes from trees which grew in the vicinity of the cave for a very short period when people were having fires, while the pollen content gives a picture of the vegetation of the wider and also more distant region over a significantly longer time period.

Below we interpret palaeobotanically the profile from below upwards, just as the layers were deposited, and trace individual events. This will rely mainly on charcoal in sedimentation levels (*Tab. 8.1*), assisted by charcoal obtained directly from hearths.

Sedimentation levels in a block of sediments enable an objective and weighted quantity and quality examination of charcoal in time in a restricted space. The deficiency of such an examination is that it does not take into account all the established taxa, because mainly the rarest finds of charcoal may be omitted. In the block of sediments, thus, charcoal of oak (*Quercus* 1), poplar and/or willow (*Populus-Salix* 3), cotoneaster (*Cotoneaster* 2) and clematis (*Clematis* 2) is not represented. Charcoal of oak and clematis would belong to sedimentation level –249 cm, where only conifers were found. Charcoal of poplar and/or willow was found in Layer 13 in the entrance part of the cave and would belong to sedimentation levels –441 cm and –453 cm. Charcoal of cotoneaster was found in Layer 10 in the entrance part of the cave and would belong to sedimentation level –405 cm. Because of gravitational movement of charcoal and the gradation by which the inclination of the layers in the sedimentation levels was established, the charcoal in the hearth sedimentation levels does not entirely correspond to the charcoal in the closed hearth entireties. A palaeo-ecological explanation which is based exclusively on finds of charcoal would be most reliable if we took into account only charcoal found in hearths. Unfortunately, too few hearths have been preserved and found in the different stratigraphic levels for such an interpretation to be possible. The interpretation could be unreliable mainly because of the gravitational movements of the dispersed charcoal.

The oldest investigated sediments at the site belong to the chronozone of the Early Würm or Early Glacial. They are represented in the layers of facies C from Layer 13 inclusive downwards. Sedimentological investigation established a relatively warm and dry climate for facies C (see Chapter 5 in this volume). This facies undoubtedly corresponds climatically and chronologically to OIS 5a–d (=MIS 5a–d) and its correlations (see Chapter 7 in this volume). Interglacial (Riss/Würm) and older sediments have not to date been adequately studied.

The modest palaeobotanical finds in the layers of facies C, of both charcoal and pollen, show that pine (*Pinus*) predominated in the tree vegetation throughout, in this case not because of the cold but because of the arid climate. In the period of slightly greater humidity, pine is first joined by spruce (*Picea*) and other conifers (e.g., *Larix*) and deciduous species: ash (*Fraxinus*), birch (*Betula*), alder (*Alnus*), lime (*Tilia*), poplar (*Populus*) and others. Charcoal or pollen of beech (*Fagus*) also appears several times.

The chronozone of the Middle Würm is represented by facies A and B (layers 2–12), which correspond to OIS 3 (=MIS 3), for which marked climatic oscillations connected with changes in temperature and precipitation (see Chapters 6 and 7 in this volume). Sediments which could be ascribed to OIS 4 (=MIS 4) or the early glacial maximum at the start of the Middle Würm are poorly represented or recognised. While sedimentological research found for the most part a very cold and humid climate for facies B, the climate in facies A was less cold and drier (see Chapter 7 in this volume, *Fig. 7.2*).

On the boundary of facies B and C, a short cold and humid phase is indicated by the presence of some conifers such as pine (*Pinus*), spruce (*Picea*) and larch (*Larix*) (*Table 8.1*). Perhaps this is only the final phase of a stronger cold spell at the transition from the Early Würm to the Middle Würm, when there was a complete absence of sedimentation (see Chapter 6 in this volume). As study of sediments shows, the temperature gradually fell, although the relatively humid climate which is typical of the entire period of facies B, together with slight warmings, enabled the existence of deciduous species, even beech. Charcoal of beech was also found in Layer 10, undoubtedly above a very well defined boundary between the chronozones of the Early and Middle Würm, which is between layers 12 and 13.

The very cold period at the time of formation of Layer 8b-10, characterised exclusively by conifers such as pine (*Pinus*), spruce (*Picea*), fir (*Abies*), larch (*Larix*) and yew (*Taxus*) was followed by a short, unpronounced warming in the lower part of Layer 8b, in which beech (*Fagus*) appears among the deciduous species, together with others such as ash (*Fraxinus*) and whitebeam (*Sorbus*). The aforementioned cold and warm phases are based mainly on findings from analyses of the sediments and would be very difficult to recognise only on the basis of remains of charcoal and fauna (see Chapter 7 in this volume, *Fig. 7.3*).

It was followed by the coldest period, to which the hearths in quadrats 13, 16 and 35 in the centre of Layer 8b belong.

Pine and spruce predominately grew at that time. The presence of fir is perhaps slightly questionable, and a mistaken determination is possible since the charcoal was difficult to identify in many cases because of strong calcification. The pollen of herbal vegetation also indicates open grassland. Above all the pollen content of the sample of sediment from trampled areas immediately beside hearths (Culiberg unpublished), where there was little pollen of tree vegetation (only a few grains of pollen each of pine, spruce, larch and juniper and pollen of birch). However, there was relatively a lot of pollen of herbal vegetation from the families of Gramineae, Compositae, Dipsacaceae, Caryophyllaceae, Cyperaceae, Umbelliferae, *Artemisia* and spores of fern.

A lengthy warming followed, which corresponds chronologically (60,000–50,000 years ago) and otherwise to the longest interstadial in the Middle Würm, the first pronounced interstadial after the cold start to the Middle Würm (see Chapters 6 and 7 in this volume, *Fig. 6.6b*; *7.2* and *7.3*). The generic composition of charcoal from associated hearths in Layer 8a and the upper part of Layer 8 indicate more favourable climatic conditions. Conifers predominate but there were also some specimens of deciduous species such as hornbeam (*Carpinus*), hornbeam or hop-hornbeam (*Carpinus-Ostrya*), ash (*Fraxinus*) and whitebeam (*Sorbus*), and beech (*Fagus*) in particular must be mentioned. Although there is only one specimen of beech in each hearth, in the opinion of I. Turk (oral communication) contamination is almost impossible[5]. The presence of beech at that time is also confirmed by pollen analysis (Culiberg, unpublished). Beech pollen was found in three samples in a nearby profile at –257 cm and –283 cm, and there was additionally alder (*Alnus*), hazel (*Corylus*) and lime (*Tilia*). It is significant that faunistic finds in these layers include dormouse (*Glis glis*) (see Chapter 10 in this

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[5] Before the find of beech charcoal in a hearth, during excavations in 1994, 4 cuts (16–19) of sediments, a total of 48 cm thick were removed. The distance to the nearest profile from which the charcoal could fall was 3 m.

volume). These animals were bound especially to deciduous forest, since the main part of their diet consists of seeds and fruits, of which beech mast would certainly be a very welcome element.

At the end of facies B and start of facies A in four successive sedimentation levels (from –261 cm to –225 cm), which represent at least 2,700 years, there is exclusively coniferous charcoal: pine (*Pinus*), spruce (*Picea*), fir (*Abies*) and yew (*Taxus*), which could indicate a relatively cold and humid climate. This does not however correspond to the interpretation of climate on the basis of research of sediments. In the middle of this complex in sediments which stratigraphically correspond to sedimentation level –249 cm, charcoal of oak (*Quercus*) and clematis (*Clematis*) was found, which are characteristic of a warm climate.

The longest warm period of the Middle Würm in Divje babe I ended with a short cold and dry climatic phase, at least as indicated by study of sediments. This cold phase is represented by Layer 6 or sedimentation level –201 cm. Deposition of the sediments of facies A began a little before then.

Analysis of 215 specimens of charcoal from Layer 6 was performed, very few of which are represented in the sedimentation level. Ninety-five percent of these belong to coniferous taxa, for the most part indigenous species (*Pinus*, *Picea*, *Abies*, *Larix*, *Taxus* and *Juniperus*). The most charcoal belongs to fir (*Abies*) and yew (*Taxus*), but it must be stressed here particularly that the number of specimens of charcoal of individual taxa in layers or in hearths does not in any way correlate with the frequency of trees of such taxa.

Together with such a variety of coniferous vegetation, at least some deciduous species must have thrived, such as ash (*Fraxinus*), birch (*Ulmus*) and maple (*Acer*). These species, both coniferous and deciduous, at least the majority of them, survive colder climatic conditions relatively well but certainly not extreme cold (stadial) and especially not a dry climate, as shown by the results of sedimentological analysis (see sub-chapter 5.3, *Fig. 5.3.6*). Fir above all, but also spruce, are among the most demanding species in terms of moisture. The question is therefore raised whether the ascertained content of the charcoal is contemporary, or whether there is also here contamination from neighbouring layers because of a break in the deposition of sediments (see Chapters 6 and 7 in this volume) or could perhaps the cause be the difficulty of assigning the charcoal to a layer; since such vegetation was more characteristic of a somewhat warmer and damper climate, such as there was when Layer 5 and Layer 7 were deposited.

A more authentic picture of the contemporary state of vegetation is given by the content of charcoal from the only relatively well preserved hearth in quadrat 34a and quadrat 41a, on the boundary of Layers 6 and 7. Coniferous charcoal almost exclusively predominates, which indicates exclusively coniferous vegetation, fully corresponding to the cold climatic conditions between approximately 50,000 and 46,000 years ago. It is significant that in Layer 6 (=sedimentation levels –201 cm and –213 cm) in the immediate vicinity of a hearth, seven smaller greatly mineralised pieces of uncharred wood were found (approximately 1 x 0.5 x 0.5 cm). It was not possible to determine more than that it was coniferous. There had to have been a damp microenvironment for the wood to have been preserved and mineralised, such as there probably was at that time.

The hearth in the lower half of Layer 5 (= 5b) and associated sedimentation level –177 cm gave mainly charcoal of conifers (*Pinus*, *Pinus cembra*, *Picea*, *Taxus*, *Juniperus*) and one unidentified deciduous species, which indicates a relatively cold and humid climate, which we only established by sediment analysis for the upper part of the layer, while for the period of the hearth a warm and more dry than humid climate is supposed to have prevailed (see sub-chapter 5.3, *Fig. 5.3.6*).

In the remaining layers of facies A, the charcoal and other macro-remains are few, in places none at all, as is evident from the stratigraphic review of the finds of charcoal in the sedimentation levels (*Tab. 8.1*). That some successive sedimentation levels are completely without charcoal is not the fault of an absence of trees, since pollen analysis indicates the existence of conifers, pine and spruce. The archaeological material, too, indicates the presence of man in the cave but not traces of burning. That there was no tree vegetation for 4,725 years (if one level represents 675 years) is very unlikely. At the time that Layer 4 was deposited, a major fire afflicted the vicinity of the cave, but which would only have destroyed the forest for a short time.

In the upper layers of facies A, deciduous species predominate among the charcoal, mainly ash (*Fraxinus*) and beech (*Fagus*), but there were also occasional specimens of conifers. Radiocarbon dating of the beech charcoal confirmed that it is recent. Unfortunately, none of the charcoal of conifers was dated, since pollen analysis shows a different picture. In the two pollen analysed profiles, from the entrance part of the cave (Šercelj, Culiberg 1991) and from the interior (Culiberg unpublished), there is the sporadic presence of pine (*Pinus*) and spruce (*Picea*) throughout, and there is also a great deal of pollen of herbal vegetation, above all Compositae and grasses and the spores of lesser clubmoss (*Selaginella selaginoides*), which undoubtedly indicates an open, alpine vegetation, and certainly trees would also have been present. The alpine vegetation in Layer 4 corresponds well with the cold climate approximately 40,000 and more years ago established on the basis of analysis of sediments and confirmed by the global development of glacial climate (see Chapter 6 in this volume, *Fig. 6.7a, b*).

CONCLUSION

The most important finding of the anthracotomical and pollen research in Divje babe I is certainly that during the Middle Würm forest remained in the vicinity of the site even in the coldest climatic phases. In more favourable climatic conditions, various deciduous species thrived, including beech. Almost all the main tree species were found that grow today in this region. Closed finds of charcoal in hearths show the contemporary growth of various tree species, mainly conifers in the region of the site. The development of forest and herbal grassland vegetation can be reliably traced for the first time in Slovenia over a 40,000 year period of the Middle Würm (= OIS/MIS 3), from approximately 80,000 to 40,000 years ago. Reconstruction of the palaeo-environment on the basis of plant remains corresponds fairly well with the picture obtained at the same site by investigation of sediments and fauna (see Chapters 5, 10 and 11 in this volume). Individual discordances can be explained by the nature of sources, which differs from source to source.

ACKNOWLEDGEMENT

I am grateful to my colleague Ivan Turk, who provided me with the extremely rich and well documented collection of charcoal from the Divje babe I site. I am also grateful to him for substantial help in the stratigraphic disposition of the samples of charcoal and for the useful directions in writing this chapter, which is the fruit of our many years of cooperation in the area of archaeobotanical research.

9. FOSILNI OSTANKI AVIFAVNE IZ DIVJIH BAB I

VESNA MALEZ

V paleolitskem najdišču Divje babe I v dolini Idrijce pod Šebreljsko planoto so bili v času dolgoletnih sistematičnih izkopavanj (Turk *et al.* 1989b, 2001, 2002b, 2003a) najdeni tudi številni skeletni ostanki ptic (*tab. 9.1*). Ostanke avifavne, ki so bili zelo redko posejani v sedimentih, smo določili s pomočjo recentnega primerjalnega avifavnističnega gradiva Zavoda za paleontologijo in geologijo kvartarja HAZU v Zagrebu (*Zavod za paleontologiju i geologiju kvartara Hrvatske akademije znanosti i umjetnosti*) (Malez 1997b). Skeletne ostanke sestavlja 57 kosti, od katerih je 27 popolnoma ohranjenih, preostalih 30 pa so proksimalni ali distalni deli. Velika bočna in navpična razpršenost ostankov avifavne v najdišču je dala naslednje izsledke.

Taksonomsko opredeljivih je bilo 56 kosti. Določili smo osemnajst ptičjih vrst, ki pripadajo šestnajstim rodovom iz dvanajstih družin. Dva kostna ostanka smo lahko določili do rodu, dva pa sta ostala neopredeljena.

Družina: Accipitridae (kragulji)
Rod: Haliaeetus (belorepi orli ali jezerci)
Vrsta: *Haliaeetus* cf. *albicilla* - belorepec ali postojna

Družina: Accipitridae (kragulji)
Rod: Buteo (kanje)
Vrsta: *Buteo buteo* – navadna kanja ali mišar

Družina: Falconidae (sokoli)
Rod: Falco (sokoli)
Vrsta: *Falco tinnunculus* – navadna postovka

Družina: Tetraonidae (gozdne kure)
Rod: Lagopus (belke)
Vrsta: *Lagopus mutus* – snežni jereb ali belka

Družina: Tetraonidae (gozdne kure)
Rod: Lagopus (belke)
Vrsta: *Lagopus lagopus* – barski snežni jereb

Družina: Tetraonidae (gozdne kure)
Rod: Lagopus (belke)
Vrsta: *Lagopus* sp.

Družina: Tetraonidae (gozdne kure)
Rod: Tetrao (divji petelini)
Vrsta: *Tetrao tetrix* – ruševec

Družina: Tetraonidae (gozdne kure)
Rod: Tetrao (divji petelini)
Vrsta: *Tetrao urogallus* – divji petelin

Družina: Phasianidae (fazanovci ali poljske kure)
Rod: Phasianus (fazani)
Vrsta: *Phasianus colchicus* – navadni fazan

Družina: Strigidae (sove)
Rod: Nyctea (snežna sova)
Vrsta: *Nyctea scandiaca* – snežna sova

Družina: Turdidae (drozgi)
Rod: Turdus (pravi drozgi)
Vrsta: *Turdus merula* – kos

Družina: Turdidae (drozgi)
Rod: Turdus (drozgi)
Vrsta: *Turdus viscivorus* – carar ali dreskač

Družina: Laniidae (srakoperji)
Rod: Lanius (srakoperji)
Vrsta: *Lanius excubitor* – veliki srakoper

Družina: Corvidae (vrane)
Rod: Garrulus (šoje)
Vrsta: *Garrulus glandarius* – šoja

Družina: Corvidae (vrane)
Rod: Nucifraga (krekovti)
Vrsta: *Nucifraga caryocatactes* – krekovt ali orehar ali lešnikar

Družina: Corvidae (vrane)
Rod: Pyrrhocorax (planinske vrane)
Vrsta: *Pyrrhocorax pyrrhocorax* – planinska vrana

Družina: Paridae (sinice)

Rod: Parus (sinice)
Vrsta: *Parus major* – velika sinica

Družina: Oriolidae (kobilarji)
Rod: Oriolus (kobilarji)
Vrsta: *Oriolus oriolus* – kobilar ali vuga

Družina: Passeridae (vrabci)
Rod: *Passer* sp. (vrabec)

Družina: Fringillidae (ščinkavci)
Rod: Fringilla (ščinkavci)
Vrsta: *Fringilla coelebs* – ščinkavec

Taksonomsko opredeljeno avifavnistično gradivo iz Divjih bab I prikazujeta dve tabeli. *Tabela 9.2* prikazuje pripadnost posamezni družini, rodu in vrsti, opredeljuje skeletne dele (MNE), njihovo ohranjenost (NISP) in najmanjše število posameznih živali (MNI). *Tabela 9.3* podaja razčlenjen pregled skeletnih delov (*cranium, sternum, coracoid, humerus, ulna, radius, metacarpus, costa, vertebra, femur, tibiotarsus, tarsometatarsus, phalanx*).

Medtem ko so se v Divjih babah I odlagali jamski sedimenti, so obstajali v širši in ožji okolici različni ekološki biotopi, ki se odslikavajo v raznolikosti ptičjih vrst (*tab. 9.4*). Ptice so živele v različnih življenjskih okoljih: na odprtih terenih (gozdne jase, manjši travniki idr. –

Tab. 9.1: Seznam najdenih ostankov ptic – taksonomija in stratigrafija.
Tab. 9.1: List of remains of birds found – taxonomy and stratigraphy.

Species	Element	Inv. no.	Quadrat(Cut)	Layer
Garrulus glandarius	*ulna, ulna*	309, 336	185-186(1)	2
Passer sp.	*ulna*	336	186-187(1)	2
Nyctea scandiaca	*humerus*	326	199-200(1)	2
Pyrrhocorax pyrrhocorax	various bones	784	84(A)	2
Pyrrhocorax pyrrhocorax	*metacarpus*	942	84(A)	2
Pyrrhocorax pyrrhocorax	*tarsometatarsus*	1366	79(XIV)	2
Lagopus mutus	*tarsometatarsus*	1187	111(III)	2
Lagopus mutus	*tibiotarsus* (2x)	154	profile x = 8 m	2
Lagopus mutus	*femur* (2x)	240	profile x = 8 m	2
Lagopus mutus	*tarsometatarsus*	241	profile x = 8 m	2
Pyrrhocorax pyrrhocorax	*metacarpus*	633	32(1)	2 and 3
Pyrrhocorax pyrrhocorax	*tarsometatarsus*	1236	98(VIII)	2 and 3
Pyrrhocorax pyrrhocorax	*ulna*	1017	87(A)	2 and 3
Pyrrhocorax pyrrhocorax	*metacarpus*	1130	112(VII)	2 and 3
Oriolus oriolus	*humerus*	1017	87(A)	2 and 3
Turdus viscivorus	*ulna*	1017	87(A)	2 and 3
Tetrao (Lyrurus) tetrix	*coracoid* (2x)	647, 666	66(1)	2 and 3
Lagopus lagopus	*tarsometatarsus*	1167	104(VII)	2 and 3
Parus major	*cranium, sternum*	1247	107(VII)	2 and 3
Turdus viscivorus	*ulna*	1242	111(VIII)	3
Pyrrhocorax pyrrhocorax	*femur*	1530	34c(8)	3
Pyrrhocorax pyrrhocorax	*tarsometatarsus*	1531	34c(8)	3
Pyrrhocorax pyrrhocorax	*coracoid*	841	23(5)	3
Lanius excubitor	*ulna*	1529	55b(9)	3
Turdus merula	*humerus*	1533	55a(9)	4
Falco tinnunculus	*coracoid*	1528	8(11)	5(a)
Pyrrhocorax pyrrhocorax	*ulna*	1532	67(9)	5
Pyrrhocorax pyrrhocorax	*tarsometatarsus*	1534	9(12)	5
Pyrrhocorax pyrrhocorax	*tibiotarsus*	s. n.	34c(11)	5
Lanius excubitor	*ulna*	s. n.	55a(10)	5
Aves indet.	*phalanx*	s. n.	55a(10)	5
Buteo buteo	*phalanx*	1699	48b(13)	5
Fringilla coelebs	*humerus*	s. n.	26(13)	5
Lagopus sp.	*tibiotarsus*	374	182(11)	8
Tetrao urogallus	*radius*	2114	24(24)	8
Nucifraga caryocatactes	*tarsometatarsus*	2113	16(22)	8
Aves indet.	*phalanx*	2627	45(26)	8
Lagopus mutus	*ulna*	s. n.	32(28)	8b-10
Pyrrhocorax pyrrhocorax	*femur*	477	175,174,193(12)	10
Phasianus colchicus	*phalanx*	s. n.	13(36)	12

Tab. 9.2: Pregled determiniranih skeletnih delov (*minimum number of elements* – MNE), njihove ohranjenosti (*number of identified specimens* – NISP) in najmanjše število primerkov (*minimum number of individuals* – MNI).
Tab. 9.2: Survey of identified skeletal parts: minimum number of elements (MNE), number of identified specimens (NISP) and minimum number of individuals (MNI)

Family, Genus, Species	**MNE**	**NISP Complete / Fragmented**	**MNI**
Accipitridae			
Haliaeetus cf. *albicilla*	1 *phalanx*	1/-	1
Buteo buteo	1 *phalanx dig. IV*	- / 1 distal part	1
Falconidae			
Falco tinnunculus	1 *coracoid*	- / 1 distal part	1
Tetraonidae			
Lagopus mutus	1 *ulna*, 2 *femora*, 2 *tibiotarsalia*, 2 *tarsometatarsalia*	5 / 2 distal parts	3
Lagopus lagopus	1 *tarsometatarsus*	- / 1 distal part	1
Lagopus sp.	1 *tibiotarsus*	- / 1 diaphysis	1
Tetrao tetrix	2 *coracoids*	- / 2 proximal parts	1
Tetrao urogallus	1 *radius*	- / 1 distal part	1
Phasianidae			
Phasianus colchicus	1 *phalanx dig. III*	1 / -	1
Strigidae			
Nyctea scandiaca	1 *humerus*	- / 1 proximal part	1
Turdidae			
Turdus merula	1 *humerus*	- / 1 proximal part	1
Turdus viscivorus	2 *ulnae*	1 / 1 proximal part	2
Laniidae			
Lanius excubitor	2 *ulnae*	1 / 1 distal part	2
Corvidae			
Nucifraga caryocatactes	1 *tarsometatarsus*	- / 1 distal part	1
Garrulus glandarius	2 *ulnae*	2 / -	2
Pyrrhocorax pyrrhocorax	2 *humeri*, 1 *coracoid*, 1 *radius*, 4 *ulnae*, 4 *metacarpalia*, 3 *femora*, 3 *tibiotarsalia*, 5 *tarsometatarsalia*, 2 *costae*, 1 part of backbone	13 / - 2 proximal parts, 4 distal parts, 7 fragments	13
Paridae			
Parus major	1 *cranium* 1 *sternum*	- / 2 fragments	1
Oriolidae			
Oriolus oriolus	1 *humerus*	- / 1 distal part	1
Passeridae			
Passer sp.	1 *ulna*	- / 1 proximal part	
Fringillidae			
Fringilla coelebs	1 *humerus*	1 / -	1
Aves indet.	1 claw	1 / -	1
SUM	*57*	*27 / 30*	*38*

5,26 %), ob vodah (rekah, jezerih – 5,26 %), v gozdovih (listavcev, iglavcev in mešanih – 42,10 %), v skalnatih (15,78 %) in mešanih predelih (mejna območja med različnimi biotopi, npr. gozd–travnik, reka–gozd, jezero–gozd idr. – 31,57 %). Vrsta *Lagopus lagopus* (barski snežni jereb) kaže bližino večjega odprtega (neporaščenega) zemljišča v okolici jame, medtem ko kaže bližino vodnega okolja najdba belorepke (*Haliaeetus* cf. *albicil-*

Tab. 9.3: Zastopanost skeletnih delov ptic iz Divjih bab I.
Legenda: Cr – cranium; St – sternum; Co – coracoid; H – humerus; U – ulna; R – radius; Mc – metacarpus; Cs – costa; Vr – vertebra; F – femur; Ti – tibiotarsus; Tt – tarsometatarsus; Ph – phalanx.
Tab. 9.3: Representation of skeletal parts of birds from Divje babe I
Legend: Cr – cranium; St – sternum; Co – coracoid; H – humerus; U – ulna; R – radius; Mc – metacarpus; Cs – costa; Vr – vertebra; F – femur; Ti – tibiotarsus; Tt – tarsometatarsus; Ph – phalanx.

Species / Element	**Cr**	**St**	**Co**	**H**	**U**	**R**	**Mc**	**Cs**	**Vr**	**F**	**Ti**	**Tt**	**Ph**
Haliaeetus cf. *albicilla*	–	–	–	–	–	–	–	–	–	–	–	–	1
Buteo buteo	–	–	–	–	–	–	–	–	–	–	–	–	1
Falco tinnunculus	–	–	1	–	–	–	–	–	–	–	–	–	–
Lagopus mutus	–	–	–	–	1	–	–	–	–	2	2	2	–
Lagopus lagopus	–	–	–	–	–	–	–	–	–	–	–	1	–
Lagopus sp.	–	–	–	–	–	–	–	–	–	–	1	–	–
Tetrao tetrix	–	–	2	–	–	–	–	–	–	–	–	–	–
Tetrao urogallus	–	–	–	–	–	1	–	–	–	–	–	–	–
Phasianus colchicus	–	–	–	–	–	–	–	–	–	–	–	–	1
Nyctea scandiaca	–	–	–	1	–	–	–	–	–	–	–	–	–
Turdus viscivorus	–	–	–	–	2	–	–	–	–	–	–	–	–
Turdus merula	–	–	–	1	–	–	–	–	–	–	–	–	–
Lanius excubitor	–	–	–	–	2	–	–	–	–	–	–	–	–
Nucifraga caryocatactes	–	–	–	–	–	–	–	–	–	–	–	1	–
Garrulus glandarius	–	–	–	–	2	–	–	–	–	–	–	–	–
Pyrrhocorax pyrrhocorax	–	–	1	2	4	1	4	2	1	3	3	5	–
Parus major	1	1	–	–	–	–	–	–	–	–	–	–	–
Oriolus oriolus	–	–	–	1	–	–	–	–	–	–	–	–	–
Passer sp.	–	–	–	–	1	–	–	–	–	–	–	–	–
Fringilla coelebs	–	–	–	1	–	–	–	–	–	–	–	–	–
Aves indet.	–	–	–	–	–	–	–	–	–	–	–	–	1
SUM: 57	1	1	4	6	12	2	4	2	1	5	6	9	4

la). Najštevilčnejše so gozdne vrste (8 vrst): *Buteo buteo* (kanja), *Tetrao tetrix* (ruševec), *Tetrao urogallus* (divji petelin), *Turdus viscivorus* (carar), *Nucifraga caryocatactes* (krekovt), *Garrulus glandarius* (šoja), *Parus major* (velika sinica) in *Oriolus oriolus* (kobilar). Predstavnice skalnega biotopa so tri: *Lagopus mutus* (belka), *Nyctea scandiaca* (snežna sova) in *Pyrrhocorax pyrrhocorax* (planinska vrana). Številčno (6 vrst) takoj za značilnimi gozdnimi vrstami so predstavnice ptic, ki živijo na meji različnih biotopov: *Falco tinnunculus* (postovka), *Phasianus colchicus* (fazan), *Turdus merula* (kos), *Lanius excubitor* (veliki srakoper), *Passer* sp. (vrabec) in *Fringilla coelebs* (ščinkavec).

V pleistocenu, posebno pa v zadnjem glacialnem vrhuncu, se je območje razširjenosti posameznih vrst avifavne pomaknilo s severnih predlov Evrope v južne. Tako so ptice iz hladnejših podnebnih pasov poselile območje Slovenije kot tudi severnejše predele sosednje Hrvaške (Malez, 1988, 1991, 1997a). V sedimentih Divjih bab I so bili najdeni skeletni ostanki ptičjih vrst, ki so pomembne indikatorke hladnejših klimatskih pasov – tundre, borealnega in visokoalpskega klimatskega pasu. Tako so *Nyctea scandiaca* (snežna sova), *Lagopus lagopus* (barski jereb) in *Lanius excubitor* (veliki srakoper) pomembni predstavniki tundre in borealnega klimatskega pasu. Za visokogorski ali alpski klimatski pas

Tab. 9.4: Avifavna iz Divjih bab I, razvrščena po ekoloških biotopih.
Tab. 9.4: Avifauna from Divje babe I, classified by ecological biotopes

Biotope	**Species**
Water area	*Haliaeetus* cf. *albicilla*
Open area	*Lagopus lagopus*
Forest	*Buteo buteo*
	Tetrao tetrix
	Tetrao urogallus
	Turdus viscivorus
	Nucifraga caryocatactes
	Garrulus glandarius
	Parus major
	Oriolus oriolus
Rocky	*Lagopus mutus*
	Nyctea scandiaca
	Pyrrhocorax pyrrhocorax
Mixed	*Falco tinnunculus*
	Phasianus colchicus
	Turdus merula
	Lanius excubitor
	Passer sp.
	Fringilla coelebs

Tab. 9.5: Zastopanost avifavne iz Divjih bab I glede na klimatske pasove.
Tab. 9.5: Representation of avifauna from Divje babe I in terms of climatic belts.

Climate	**Species**
Boreal	*Nyctea scandiaca*
	Lagopus lagopus
	Lanius excubitor
Alpine	*Lagopus mutus*
	Nucifraga caryocatactes
	Pyrrhocorax pyrrhocorax
Moderate	*Haliaeetus* cf. *albicilla*
	Buteo buteo
	Falco tinnunculus
	Tetrao tetrix
	Tetrao urogallus
	Phasianus colchicus
	Turdus merula
	Turdus viscivorus
	Garrulus glandarius
	Parus major
	Oriolus oriolus
	Passer sp.
	Fringilla coelebs

so pomembni predstavniki avifavne, ki še vedno prebivajo na območju Julijskih in Kamniških Alp, in so v Divjih babah I zastopani s tremi vrstami: Lagopus *mutus* (belka), *Nucifraga caryocatactes (*krekovt) in *Pyrrhocorax pyrrhocorax* (planinska vrana). Največ ptičjih vrst (13 predstavnikov) živi v zmernem klimatskem pasu. Te so: *Haliaeetus* cf. *albicilla* (belorepka), *Buteo buteo* (kanja), *Falco tinnunculus* (postovka), *Tetrao tetrix* (ruševec), *Tetrao urogallus* (divji petelin), *Phasianus colchicus* (fazan), *Turdus viscivorus* (carar), *Turdus merula* (kos), *Garrulus glandarius* (šoja), *Parus major* (velika sinica), *Oriolus oriolus* (kobilar), *Passer* sp. (vrabec) in *Fringilla coelebs* (ščinkavec) (*tab. 9.5*).

Določitev fosilnega avifavnističnega gradiva iz Divjih bab I je dala naslednje rezultate:

Od sedeminpetdesetih najdenih skeletnih ostankov smo jih taksonomsko opredelili šestinpetdeset. Ti ostanki pripadajo različnim skeletnim delom. Določili smo osemnajst ptičjih vrst in najmanj osemintrideset ptic. Ptice pripadajo različnim ekološkim biotopom. Odprti in vodni biotopi so predstavljeni samo s po eno ptičjo vrsto. Največ najdenih vrst avifavne je prebivalo v gozdnatih predelih (8 predstavnikov), medtem ko so tri vrste značilne za skalnate predele. Za mejna območja med različnimi biotopi je značilnih šest ptičjih vrst. Ptičje vrste tudi zelo dobro opredeljujejo klimo. Tako je šest predstavnikov ptic bivalo v pasu s hladnejšo, borealno in visokoalpsko klimo (v tundri), medtem ko je največ ptic (13 vrst) bivalo v zmernem klimatskem pasu.

Iz hrvaščine prevedel I. Turk

9. FOSSIL REMAINS OF AVIFAUNA FROM DIVJE BABE I

VESNA MALEZ

Numerous skeletal remains of birds were also found during the course of the lengthy systematic excavation of the palaeolithic site Divje babe I in the Idrijca valley below Šebrelje plateau (Turk *et al.* 1989b, 2001, 2002b, 2003a (*Tab. 9.1*). The remains of avifauna, which were very sparsely scattered in sediments, were identified with the aid of recent comparable avifaunistic material from the Institute for Quaternary paleontology and geology of the Croatian Academy of Sciences and Arts (Malez 1997b). The skeletal remains consist of 57 bones, of which 27 are preserved complete and the remaining 30 are proximal or distal parts. The large lateral and vertical dispersion of the remains of avifauna at the site gave the following results:

Fifty six bones were taxonomically identified. Eighteen bird species were identified, belonging to 16 genuses from 12 families. Two bone remains were identified to the level of genus and two remained unidentified.

Family: Accipitridae (hawks)
Genus: Haliaeetus (white-tailed eagles)
Species: *Haliaeetus* cf. *albicilla* – White-tailed Sea Eagle[1]

Family: Accipitridae (hawks)
Genus: Buteo (buzzards)
Species: *Buteo buteo* – Common Buzzard, Eurasian Buzzard

Family: Falconidae (falcons)
Genus: Falco (falcons)
Species: *Falco tinnunculus* – Kestrel, Common Kestrel

Family: Tetraonidae (grouse)
Genus: Lagopus (ptarmigans)
Species: *Lagopus mutus* – Ptarmigan, Rock Ptarmigan

Family: Tetraonidae (grouse)
Genus: Lagopus (ptarmigans)
Species: *Lagopus lagopus* – Willow Grouse

Family: Tetraonidae (grouse)
Genus: Lagopus (ptarmigans)
Species: *Lagopus* sp.

Family: Tetraonidae (grouse)
Genus: Tetrao
Species: *Tetrao tetrix* – Black Grouse, Eurasian Black Grouse

Family: Tetraonidae (grouse)
Genus: Tetrao
Species: *Tetrao urogallus* – Capercaillie, Western Capercaillie

Family: Phasianidae (pheasants)
Genus: Phasianus (pheasants)
Species: *Phasianus colchicus* – Common Pheasant, Ring-necked Pheasant

Family: Strigidae (typical owls)
Genus: Nyctea (snowy owl)
Species: *Nyctea scandiaca* – Snowy Owl

Family: Turdidae (thrushes, robins, chats and wheatears)
Genus: Turdus (robins)
Species: *Turdus merula* – Blackbird

Family: Turdidae (thrushes, robins, chats and wheatears)
Genus: Turdus (robins)
Species: *Turdus viscivorus* – Mistle Thrush

Family: Laniidae (shrikes)
Genus: Lanius (shrikes)
Species: *Lanius excubitor* – Great Grey Shrike

Family: Corvidae (crows and jays)
Genus: Garrulus (jays)
Species: *Garrulus glandarius* – Eurasian Jay

Family: Corvidae (crows and jays)

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[1] English names of birds according to Harison (1982) and Radović *et al.* (2005).

Genus: Nucifraga (nutcrackers)
Species: *Nucifraga caryocatactes* – Nutcracker

Family: Corvidae (crows and jays)
Genus: Pyrrhocorax (alpine choughs)
Species: *Pyrrhocorax pyrrhocorax* – Alpine Chough

Family: Paridae (chickadees and titmice)
Genus: Parus (tits)
Species: *Parus major* – Great Tit

Family: Oriolidae (Old world orioles)
Genus: Oriolus (orioles)
Species: *Oriolus oriolus* –Golden Oriole

Family: Passeridae (sparrows)
Genus: *Passer* sp. (sparrow)

Family: Fringillidae (finches)
Genus: Fringilla (bramblings and chaffinches)
Species: *Fringilla coelebs* – Chaffinch

Taxonomic identification of avifaunistic material from Divje babe I is presented in two tables. *Table 9.2* shows affiliation to individual families, genuses and species, identifies skeletal parts (MNE), their preservation (NISP) and the minimum number of individuals (MNI). *Table 9.3* provides an analytical review of skeletal parts (*cranium, sternum, coracoid, humerus, ulna, radius, metacarpus, costa, vertebra, femur, tibiotarsus, tarsometatarsus, phalanx*).

Various ecological biotopes existed in the wider and more immediate environment of Divje babe I, which are reflected in the diversity of bird species (*Tab. 9.4*). The birds lived in various habitats: in open terrain (forest clearings, small meadows etc. – 5.26 %), by water (rivers, lakes – 5.26 %), in forests (deciduous, coniferous and mixed – 42.10 %), in rocky (15.78 %) and mixed areas (boundary areas between different biotopes, e.g., forest-grassland, river-forest, lake-forest etc. – 31.57 %). The species *Lagopus lagopus* (willow grouse) indicates the vicinity of major open (un-forested) land in the vicinity of the cave, while the find of white-tailed sea eagle (*Haliaeetus* cf. *albicilla*) indicates the proximity of a wetland environment. Forest species are the most numerous (8 species): *Buteo buteo* (common buzzard), *Tetrao tetrix* (Eurasian black grouse), *Tetrao urogallus* (capercaillie), *Turdus viscivorus* (mistle thrush), *Nucifraga caryocatactes* (nutcracker), *Garrulus glandarius* (jay), *Parus major* (great tit) in *Oriolus oriolus* (golden oriole). There are three representatives of a rocky biotope: *Lagopus mutus* (ptarmigan), *Nyctea scandiaca* (snowy owl) and *Pyrrhocorax pyrrhocorax* (alpine chough). Birds that live on the boundary of different biotopes are numerically (6 species) immediately behind typical forest species: *Falco tinnunculus* (common kestrel), *Phasianus colchicus* (common pheasant), *Turdus merula* (blackbird), *Lanius excubitor* (great grey shrike), *Passer* sp. (sparrow) and *Fringilla coelebs* (chaffinch).

In the Pleistocene, and especially in the last glacial maximum, the area of distribution of individual species of avifauna shifted from northern parts of Europe towards the south. Birds from colder climatic belts thus settled areas of Slovenia, as well as more northerly parts of neighbouring Croatia (Malez, 1988, 1991, 1997a). Skeletal remains of bird species that are important indicators of colder climatic belts – tundra, boreal and high mountain belts – were found in the sediments of Divje babe I. *Nyctea scandiaca* (snowy owl), *Lagopus lagopus* (willow grouse) and *Lanius excubitor* (great grey shrike) are thus important representatives of tundra and boreal climatic belts. Representatives of avifauna which still inhabit the region of the Julian and Kamnik Alps are important species of the high mountain or alpine climatic belt, and are represented in Divje babe I by three species: Lagopus *mutus* (ptarmigan), *Nucifraga caryocatactes* (nutcracker) and *Pyrrhocorax pyrrhocorax* (alpine chough). The largest number of bird species (13 representatives) lives in the moderate climatic belt. They are: *Haliaeetus* cf. *albicilla* (white-tailed sea eagle), *Buteo buteo* (common buzzard), *Falco tinnunculus* (common kestrel), *Tetrao tetrix* (Eurasian black grouse), *Tetrao urogallus* (capercaillie), *Phasianus colchicus* (common pheasant), *Turdus viscivorus* (mistle thrush), *Turdus merula* (blackbird), *Garrulus glandarius* (Eurasian jay), *Parus major* (great tit), *Oriolus oriolus* (golden oriole), *Passer* sp. (sparrow) and *Fringilla coelebs* (chaffinch) (*Tab. 9.5*).

The identification of fossil avifaunistic material from Divje babe I gave the following results: of 57 skeletal remains found, 56 were taxonomically identified. These remains belong to various skeletal parts. We identified 18 bird species and at least 38 birds. The birds belong to various ecological biotopes. Open and water biotopes were represented by only one species each. The largest number of species of avifauna lived in forested areas (8 representatives) while three species are typical of rocky areas. Six bird species are characteristic of boundary areas between different biotopes. The bird species also define climate very well. Six representatives of birds thus lived in colder boreal or high mountain climates (in tundra), while the majority of the birds (13 species) lived in the moderate climatic belt.

10. MALI TERESTRIČNI SESALCI (ERINACEOMORPHA, SORICOMORPHA, CHIROPTERA, RODENTIA) IZ DIVJIH BAB I

BORUT TOŠKAN in BORIS KRYŠTUFEK

Izvleček

V mlajšepleistocenskih (OIS 3 in OIS 5a) plasteh paleolitskega jamskega najdišča Divje babe I so bili najdeni ostanki najmanj 407 primerkov malih sesalcev, pripadajočih vsaj 17 različnim vrstam: *Erinaceus* cfr. *romanicus*, *Sorex alpinus*, *S. araneus*, *Talpa europaea* seu *caeca*, *Vespertilio murinus*, *Marmota marmota*, *Chionomys nivalis*, *Arvicola terrestris*, *Myodes glareolus*, *Microtus agrestis*, *M. arvalis*, *M. liechtensteini*, *M. subterraneus*, *Apodemus* cfr. *sylvaticus*, *Glis glis*, *Muscardinus avellanarius* in *Sicista* cfr. *subtilis*. Na osnovi tedanjih združb malih sesalcev izhaja, da so bili v OIS 5a odprti, travniški habitati bolj razprostranjeni od gozdov. Drugačno sliko kaže mikrofavna iz OIS 3, ko naj bi v okolici Divjih bab I prevladoval mozaični tip habitata z mešanimi, pretežno iglastimi gozdovi in travniki s kamenišči. Primerjava med mlajšepleistocensko (OIS 5a in OIS 3) favno malih sesalcev iz Divjih bab I s sočasnimi favnami z območij severno od Alp je izpostavila velike razlike v vrstni sestavi. V würmu so bile namreč na južnem robu alpske poledenitve že prisotne recentne gozdne vrste, medtem ko so severneje še vedno prevladovale borealne in stepske vrste.

Jama Divje babe I je, ob Potočki zijalki (izkopavanja v letih 1997–2000; Rabeder 2004), edino mlajšepleistocensko najdišče v Sloveniji, kjer so raziskovalci ustrezno pozornost namenili tudi pobiranju ostankov malih sesalcev. O posameznih najdbah žužkojedov, netopirjev in glodalcev sicer poročajo tudi iz nekaterih drugih paleolitskih postaj na Slovenskem (Rakovec 1973; Pohar 1976; 1985; 1991; Brodar, S. & M. 1983), vendar premajhni vzorci[1] ne omogočajo smiselnih statističnih obdelav. Fosilni ostanki malih sesalcev iz zgornjih petih plasti Divjih bab I so že bili predmet podrobne analize (Kryštufek 1997; Toškan 2002). Obdelava najdb iz še preostalih, globljih plasti 6 do 17a1, katere rezultate predstavljava v tem prispevku, omogoča še jasnejši vpogled v würmsko mikrofavno z južnega roba alpske poledenitve.

METODE

Jama Divje babe I se nahaja v predalpskem območju zahodne Slovenije (450 m nm. v.). Podrobne podatke o najdišču in metodologiji terenskega raziskovanja podaja Turk (Uvod in poglavje 1 v tem zborniku). Ostanki sesalske mikrofavne izvirajo iz sklopa plasti 2 do 17a1, tj. iz obdobja od pribl. 80.000 do pribl. 40.000 let pred sedanjostjo – p. s. (Turk *et al.* 2001a; poglavji 6 in 7 v tem zborniku). Plasti 12 do 17a1 so domnevno nastale ob koncu zgodnjega glaciala (OIS 5a), plasti 2 do 11/12 pa v interpleniglacialu (OIS 3). OIS 4 (tj. pleniglacial I) v jami v glavnem ni zastopan, saj je takrat prišlo do zastoja v sedimentaciji (poglavji 6 in 7 v tem zborniku). Zaradi pogosto preskromnega števila najdb na plast sva pri nekaterih analizah te združila v tri sklope, t.i. facije: facija A (obsega plasti 2 do 6), facija B (plasti 7 do 11/12) in facija C (plasti 12/13-17a1). Takšna delitev temelji na sedimentoloških podatkih in ostankih medveda (Turk 2003a; poglavji 5 in 12 v tem zborniku).

Pri izkopavanju je bila osnovna enota kvadrat 1 x 1 m in reženj (izkop) debeline 12 cm. Sediment je bil v celoti spran skozi sita z velikostjo luknjic 10 mm, 3 mm in 0,5 mm. Prostorninsko enake enote usedlin predstavljajo standardne vzorce za vse analize. Iz njih je bilo med izkopavanji odvzeto približno 3 dm^3 frakcije sedimenta velikosti 0,5 do 3 mm.[2] Ta je bila v nadaljevanju pregledana pod stereomikroskopom, pri čemer so bili pobrani ostanki malih sesalcev. Nabrano gradivo je obsegalo zobe, spodnje in zgornje čeljustnice ter postkranialne skeletne elemente; slednjih v nadaljnjo analizo nisva vključila. Vsi vzorci so označeni s številko kvadrata in izkopa na način kvadrat/izkop; izkopi so označeni od površja navzdol (za globine izkopov oz. režnjev glej poglavje 1 opomba 5 v tem zborniku).

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[1] V tem smislu predstavljajo edino izjemo mestoma dokaj številčni ostanki alpskega svizca (*Marmota marmota*).

[2] Izjema je 11 vzorcev, ki so bili z ostanki mikrofavne najbogatejši in sva jih zato pregledala v celoti. Ti vzorci so (kvadrat/reženj): 26/33, 28/32, 32/31, 26/35, 28/35, 29/35, 32/33, 28/34, 29/36, 29/34 in 32/34.

Ostanke malih sesalcev sva določala in merila pod stereomikroskopom pri različnih povečavah. Primerjalni recentni material izvira iz Slovenije in s sosednjih območij Balkana (zbirka Prirodoslovnega muzeja Slovenije, Ljubljana). V besedilu uporabljava za meljake okrajšavo *M*, položaj zoba v nizu pa je označen s številko (anteriorno → posteriorno). Za oznake dentinskih polj arvikolinskih meljakov glej Kryštufek (1991).

Kvantitativne primerjave med favnami temeljijo na številu določenih primerkov (*Number of Identified Specimens*, NISP) in najmanjšem številu živali (*Minimum Number of Individuals*, MNI). V okviru biometrične analize sva obstoj statistično značilne heterogenosti med posameznimi vzorci ugotavljala z enosmerno analizo variance, največje homogene sete pa sva prepoznala s pomočjo Schefféjevega testa. Majhni vzorci, pri katerih ni bila razvidna normalnost v porazdelitvi, sva testirala z neparametričnim Kruskal-Wallisovim testom. Alopatrične in alohrone glodalske favne sva primerjala z večdimenzionalnim skaliranjem (*Multidimensional scaling*), temelječim na diagonalno simetrični matriki evklidskih razdalj. V izhodiščni matriki sva abundanco razdelila v pet razredov: razred 0 (takson v vzorcu ni zastopan), razred 1 (MNI < 5 % skupnega MNI), razred 2 (MNI 6–20 % skupnega MNI), razred 3 (MNI 21–50 % skupnega MNI) in razred 4 (MNI > 50 % skupnega MNI).

Ocena značilnosti nekdanjih habitatov temelji na korespondečni analizi (*Correspondence analysis*) med tremi fosilnimi favnami glodalcev iz Divjih bab I (facije A, B in C) in 19 recentnimi favnami z znanimi habitatnimi tipi. V tej analizi je bila abundanca posameznega taksona izražena kot MNI.

Statistična obdelava je bila narejena s programskim paketom StatSoft 2001, STATISTICA za Windows, verzija 6.0. Nomenklatura meljakov voluharic je povzeta po Van Der Meulenu (1973).

Fosilne ostanke sesalske mikrofavne iz Divjih bab I hrani Narodni muzej Slovenije v Ljubljani.

REZULTATI IN RAZPRAVA

TAKSONOMIJA

Skupno je bilo iz sklopa plasti 6 do 17a1 pridobljenih 2.337 kočnikov malih sesalcev, od katerih jih je bilo vsaj do nivoja rodu mogoče določiti 1.492. Gre za ostanke najmanj 407 živali, ki sva jih pripisala 17 vrstam iz devetih družin. Delež glodalcev presega 98 odstotkov določljivih primerkov, medtem ko je red netopirjev zastopan z eno samo najdbo. Vse vrste, ki so zastopane v vzorcu, so tudi recentne in večina jih še vedno poseljuje območje Slovenije. V tem smislu predstavljata edini izjemi stepska brezova miš (*Sicista subtilis*) in sredozemski krt (*Talpa caeca*), katerega taksonomska uvrstitev pa ni povsem zanesljiva.

Taksonomski in nomenklatorni vir sta Wilson in Reeder (2005).

Red: Ježi (Erinaceomorpha)
Družina: Ježi (Erinaceidae)

Erinaceus cfr. *roumanicus*

Gradivo: plast 10: spodnja čeljustnica (vzorec 6/32).

Fragmentirano spodnjo čeljustnico iz vzorca 6/32 sva lahko določila le do nivoja rodu. Zaradi manjkajoče vertikalne veje (*ramus ascendens*) na ohranjenem materialu namreč ni mogoče razlikovati med rjavoprsim ježem (*Erinaceus europaeus* Linnaeus, 1758) in beloprsim ježem (*Erinaceus concolor/roumanicus*). Danes je rjavoprsi jež omejen na območje zahodne Evrope do črte Tržaški zaliv – ustje Odre na vzhodu (v Sloveniji je znan le iz okolice Nove Gorice; Petrov 1989), medtem ko je beloprsi jež splošno razširjen (Kryštufek 1991). Podatki o fosilnih ostankih obeh vrst so skromni, kar še posebej velja za beloprsega ježa. Kot samostojna vrsta je bil namreč prepoznan razmeroma pozno, in to na osnovi razlik v obliki nekaterih kromosomov (Král 1967). Zato so njegove fosilne ostanke v preteklosti pripisali vrsti *E. europaeus*. Čeprav prisotnost beloprsega ježa v mlajšem pleistocenu Evrope ni vprašljiva (Rzebik-Kowalska 2003), uvršča večina avtorjev fosilne najdbe ježa k *E. europaeus*. Tako je tudi v pregledu mlajšepleistocenske sesalske favne SV Italije (Bon *et al.* 1991), južne Avstrije (Fladerer 2000), Madžarske (Jánossy) in nekdanje Jugoslavije (Malez 1986a). Edine doslej znane fosilne najdbe ježa s Slovenskega so bile najdene v Parski golobini v Pivški kotlini, ki jih je Rakovec (1961) pripisal vrsti *E. europaeus*, časovno pa umestil v würm II + würm III. Ti ostanki so torej geološko mlajši od primerka iz Divjih bab I (plast 10 je domnevno nastala v začetku OIS 3; Turk *et al.* 2001a).

Red: Rovke in krti (Soricomorpha)

Družina: Rovke (Soricidae)

Sorex alpinus Schinz, 1837

Gradivo: plast 8: spodnja čeljustnica (vzorec iz profila: y = –1,00 z = –3,06 do –3,14); plast 10: spodnja čeljustnica (vzorec 32/29); plast 14: spodnja čeljustnica (vzorec 28/32) in plast 15/16: spodnja čeljustnica (vzorec 31/32).

Gorski rovki pripadajo štiri spodnje čeljustnice. Koronoidna višina je pri vseh pod 4,5 mm (*tab. 10.1*), kar velja za zanesljiv taksonomski znak pri razlikovanju recentnega materiala *S. alpinus* in *S. araneus* v Sloveniji (Kryštufek 1991).

Tab. 10.1: Opisna statistika za koronoidno višino spodnje čeljustnice v štirih vzorcih gorskih rovk (*Sorex alpinus*). Vzorci: 1 – fosilni primerki iz Divjih bab I (sklop plasti 7 do 17a1); 2 – fosilni primerki iz Divjih bab I (sklop plasti 2 do 5); 3 – fosilni primerek iz Potočke zijalke (pribl. 35.000 do 26.000 p.s.); 4 – recentna *S. alpinus* iz Slovenije. Podana sta velikost vzorca (N) in variacijska širina (min.–max.). Vrednosti za vzorec 2 podaja Kryštufek (1997), za vzorec 3 Rabeder (2004), za vzorec 4 pa Kryštufek (1991). Vse mere so v mm.
Tab. 10.1: Descriptive statistics for coronoid height (in mm) in four samples of the Alpine shrew (*Sorex alpinus*). Samples: 1 – fossil specimens from Divje babe I (layers 7 to 17a1); 2 – fossil specimens from Divje babe I (layers 2 to 5); 3 – fossil specimens from Potočka zijalka (approx. 35,000 to 26,000 B.P.); 4 – recent *S. alpinus* from Slovenia. Given are sample size (N) and range (min.–max.). Sources: 2 – Kryštufek (1997), 3 – Rabeder (2004), 4 – Kryštufek (1991).

Sample	N	min–max
1	3	4.16–4.33
2	2	4.30–4.35
3	1	3.91
4	21	4.0–4.5

Sorex araneus Linnaeus, 1758

Gradivo: plast 8: spodnja čeljustnica (vzorec 26/27); plast 8/10: rostrum (vzorec 30/28); plast 10: spodnja čeljustnica (vzorec 29/29).

Gozdna rovka je v obravnavanem vzorcu zastopana s tremi najdbami. Koronoidna višina pri obeh spodnjih čeljustnicah presega 4,5 mm in torej ustreza vrsti *S. araneus* (*tab. 10.2*). Specifično determinacijo rostruma omogoča pigmentiran hipokon prvega zgornjega meljaka (Kryštufek 1991).

Tab. 10.2: Opisna statistika za koronoidno višino spodnje čeljustnice v štirih vzorcih gozdnih rovk (*Sorex araneus*). Vzorci: 1 – fosilni primerki iz Divjih bab I (sklop plasti 7 do 17a1); 2 – fosilni primerki iz Divjih bab I (sklop plasti 2 do 5); 3 – fosilni primerek iz Potočke zijalke (pribl. 35.000 do 26.000 p.s.); 4 – recentna *S. araneus* iz Slovenije. Podana sta velikost vzorca (N) in variacijska širina (min.–max.). Vrednosti za vzorec 2 podaja Kryštufek (1997), za vzorec 3 Rabeder (2004), za vzorec 4 pa Kryštufek (1991). Vse mere so v mm.
Tab. 10.2: Descriptive statistics for coronoid height (in mm) in four samples of the common shrew (*Sorex araneus*). Samples: 1 – fossil specimens from Divje babe I (layers 7 to 17a1); 2 – fossil specimens from Divje babe I (layers 2 to 5); 3 – fossil specimens from Potočka zijalka (approx. 35,000 to 26,000 B.P.); 4 – recent *S. araneus* from Slovenia. Given are sample size (N) and range (min.–max.). Sources for samples: 2 – Kryštufek (1997), 3 – Rabeder (2004), 4 – Kryštufek (1991).

Sample	N	min–max
1	2	4.69–4.80
2	2	4.7–4.9
3	6	4.65–4.83
4	36	4.7–5.3

Sorex alpinus / araneus

Gradivo: plast 8: spodnja čeljustnica (vzorec iz profila: y = –1,00 z = –3,06 do –3,14), spodnja čeljustnica (vzorec 36/27), zob (vzorec 13/26-27); plast 11: zob (vzorec 31/30); plast 14: spodnja čeljustnica (vzorec 28/32); plast 16: zob (vzorec 29/35).

V zgoraj navedenih primerih zanesljivo razlikovanje med gorsko in gozdno rovko ni mogoče. Medtem ko je v plasteh 8 in 14 rod *Sorex* zastopan še z nekaterimi drugimi ostanki, ki so določljivi do nivoja vrste (*tab. 10.12*), pa sta izolirana zoba iz plasti 11 in 16 edini najdbi rovk v teh plasteh.

Družina: Krti (Talpidae)

Talpa europaea / caeca

Gradivo: plast 8: zob (2x; vzorec 13/26–27); plast 14: zob (2x; vzorca 31/31 in 32/31); plast 16: zob (vzorec 26/35).

Rod *Talpa* je v obravnavanem vzorcu zastopan z majhnim številom izoliranih zob in z več ostanki postkranialnega skeleta. Na osnovi morfologije zob ni mogoče zanesljivo razlikovati med navadnim krtom (*Talpa europaea* Linnaeus, 1758) in sredozemskim krtom (*Talpa caeca* Savii, 1822). Čeprav se vrsti razlikujeta v velikosti (navadni krt je večji), se namreč vrednosti dolžine in širine meljakov na veliko prekrivajo. Prvi spodnji meljak iz vzorca 32/31 (plast 14; *pril. 10.1b*) je po dolžini znotraj variacijske širine recentnih navadnih krtov iz zahodne Slovenije (ter s tem presega vrednosti sredozemskih krtov iz Bosne in Hercegovine, Črne gore ter Kosova; Toškan 2002). Dimenzije preostalih spodnjih meljakov iz plasti 14 in 16 so z območja prekrivanja variacijskih širin obeh vrst (*sl. 10.1*). Material iz plasti 8 je fragmentiran.

Navadni krt danes naseljuje pretežni del Evrope in je splošno razširjen tudi v Sloveniji (Kryštufek 1999a). Za sredozemskega krta je značilen mediteranski tip areala z nekaj reliktnimi populacijami bolj na severu (Kryštufek 1999b). Slednji v Sloveniji ne živi, pa tudi za mlajši pleistocen Slovenije navajajo Rakovec (1973), Poharjeva (1976) in Rabeder s sodelavci (2004a) le vrsto *T. europaea*.[3] Ostanki vrste *T. caeca* so sicer znani iz würma SV Italije (npr. Brecce di Soave pri Veroni; Bon *et al.* 1991) in nekdanje Jugoslavije (Malez 1986), vendar so tudi tam razmeroma redki.

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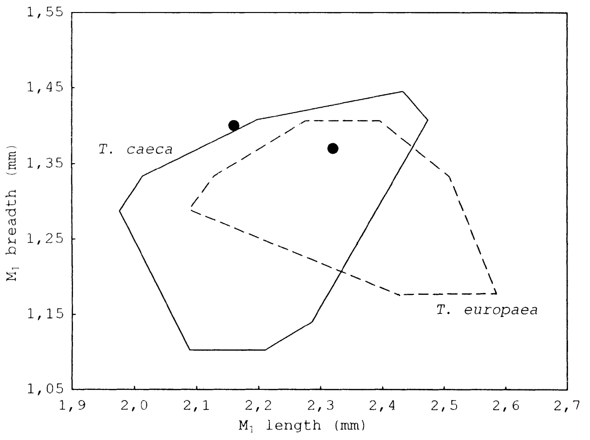
[3] Vrsti *T. europaea* so bili pripisani tudi vsi fosilni ostanki krtov iz zgornjih petih plasti Divjih bab I (Kryštufek 1997).



Sl. 10.1: Odnos med širino in dolžino drugega spodnjega meljaka pri krtih. Poligona obkrožata vrednosti za 29 recentnih primerkov vrste *T. europaea* iz zahodne Slovenije (prekinjena črta) in 30 recentnih primerkov *T. caeca* iz Bosne in Hercegovine, Črne gore ter Kosova (sklenjena črta). Piki predstavljata fosilna M_2 iz Divjih bab I (plast 14: vzorec 31/31 in plast 16: vzorec 26/35).

Fig. 10.1: Bivariate plot of breadth of 2nd lower molar against its length in moles. Polygons enclose extremes for 29 recent *Talpa europaea* from western Slovenia (dashed line) and 30 recent *T. caeca* from Bosnia and Herzegovina, Montenegro and Kosovo (full line), respectively. Dots are two M_2 specimens from Divje babe I (Layer 14: sample 31/31, and Layer 16: sample 26/35).

Obe vrsti sta zastopani tudi v staroholocenski favni Viktorjevega spodmola pri Divači na Krasu (Toškan, Kryštufek 2004).

Red: Netopirji (Chiroptera)
Družina: Gladkonosi netopirji (Vespertilionidae)

Vespertilio murinus Linnaeus, 1758

Gradivo: plast 16: rostrum (vzorec 32/33).

Poškodovan rostrum dvobarvnega (ponočnega) netopirja predstavlja edino najdbo redu Chiroptera v sklopu plasti 6 do 17a1 Divjih bab I. Vrsta naseljuje območje Slovenije tudi danes, a je redka (znanih je le pet nahajališč; Kryštufek in Režek Donev 2005). Osnovni habitat so verjetno gore in stepe (Kryštufek 1991).

Red: Glodalci (Rodentia)
Družina: Veverice (Sciuridae)

Marmota marmota (Linnaeus, 1758)

Najdbe alpskega svizca, ki so v plasteh iz Divjih bab I pogoste (NISP = 234), so obravnavane v poglavju o sesalski makrofavni (poglavje 11 v tem zborniku).

Družina: Hrčki (Cricetidae)
Poddružina: Voluharice (Arvicolinae)

Chionomys nivalis (Martins, 1842)

Gradivo: plast 8: 17 zob; plast 8/10: 6 zob; plast 10: 34 zob; plast 10/11: 4 zobje; plast 11: spodnja čeljustnica in 24 zob; plast 13: 7 zob; plast 13/14: 5 zob; plast 14: 35 zob; plast 15: spodnja čeljustnica in 7 zob; plast 15/16: 10 zob; plast 16: 80 zob; plast 16a: 10 zob; plast 16a/17a1: 2 zoba. Številke pretežnega dela vzorcev, iz katerih so bili pobrani posamezni zobje, podaja Toškan (2002). Seznam preostalih vzorcev: plast 11: spodnja čeljustnica (vzorec 12/33); plast 15: spodnja čeljustnica (vzorec 29/33).

Snežna voluharica je bila v sklopu plasti 6 do 17a1 Divjih bab I zastopana z 243 izoliranimi meljaki. Po dolžini M_1 se primerki iz facije C (plasti 12/13–17a1; OIS 5a) ujemajo z recentnimi *Ch. nivalis* iz Julijskih Alp ter s subfosilnimi konspecifičnimi primerki iz Viktorjevega spodmola na Krasu, ne dosegajo pa vrednosti recentnih *Ch. nivalis* s Snežnika ter fosilnih primerkov iz interpleniglacialnih plasti Divjih bab I (*tab. 10.3*). Za populacije iz hladnejših faz würma so značilne večje povprečne vrednosti dolžine M_1 od tistih iz toplejših zgodnjega glaciala in holocena, vseeno pa material še

Tab. 10.3: Opisna statistika za dolžino prvega spodnjega meljaka v šestih vzorcih snežne voluharice (*Chionomys nivalis*). Homogeni nizi temeljijo na Schefféjevem testu. Vzorci: 1 - recentni *Ch. nivalis* iz Julijskih Alp; 2 - recentni *Ch. nivalis* s Snežnika; 3 - subfosilni primerki iz Viktorjevega spodmola; 4 - fosilni primerki iz Divjih bab I (facija A; OIS 3); 5 - fosilni primerki iz Divjih bab I (facija B; OIS 3); 6 -fosilni primerki iz Divjih bab I (facija C; OIS 5a). Podani so velikost vzorca (N), povprečna vrednost (M), razpon (min.-max.) in standardna deviacija (SD). Vrednosti za vzorec 3 podajata Toškan in Kryštufek (2004), za vzorec 4 pa Kryštufek (1997). Vse mere so v mm.

Tab. 10.3: Descriptive statistics for length of 1st lower molar (in mm) in six snow vole (*Chionomys nivalis*) samples. The largest homogeneous sets were identified by Scheffé test. Samples: 1 - recent *Ch. nivalis* from the Julian Alps; 2 - recent *Ch. nivalis* from Mt. Snežnik; 3 - subfossil specimens from Viktorjev spodmol; 4 - fossil material from Divje babe I (facies A; OIS 3); 5 - fossil material from Divje babe I (facies B; OIS 3); 6 - fossil material from Divje babe I (facies C; OIS 5a). Given are sample size (N), arithmetic mean (M), range (min.-max.) and standard deviation (SD). Sources for samples: 3 -Toškan and Kryštufek (2004), 4 - Kryštufek (1997).

Sample	N	M	min-max	SD	Homogeneous sets		
1	35	2.84	2.53-3.19	0.156		X	X
2	16	3.07	2.74-3.44	0.202	X		
3	15	2.76	2.58-2.96	0.130			X
4	75	3.01	2.53-3.37	0.161	X		
5	36	2.93	2.66-3.15	0.123	X	X	
6	62	2.88	2.55-3.15	0.142		X	X

ne dopušča trdnega sklepanja o vzročno-posledični povezavi med klimo in velikostjo snežnih voluharic. Analiza fosilnih ostankov iz bolgarske jame Bacho Kiro (N = 298) kaže na postopno zmanjševanje dimenzij prvih spodnjih meljakov v celotnem würmu, ki pa ni bilo odvisno od nihanj v temperaturi (Nadachowski 1984a). Razpoložljivi fosilni material iz Slovenije kaže tudi na morebitne geografske trende sinhronih populacij. Dimenzije šestih M_1 iz interpleniglacialnih plasti visokoalpske paleolitske postaje Potočka zijalka v Savinjskih Alpah[4] so npr. v povprečju značilno manjše od primerkov iz le nekaj tisoč let starejših plasti iz Divjih bab I.

V Divjih babah I je bilo zastopanih vseh pet morfotipov M_1, ki jih navaja Nadachowski (1984a). Daleč najštevilčnejši je morfotip *nivalid* (*tab. 10.4*), kar je značilno tudi za recentne populacije *Ch. nivalis* iz Julijskih Alp in s Snežnika (Kryštufek 1990), za subfosilni material iz Viktorjevega spodmola (Toškan, Kryštufek 2004) ter za fosilne populacije *Ch. nivalis* iz Potočke zijalke (Rabeder 2004) in Mujine pećine v Dalmaciji (Mauch Lenardić 2005).

Tab. 10.4: Frekvence zastopanosti posameznih morfotipov prvega spodnjega meljaka pri fosilnih snežnih voluharicah (*Chionomys nivalis*) iz Divjih bab I. Vzorci: 1 - facija A (OIS 3); 2 - facija B (OIS 3), 3 - facija C (OIS 5a). Podatke za vzorec 1 podaja Kryštufek (1997).

Tab. 10.4: Frequencies of morphotypes of 1st lower molar in snow voles (*Chionomys nivalis*) from Divje babe I. Samples: 1 - facies A (OIS 3); 2 - facies B (OIS 3), 3 - facies C (OIS 5a). Sample 1 is from Kryštufek (1997).

Morphotype	Sample 1	Sample 2	Sample 3
Ratticepid	–	–	1
Advanced nivalid	3	–	1
Nivalid-ratticepid	37	8	15
Nivalid	68	29	65
Gud	1	–	–
TOTAL	109	37	82

Arvicola terrestris (Linnaeus, 1758)

Gradivo: plast 7: zob; plast 8: 8 zob; plast 8/10: zob; plast 10: 8 zob; plast 11: 19 zob; plast 11/12: 2 zoba; plast 12/13: zob; plast 13: spodnja čeljustnica in 3 zobje; plast 13/14: 7 zob; plast 14: 26 zob; plast 15: 6 zob; plast 15/16: 2 zoba; plast 16: 35 zob; plast 16a: 3 zobje. Številke pretežnega dela vzorcev, iz katerih so bili pobrani posamezni zobje, podaja Toškan (2002). Seznam preostalih vzorcev: plast 8: zob (vzorec 16/26); plast 13: spodnja čeljustnica (vzorec 22/34); plast 15/16: zob (vzorec 32/32); plast 16: spodnja čeljustnica (vzorec 25/35); iz profila: zob (y = –2,0 z = –3,21 do –3,30), zob (y = –1,0 z = –3,14 do –3,19), zob (y = –2,0 z = –3,37 do –3,43), 2 zoba (y = –2,0 z = –3,21 do –3,30).

Veliki voluhar je bil v sklopu plasti 6 do 17a1 Divjih bab I zastopan s 123 najdbami. Prvi spodnji meljaki nimajo odebeljene posteriorne plasti sklenine in tanke anteriorne plasti, zato jih uvrščava k recentni vrsti *A. terrestris*. Sodeč po dolžini M_1 in M^3 so bili veliki voluharji iz zgodnjega glaciala (facija C) na območju Divjih bab I značilno večji od tistih iz interpleniglaciala (faciji A in B) in holocena (Kruskal-Wallisov test: $p < 0,05$; *tab. 10.5*). O podobnem trendu zmanjševanja dolžine meljakov v času würma in holocena poročata tudi Nadachowski (1984a) za M^3 velikega voluharja iz bolgarske jame Bacho Kiro (N = 41) in Mauch Lenardić (2005) za M_2 (ne pa tudi M_1) iste vrste iz hrvaške jame Vindija (M_1: N = 302; M_2: N = 133). Zaradi nedavnih sprememb v taksonomiji rodu *Arvicola* (Wilson, Reeder 2005) so tolmačenja sprememb v velikosti težavna. Tako lahko tradicionalno interpretacijo o intraspecijskih trendih nadomestimo s hipotezo o alternaciji dveh vrst: večje *A.*

Tab. 10.5: Opisna statistika za dolžino prvega spodnjega in tretjega zgornjega meljaka v štirih oz. treh vzorcih velikega voluharja (*Arvicola terrestris*). Homogeni nizi temeljijo na Schefféjevem testu. Vzorci: 1 - recentni *A. terrestris* iz Slovenije (Žirovski vrh, Čaven, okolica Divjih bab I); 2 - fosilni primerki iz Divjih bab I (facija A; OIS 3); 3 - fosilni primerki iz Divjih bab I (facija B; OIS 3); 4 - fosilni primerki iz Divjih bab I (facija C; OIS 5a); 5 - recentni *A. terrestris* iz Slovenije (Žirovski vrh, Čaven); 6 - subfosilni primerki iz Viktorjevega spodmola; 7 - fosilni primerki iz Divjih bab I (facije A–C; OIS 3 in OIS 5a). Podani so velikost vzorca (N), povprečna vrednost (M) in razpon (min.-max.). Vrednosti za vzorec 2 podaja Kryštufek (1997), za vzorec 6 pa Toškan in Kryštufek (2004). Vse mere so v mm.

Tab. 10.5: Descriptive statistics for length of 1st lower and 3rd upper molar (in mm) in four and three water vole (*Arvicola terrestris*) samples, respectively. The largest homogeneous sets were identified by Scheffé test. Samples: 1 - recent *A. terrestris* from Slovenia (Žirovski vrh, Čaven, vicinity of Divje babe I); 2 - fossil material from Divje babe I (facies A; OIS 3); 3 - fossil material from Divje babe I (facies B; OIS 3); 4 - fossil material from Divje babe I (facies C; OIS 5a); 5 - recent *A. terrestris* from Slovenia (Žirovski vrh, Čaven); 6 - subfossil specimens from Viktorjev spodmol; 7 - fossil material from Divje babe I (facies A–C; OIS 3 and OIS 5a). Given are sample size (N), arithmetic mean (M), range (min.-max.) and standard deviation (SD). Sources for samples: 2 - Kryštufek (1997), 6 - Toškan and Kryštufek (2004).

Sample	N	M	min-max	Homogeneous sets	
M_1:					
1	34	3.82	3.50-4.42	X	
2	10	3.87	3.23-4.32	X	
3	13	3.84	3.61-4.26	X	
4	17	3.97	3.69-4.45		X
M^3:					
5	30	2.34	1.98-2.58	X	
6	6	2.43	2.24-2.55	X	X
7	10	2.55	2.20-2.70		X

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[4] dolžina M_1: Me = 2,83; razpon: 2,55-2,94 (Rabeder 2004)

amphibius (Linnaeus, 1758) in manjše *A. scherman* (Shaw, 1801). Ta problematika zahteva posebno obravnavo.

Analiza morfotipov je v gradivu iz Divjih bab I (sklop plasti 6 do 17a1) kar sedem M^3 od desetih uvrstila h kompleksnemu morfotipu *exitus* (*sensu* Nadachowski 1984a), preostale tri pa k preprostejšemu morfotipu *terrestris*. Slednjega Nadachowski (1984a) povezuje z milejšo klimo, kar pa ni v skladu z najinimi rezultati. Morfotip *terrestris* namreč prevladuje v interpleniglacialnih facijah A in B (= OIS 3), *exitus* pa v zgodnjeglacialni faciji C (= OIS 5), ki je nastajal v obdobju bistveno milejše klime (*tab. 10.6*). Tudi v vzorcih recentnega *A. terrestris* (*A. scherman sensu* Wilson, Reeder 2005) z Žirovskega vrha (N = 14), subfosilnih primerkov iz Viktorjevega spodmola (N = 7; Toškan, Kryštufek 2004) in fosilnega materiala iz Vindije (würm II in würm III; N = 71; Mauch Lenardić 2005) izrazito prevladuje morfotip *terrestris*.

Tab. 10.6: Frekvence zastopanosti morfotipov *terrestris* in *exitus* (*sensu* Nadachowski 1984a) tretjega zgornjega meljaka pri fosilnih velikih voluharjih (*Arvicola terrestris*) iz Divjih bab I. Vzorci: 1 – facija A (OIS 3); 2 – facija B (OIS 3), 3 – facija C (OIS 5a). Podatke za vzorec 1 podaja Kryštufek (1997).

Tab. 10.6: Frequencies of two morphotypes (*terrestris* and *exitus sensu* Nadachowski 1984a) of 3rd upper molar in fossil water voles (*Arvicola terrestris*) from Divje babe I. Samples: 1 – facies A (OIS 3); 2 – facies B (OIS 3), 3 – facies C (OIS 5a). Sample 1 is from Kryštufek (1997).

Morphotype	**Sample 1**	**Sample 2**	**Sample 3**
terrestris	4	1	2
exitus	–	1	6
TOTAL	4	2	8

Myodes glareolus (Schreber, 1780)

Gradivo: plast 7: zob; plast 8: 3 spodnje čeljustnice in 87 zob; plast 8/10: 9 spodnjih čeljustnic, 5 rostrumov in 22 zob; plast 10: 69 zob; plast 10/11: 8 zob; plast 11: 50 zob; plast 11/12: 10 zob; plast 12/13: 14 zob; plast 13: spodnja čeljustnica in 14 zob; plast 13/14: 26 zob; plast 14: 130 zob; plast 15: 32 zob; plast 15/16: 18 zob; plast 16: 301 zob; plast 16a: 68 zob; plast 16a/17a1: 5 zob; plast 17a: zob. Številke pretežnega dela vzorcev, iz katerih so bili pobrani posamezni zobje, podaja Toškan (2002). Seznam preostalih vzorcev: plast 8: 9 zob (vzorci 35/26, 13/26-27, 36/27, 35/26, 16/26); plast 10: 4 spodnje čeljustnice in zgornja čeljustnica (vzorec 18/31); plast 10/11: 2 zoba (vzorec 22 in 25/31); plast 14: spodnja čeljustnica (vzorec 46/32); iz profila: spodnja čeljustnica (y = –1,0 z = –3,19 do –3,29), 5 spodnjih in 5 zgornjih čeljustnic (y = –2,0 z = –3,37 do –3,43), 2 spodnji čeljustnici (y = –2,0 z = –3,21 do –3,30), zob (y = –1,0 z = –3,14 do –3,19), 2 zoba (y = –2,0 z = –3,69 do –3,75), zob (y = –1,0 z = –3,06 do –3,14), zob (y = –2,0 z = –3,96 do –4,05), 2 zoba (y = –2,0 z = –3,37 do –3,43), 3 zobje (y = –2,0 z = –3,21 do –3,30).

Gozdna (rdeča) voluharica je v sklopu plasti 6 do 17a1 Divjih bab I zastopana z 874 najdbami, tako da je v obravnavanem gradivu najbolje zastopan takson malih sesalcev. K takšni percepciji prispeva tudi dejstvo, da značilna morfologija meljakov (prisotnost korenin, zaobljena oblika skleninskih grebenov) omogoča zanesljivo specifično determinacijo vseh meljakov *M. glareolus*, medtem ko je bilo voluharice iz rodov *Microtus* in *Chionomys* mogoče zanesljivo identificarati le na osnovi M_1.

Fosilne gozdne voluharice iz Divjih bab I imajo daljši M_1 od recentnih primerkov iz Slovenije, se pa ne razlikujejo od subfosilnega materiala iz Viktorjevega spodmola (*tab. 10.7*). Čeprav obstaja pri recentnih gozdnih voluharicah iz Slovenije in sosednjih območij pozitivna korelacija med velikostjo in klimo (Janžekovič 1996), pa spremembe velikosti (dolžina M_1) med klimatskimi oscilacijami niso vselej v skladu s pričakovanim pozitivnim Bergmannovim odzivom. V materialu iz Divjih bab I je odsotnost takšnega odziva razvidna iz dolžine M_1 v zgodnjeglacialni faciji C glede na interpleniglacialni faciji A in B (*tab. 10.7*). Kljub očitnim razlikam v klimi med obdobjema nastanka obeh facij (zgodnji glacial je bil bistveno toplejši) razlike med vzorcema namreč niso statistično značilne (F test: F = 0,200; p = 0,655).

Tab. 10.7: Opisna statistika za dolžino prvega spodnjega meljaka v petih vzorcih gozdne voluharice (*Myodes glareolus*). Homogeni nizi temeljijo na Schefféjevem testu. F-test je statistično značilen (F = 10,89; p < 0,001). Vzorci: 1 – recentni *M. glareolus* iz Slovenije; 2 – subfosilni primerki iz Viktorjevega spodmola; 3 – fosilni primerki iz Divjih bab I (facija A; OIS 3); 4 – fosilni primerki iz Divjih bab I (facija B; OIS 3); 5 – fosilni primerki iz Divjih bab I (facija C; OIS 5a). Podani so velikost vzorca (N), povprečna vrednost (M), razpon (min.–max.) in standardna deviacija (SD). Vrednosti za vzorec 2 podajata Toškan in Kryštufek (2004). Vse mere so v mm.

Tab. 10.7: Descriptive statistics for length of 1st lower molar in five bank vole (*Myodes glareolus*) samples (in mm). The largest homogeneous sets were identified by Scheffé test; F-statistics is significant (F = 10.89; p < 0.001). Samples: 1 – recent *M. glareolus* from Slovenia; 2 – subfossil specimens from Viktorjev spodmol; 3 – fossil material from Divje babe I (facies A; OIS 3); 4 – fossil material from Divje babe I (facies B; OIS 3); 5 – fossil material from Divje babe I (facies C; OIS 5a). Given are sample size (N), arithmetic mean (M), range (min.–max.) and standard deviation (SD). Sample 2 is from Toškan and Kryštufek (2004).

Sample	**N**	**M**	**min–max**	**SD**	**Homogeneous sets**	
1	104	2.28	1.79–2.60	0.197	X	
2	112	2.37	1.98–2.93	0.147		X
3	90	2.43	2.11–2.76	0.148		X
4	94	2.38	2.05–2.96	0.167		X
5	73	2.41	2.05–2.96	0.183		X

Analiza morfotipov M^3 v fosilnem gradivu iz Divjih bab I je pokazala na prevlado tipa *complex* (predvsem podtipa *typica*), kar je sicer značilno tudi za recentne gozdne voluharice iz Slovenije, subfosilne primerke iz Viktorjevega spodmola (Toškan, Kryštufek 2004) ter fosilni material iz Vindije (Mauch Lenardić 2005; *tab. 10.8*).

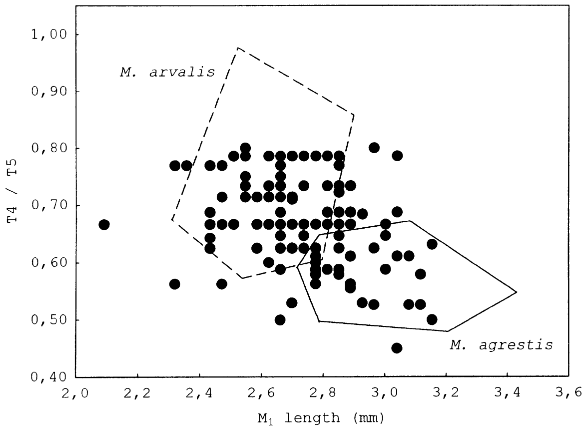
Microtus ex gr. *agrestis* - *arvalis*

Gradivo: plast 8: zob; plast 8/10: zob; plast 10: 8 zob; plast 10/11: zob; plast 11: 9 zob; plast 11/12: 3 zobje; plast 13: 5 zob; plast 13/14: 6 zob; plast 14: 35 zob; plast 15: 16 zob; plast 15/16: 7 zob; plast 16: 115 zob; plast 16a: 16 zob; plast 16a/17a1: 3 zobje. Številke pretežnega dela vzorcev, iz katerih so bili pobrani posamezni zobje, podaja Toškan (2002). Seznam preostalih vzorcev: plast 8: zob (vzorec 13/26-27).

Številčen arvikolinski material M_1 iz sklopa plasti 6 do 17a1 Divjih bab I (226 primerkov) sva na osnovi oblike anterokonidnega kompleksa (ločeni dentinski polji T4 in T5) uvrstila v kompleks dveh recentnih vrst: poljske voluharice *Microtus arvalis* (Pallas, 1779) in travniške voluharice *M. agrestis* (Linnaeus, 1761). Zanesljivo razlikovanje med obema vrstama omogoča le M^2, ki ima pri travniški voluharici dodaten posterolingvalni trikotnik (T5), čeprav je tudi ta znak podvržen časovni in geografski variabilnosti (Kowalski 1970; Nadachowski 1985; Kryštufek 1986). Razmeroma veliko število M^2 s prisotnim trikotnikom T5 v vzorcu iz Divjih bab I (N = 33) vseeno nedvoumno dokazuje prisotnost travniške voluharice.

Tab. 10.8: Frekvence zastopanosti posameznih morfotipov tretjega zgornjega meljaka pri štirih vzorcih gozdnih voluharic (*Myodes glareolus*). Vzorci: 1 - recentni *M. glareolus* iz Slovenije; 2 - subfosilni primerki iz Viktorjevega spodmola; 3 - fosilni primerki iz Vindije (würm II in würm III); 4 - fosilni primerki iz Divjih bab I (facije A do C; OIS 3 in OIS 5a). Podatke za vzorec 2 podajata Toškan in Kryštufek (2004), za vzorec 3 pa Mauch Lenardić (2005).
Tab. 10.8: Frequencies of morphotypes of 3rd upper molar in four bank vole (*Myodes glareolus*) samples. Samples: 1 - recent *M. glareolus* from Slovenia; 2 - subfossil specimens from Viktorjev spodmol; 3 - fossil specimens from Vindija (Würmian II and III); 4 - fossil material from Divje babe I (facies A to C; OIS 3 and OIS 5a). Sample 2 is from Toškan and Kryštufek (2004), sample 3 is from Mauch Lenardić (2005).

Morphotype	**Sample**			
	1	**2**	**3**	**4**
Simplex	5	26	–	11
Complex	7	10	9	1
Complex-typica	10	55	3	36
Complex-duplicata	8	12	4	18



Sl. 10.2: Odnos med količnikom trikotnikov T4 in T5 kot imenovalcem (T4/T5) in dolžino prvega spodnjega meljaka pri *Microtus* ex. gr. *agrestis*/*arvalis*. Poligona obkrožata vrednosti za 45 recentnih primerkov *M. agrestis* (sklenjena črta) in 45 recentnih primerkov *M. arvalis* (prekinjena črta) iz osrednje Slovenije. Pike označujejo fosilne primerke *Microtus* ex gr. *agrestis-arvalis* iz Divjih bab I (sklop plasti 6 do 17a1).
Fig. 10.2: Bivariate plot of quotient between enamel triangles T4 and T5 (T4/T5) against length of 1st lower molar in *Microtus* ex. gr. *agrestis-arvalis*. Polygons enclose extremes for 45 recent *M. agrestis* (full line) and 45 recent *M. arvalis* (dashed line), respectively, from central Slovenia. Dots are fossil specimens of *Microtus* ex gr. *agrestis-arvalis* from Divje babe I (layers 6 to 17a1).

Prve spodnje meljake sva določala po znakih, ki jih predlaga Nadachowski (1984b). Ker sta pri *M. arvalis* trikotnika T4 in T5 približno enako velika, pri *M. agrestis* pa je T5 večji od T4, omogoča količnik med dolžinama trikotnikov (T4/T5) glede na dolžino M_1 razmeroma učinkovito razlikovanje obeh vrst. Na tej osnovi sva v gradivu iz Divjih bab I lahko potrdila prisotnost obeh vrst, od katerih je bila *M. arvalis* pogostejša (*sl. 10.2*). V dolžini M_1 tvorijo fosilni primerki iz vsake od treh facij Divjih bab I homogeno skupino s subfosilnimi M_1 iz Viktorjevega spodmola ter z recentnimi *M. arvalis* z Ljubljanskega barja, Kranjske gore in Julijskih Alp (*tab. 10.9*); recentni primerki *M. agrestis* z Ljubljanskega barja so statistično značilno večji (F-test: F = 130; p < 0,001).

Microtus ex gr. *liechtensteini* - *subterraneus*

Gradivo: plast 10: 2 zoba (vzorec 18/31); plast 11: 4 zobje (vzorci 29/30, 32/30, 40/30); plast 14: 7 zob (vzorca 32/31, 28/32); plast 16: 4 zobje (vzorci 32/33, 29/34, 28/35, 29/36).

Pitymoidne prve spodnje meljake (N = 17) lahko vse pripišemo vrtni voluharici *Microtus subterraneus* (de Salys-Longchamps, 1836) ali ilirski voluharici *M. liechtensteini* (Wettstein, 1927). Meljake tega taksona smo našli v 10 vzorcih iz štirih plasti.

Vrsti *Microtus subterraneus* in *M. liechtensteini* se razlikujeta po kromosomskem številu, morfološko pa sta

Tab. 10.9: Opisna statistika za dolžino prvega spodnjega meljaka v šestih vzorcih travniške / poljske voluharice (*Microtus* ex gr. *agrestis* - *arvalis*). Homogeni nizi temeljijo na Schefféjevem testu. Vzorci: 1 - recentni *M. agrestis* iz Slovenije (Ljubljansko barje, Kranjska gora, Julijske Alpe); 2 - recentni *M. arvalis* iz Slovenije (Ljubljansko barje); 3 - subfosilni primerki obeh vrst iz Viktorjevega spodmola; 4 - fosilni primerki obeh vrst iz Divjih bab I (facija A; OIS 3); 5 - fosilni primerki obeh vrst iz Divjih bab I (facija B; OIS 3); 6 - fosilni primerki obeh vrst iz Divjih bab I (facija C; OIS 5a). Podani so velikost vzorca (N), povprečna vrednost (M), razpon (min.-max.) in standardna deviacija (SD). Vse mere so v mm.
Tab. 10.9: Descriptive statistics for length of 1st lower molar (in mm) in six samples of common / field voles (*Microtus* ex gr. *agrestis* - *arvalis*). The largest homogeneous sets were identified by Scheffé test. Samples: 1 - recent *M. agrestis* from Slovenia (Ljubljansko barje, Kranjska gora, the Julian Alps); 2 - recent *M. arvalis* from Slovenia (Ljubljansko barje); 3 - subfossil specimens of both species from Viktorjev spodmol; 4 - fossil material of both species from Divje babe I (facies A; OIS 3); 5 - fossil material of both species from Divje babe I (facies B; OIS 3); 6 - fossil material of both species from Divje babe I (facies C; OIS 5a). Given are sample size (N), arithmetic mean (M), range (min.-max.) and standard deviation (SD).

Sample	N	M	min-max	SD	Homogeneous sets	
1	45	3.03	2.77-3.47	0.143	X	
2	45	2.68	2.42-2.95	0.138		X
3	106	2.68	2.28-3.15	0.198		X
4	38	2.73	2.39-3.26	0.192		X
5	23	2.70	2.32-3.15	0.201		X
6	127	2.73	2.09-3.15	0.184		X

Tab. 10.10: Opisna statistika za dolžino prvega spodnjega meljaka v štirih vzorcih vrtne / ilirske voluharice (*Microtus* ex gr. *subterraneus* - *liechtensteini*). Homogeni nizi temeljijo na Schefféjevem testu. Vzorci: 1 - recentni *M. liechtensteini* iz Slovenije; 2 - recentni *M. subterraneus* iz osrednje Slovenije; 3 - fosilni primerki obeh vrst iz Divjih bab I (faciji A in B; OIS 3); 4 - fosilni primerki obeh vrst iz Divjih bab I (facija C; OIS 5a). Podani so velikost vzorca (N), povprečna vrednost (M), razpon (min.-max.) in standardna deviacija (SD). Vse mere so v mm.
Tab. 10.10: Descriptive statistics for length of 1st lower molar (in mm) in four samples of common / Liechtenstein's pine voles (*Microtus* ex gr. *subterraneus* - *liechtensteini*). The largest homogeneous sets were identified by Scheffé test. Samples: 1 - recent *M. liechtensteini* from Slovenia; 2 - recent *M. subterraneus* from central Slovenia; 3 - fossil specimens of both species from Divje babe I (facies A and B; OIS 3); 4 - fossil specimens of both species from Divje babe I (facies C; OIS 5a). Given are sample size (N), arithmetic mean (M), range (min.-max.) and standard deviation (SD).

Sample	N	M	min-max	SD	Homogeneous sets	
1	33	2.76	2.48-3.15	0.154	X	
2	30	2.65	2.23-2.85	0.128		X
3	25	2.69	2.39-3.16	0.174	X	X
4	9	2.68	2.51-2.92	0.119	X	X

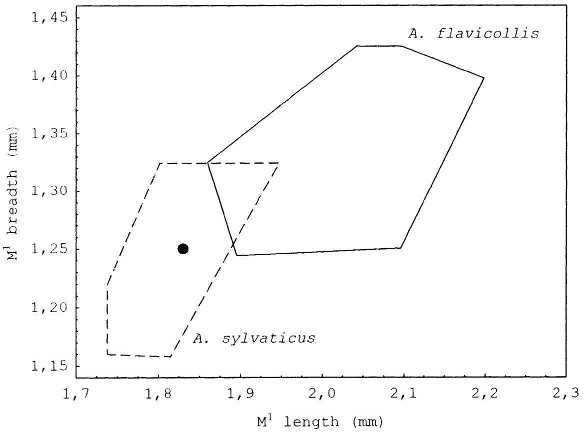
si zelo podobni. *Microtus liechtensteini* je sicer večji, vendar se vrednosti dolžine izoliranih zob na veliko prekrivajo (Kryštufek 1997). Večina navedenih pitymoidnih M_1 iz Divjih bab I je v velikosti vseeno bližja vrtni voluharici (*tab. 10.10*), kar je značilno tudi za material interpleniglacialne starosti iz Potočke zijalke (Rabeder 2004) in Vindije (Mauch Lenardić 2005).

Družina: Miši (Muridae)

Apodemus cfr. *sylvaticus* (Linnaeus, 1758)

Gradivo: plast 16: zob (vzorec 29/34).

Prvi zgornji meljak iz plasti 16 predstavlja edino najdbo rodu *Apodemus* v sklopu plasti 6 do 17a1 Divjih bab I. Specifična determinacija temelji na metričnih podatkih[5] in zato ni povsem zanesljiva (*sl. 10.3*); recentne populacije *A. sylvaticus* in *A. flavicollis* namreč izkazujejo znatno variabilnost v velikosti (Alcántra 1991; Kryštufek, Stojanovski 1996). Navadna belonoga miš je bila v Divjih babah I verjetno zastopana tudi v sklopu plasti 2 do 5, kjer pa po številu najdb močno zaostaja za vrsto *A. flavicollis* (Kryštufek 1997).



Sl. 10.3: Odnos med dolžino prvega zgornjega meljaka in njegovo širino pri *Apodemus* ex gr. *flavicollis-sylvaticus*. Poligona obkrožata vrednosti za 35 recentnih primerkov *A. flavicollis* (sklenjena črta) in 35 recentnih primerkov *A. sylvaticus* (prekinjena črta) iz osrednje Slovenije. Pika predstavlja fosilni primerek iz Divjih bab I (plast 16: vzorec 29/34).
Fig. 10.3: Bivariate plot of breadth of 1st upper molar against its length in *Apodemus* ex gr. *flavicollis-sylvaticus*. Polygons enclose extremes for 35 recent *A. flavicollis* (full line) and 35 recent *A. sylvaticus* (dashed line), respectively, from central Slovenia. Dot is a fossil specimen from Divje babe I (Layer 16: sample 29/34).

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[5] Razlike v morfologiji zob med vrstama *Apodemus sylvaticus* in *A. flavicollis* (Melchior, 1834) so zelo majhne in praviloma ne dovoljujejo razlikovanja na nivoju vrste (Mayhew 1978; Kowalski, Nadachowski 1982; Popov 1989; Janžekovič, Kryštufek 2004).

Družina: Polhi (Gliridae)

Glis glis (Linnaeus, 1766)

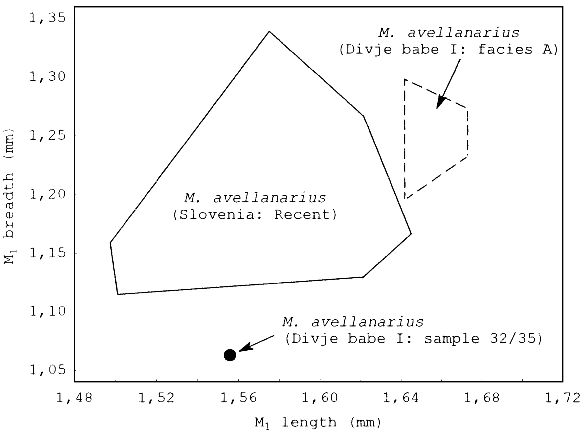
Gradivo: plast 7: spodnja čeljustnica (vzorec 3/21).

Navadni polh je v gradivu iz sklopa plasti 6 do 17a1 Divjih bab I zastopan le s spodnjo čeljustnico iz plasti 7,[6] medtem ko predstavlja v vzorcu malih sesalcev iz sklopa plasti 2 do 5 skoraj 50 odstotkov skupnega MNI (Kryštufek 1997). Večina ostankov izvira iz najbolj zgornjih pleistocenskih plasti tik pod površjem, zaradi česar ne moreva izključiti kontaminacije z recentnimi polhi. V času izkopavanj v Divjih babah I je namreč I. Turk približno 20 cm pod površjem (torej pod sigo, ki je holocenskega izvora) dvakrat našel speče polhe. Znano je, da polhi redno zahajajo globoko v jame, kjer tudi prezimijo (Polak 1996). Kljub možnosti kontaminacije pa je vsaj delu ostankov vrste *G. glis* iz Divjih bab I vendarle mogoče pripisati pleistocensko starost. O najdbah navadnega polha namreč poročajo tudi iz približno sočasnih najdišč Italije (Bon *et al.* 1991; Bartolomei 2003), Avstrije (Fladerer 2000) in Slovenije (Potočka zijalka; Brodar, S. & M., 1983).

Muscardinus avellanarius (Linnaeus, 1758)

Gradivo: plast 13/14: zob (vzorec 13/14); plast 16a/17a1: zob (vzorec 32/35).

Podlesek je v gradivu iz sklopa plasti 6 do 17a1 Divjih bab I zastopan le z dvema izoliranima kočnikoma, od katerih je eden fragmentiran. Nepoškodovan prvi spodnji meljak iz plasti 16a/17a1 je po dimenzijah pod variacijsko širino recentnih *M. avellanarius* iz Slovenije. Razlika v velikosti je še očitnejša v primerjavi z desetimi fosilnimi M_1 iz zgornjih petih plasti Divjih bab I (*sl. 10.4*).



Sl. 10.4: Odnos med dolžino prvega spodnjega meljaka in njegovo širino pri podlesku (*Muscardinus avellanarius*). Poligona obkrožata vrednosti za 14 recentnih primerkov *M. avellanarius* iz Slovenije (sklenjena črta) in 10 fosilnih primerkov iste vrste iz sklopa plasti 2 do 5 Divjih bab I (prekinjena črta; Kryštufek 1997). Pika predstavlja fosilni primerek iz Divjih bab I (plast 16a/17a1: vzorec 32/35).
Fig. 10.4: Bivariate plot of breadth of 1st lower molar against its length in common dormice (*Muscardinus avellanarius*). Polygons enclose extremes for 14 recent *M. avellanarius* from Slovenia (full line) and 10 fossil specimens from layers 2 to 5 of Divje babe I (dashed line; Kryštufek 1997), respectively. Dot is a fossil animal from Divje babe I (Layer 16a/17a1: sample 32/35).

Družina: Skočice (Dipodidae)

Sicista cfr. *subtilis* (Pallas, 1773)

Gradivo: plast 13/14: zob (vzorec 26/33).

Rod *Sicista* je v Divjih babah I zastopan le s prvim spodnjim meljakom iz plasti 13/14. Zanesljiva specifična determinacija ni mogoča, saj razlikovanje med severno brezovo mišjo *Sicista betulina* (Pallas, 1779) in stepsko brezovo mišjo (*S. subtilis*) le na osnovi izoliranih zob ni vselej zanesljivo. *S. subtilis* se od *S. betulina* do neke mere loči po preprosteje oblikovani žvekalni površini meljakov (Kowalski, Nadachowski 1982), vendar pa Chaline (1972) omenjenih morfoloških razlik ne obravnava kot zanesljiv taksonomski znak. Uporabnejši znak so dimenzije meljakov (večje pri stepski vrsti). Širina prvega spodnjega meljaka iz Divjih bab I je znotraj variacijske širine za recentne *S. subtilis* iz Romunije, njegova dolžina pa jo celo presega (*tab. 10.11*). Ker fosilni zobje severne in stepske brezove miši v svojih dimenzijah presegajo vrednosti recentnega materiala (Terzea 1974; Kowalski, Nadachowski 1982; Popov 1994), sva M_1 iz Divjih bab I primerjala še s fosilnimi prvimi spodnjimi meljaki obeh vrst. Primerjava je pokazala, da je primerek iz Divjih bab I po svoji dolžini in širini znotraj variacijske širine fosilnih *S. subtilis* (*tab. 10.11*), zato sva ga pogojno pripisala k tej vrsti.

Stepska brezova miš velja za razmeroma evritopično vrsto, ki ji ustrezajo tako stepe, travniki in odprti gozdovi kot tudi agrocenoze in robovi obdelanih površin (Pucek 1999). V recentni favni Slovenije vrsta ni zastopana (Kryštufek 1991), še vedno pa naseljuje Panonsko nižino, Romunijo, Bolgarijo in jugovzhodno Poljsko (Pucek 1999). Da je bil v mlajšem pleistocenu njen areal razširjenosti bistveno obsežnejši, dokazujejo najdbe iz Francije (Chaline, Brochet 1989), morda severne Italije (Bon *et al.* 1991), Švice, Nemčije (Kowalski in Nadachowski 1982), Avstrije (Fladerer 2000), nekdanje Češkoslovaške (Kurtén 1968), Srbije (Dimitrijević 1996) in Grčije (Mayhew 1978). Za pleistocen Slovenije je Rakovec (1973) ne omenja, so pa bili njeni ostanki najdeni v interpleniglacialnih sedimentih iz Potočke zijalke (Toškan, Kryštufek 2006).

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[6] V isti plasti je bilo najdeno tudi oglje bukve (glej poglavje 8 v tem zborniku).

Tab. 10.11: Opisna statistika za dolžino in širino prvega spodnjega meljaka v desetih vzorcih *Sicista subtilis / betulina*. Številke vzorcev: 1 – recentne *S. subtilis* iz Valul lui Traiana (Romunija); 2 – recentne *S. subtilis* iz južnega dela nekdanje Sovjetske zveze; 3 – subfosilni primerki *S. subtilis* iz jame Peştera Bursucilor (Romunija, holocen); 4 – fosilni primerki *S. subtilis* iz jame Peştera Bursucilor (Romunija, würm); 5 – fosilni primerki *S. subtilis* iz jame Peştera Hotilor (Romunija, würm); 6 – fosilni primerki *S. subtilis* iz jame Temnata (Bolgarija, mlajši pleistocen); 7 – fosilni primerki *S. subtilis* iz jame Morovitsa (Bolgarija, srednji pleistocen); 8 – recentne *S. betulina* iz Białowieze (Poljska); 9 – recentne *S. betulina* iz južnega dela nekdanje Sovjetske zveze; 10 – fosilni primerek *Sicista* cfr. *subtilis* iz Divjih bab I (plast 13/14). Podani so velikost vzorca (N), povprečna vrednost (M) in variacijska širina (min.-max.). Podatke za vzorca 1 in 8 podajata Niethammer in Krapp (1982), za vzorce 2, 3, 4, 5 in 9 Terzea (1974), za vzorca 6 in 7 pa Popov (1989; 1994). Vse mere so v mm.

Tab. 10.11: Descriptive statistics for length and breadth of 1st lower molar (in mm) in ten samples of *Sicista subtilis / betulina*. Samples: 1 – recent *S. subtilis* from Valul lui Traiana (Romania); 2 – recent *S. subtilis* from southern parts of former Soviet Union; 3 – subfossil specimens of *S. subtilis* from the cave Peştera Bursucilor (Romania, Holocene); 4 – fossil specimens of *S. subtilis* from the cave Peştera Bursucilor (Romania, Würm); 5 – fossil specimens of *S. subtilis* from the cave Peştera Hotilor (Romania, Würm); 6 – fossil specimens of *S. subtilis* from the cave Temnata (Bulgaria, Upper Pleistocene); 7 – fossil specimens of *S. subtilis* from the cave Morovitsa (Bulgaria, Middle Pleistocene); 8 – recent *S. betulina* from Białowieze (Poland); 9 – recent *S. betulina* from southern parts of former Soviet Union; 10 – fossil specimens of *Sicista* cfr. *subtilis* from Divje babe I (Layer 13/14). Given are sample size (N), arithmetic mean (M) and range (min.-max.). Sources for samples: 1, 8 – Niethammer and Krapp (1982), 2, 3, 4, 5 and 9 – Terzea (1974), 6 and 7 – Popov (1989; 1994).

Dimension	Sample	N	M	min-max
M_1 length	1	19	1.12	1.08-1.18
	2	16	–	1.1-1.2
	3	11	–	1.08-1.15
	4	1	1.25	–
	5	6	–	1.05-1.22
	6	8	1.25	1.20-1.27
	7	9	1.27	1.24-1.38
	8	23	1.02	0.96-1.07
	9	13	–	1.0-1.1
	10	1	1.25	–
M_1 breadth	1	19	0.88	0.80-0.93
	6	8	0.96	0.90-1.00
	7	9	0.92	0.85-0.95
	8	23	0.74	0.71-0.79
	10	1	0.84	–

TAFOCENOZA

Najmanjše število osebkov posameznih taksonov malih sesalcev iz fosilnega gradiva Divjih bab I (sklop plasti 6 do 17a1) podajava v *tabeli 10.12*. Posamezne plasti se po številu ostankov na enoto sedimenta med seboj zelo razlikujejo. Čeprav je izkopno polje, s katerega izvira material malih sesalcev, obsegalo 83 m², je bilo kar 85 odstotkov vseh čeljustnic in izoliranih zob najdenih v le štirih kvadratih (in sicer: 26, 28, 29 in 32).

Tako kot to velja za večino kostnih akumulacij malih sesalcev v jamah so bile zelo verjetno tudi v Divjih babah I poglavitni dejavnik njene akumulacije sove. To med drugim pomeni, da se v sestavi vzorca kažejo preference plenilca do posamezne kategorije plena, tako da razpoložljivo gradivo ne odseva dejanske sestave nekdanje združbe malih sesalcev (Andrews 1990; Popov 1994; Chaline *et al.* 1995). Razlike v sestavi prehrane so pri sovah celo med osebki iste vrste, ki naseljujejo različne habitate (npr. Purger 1989–90; Tome 1992; Lipej in Gjerkeš 1994; 1996). Sestava prehrane se spreminja tudi s sezono plenjenja ter s starostjo plenilca in plena. Interpretacija tafocenoz je dodatno otežena zaradi razlik v intenzivnosti, s katero se kosti uplenjenih živali raztapljajo v prebavnih sokovih sov (Andrews 1990; Chaline *et al.* 1995). Kljub temu v primeru Divjih bab I ocenjujeva, da ugotovljene razlike med favno treh facij zadovoljivo povzemajo značilnosti nekdanjih okolij. Ker se je material v posameznih facijah akumuliral skozi dolgo časovno obdobje, so v skupnem vzorcu vsaj nekatere od zgoraj navedenih pristranosti namreč domnevno izničene.

Sodeč po vrstni sestavi vzorca iz facije C (plasti 12/13 do 17a1) je bila ob koncu zgodnjega glaciala klima v širši okolici Divjih bab I zmerna. To dokazuje prisotnost krta, ki ne prenese globoke sezonske zamrznitve tal. Najmanj dve vrsti (*M. glareolus* in *M. avellanarius*) kažeta na obstoj gozdov. Glede na zastopanost vrste *S. alpinus* (morda pa tudi *S. araneus*) ter hkratno odsotnost frugivornih vrst (*G. glis*, *A. flavicollis*) sodiva, da so v gozdovih prevladovali iglavci. Sicer pa delež na gozd vezanih vrst zelo zaostaja za deležem tistih, ki naseljujejo odprte habitate (*sl. 10.5*). Med slednjimi močno prevladujejo vrste rodu *Microtus* (*M.* ex gr. *agrestis-arvalis* tvori 40 % skupnega MNI), številni pa so tudi ostanki vrste *Ch. nivalis* (19 % skupnega MNI). Domnevni prevladi travnatih površin in kamenišč nad gozdnimi sestoji v OIS 5a[7] pa najverjetneje niso botrovale prenizke temperature (najdbe krta), ampak sušna klima. Skladni s takšnim sklepom sta najdbi stepske brezove miši in dvobarvnega netopirja. Obe vrsti je sicer mogoče najti tudi v odprti gozdnati krajini (Kryštufek, Červeny 1997; Pucek 1999), njuna osnovna habitata pa so vendarle stepa in gore (*V. murinus*; Kryštufek 1991) oz. stepa in travnik (*S. subtilis*; Pucek 1999).

Na razširjenost odprtih habitatov v okolici Divjih bab I ob koncu zgodnjega glaciala kažejo tudi nizka vrst-

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[7] To potrjujejo izsledki palinološke analize, saj se je v OIS 5a delež zeliščnega peloda z začetnih 10 odstotkov postopoma povzpel na kar 80 odstotkov vsega zbranega peloda (Šercelj, Culiberg 1991).

Tab. 10.12: Najmanjše število osebkov (MNI) v fosilnih združbah malih sesalcev iz Divjih bab I (sklop plasti 6 do 17a1). Senčena polja označujejo prisotnost taksona v plasti. Podani so tudi število določenih elementov (NISP) za posamezen takson, skupno število vzorcev na posamezno plast ter skupni volumen frakcije sedimenta velikosti 0,5 do 10 mm na plast.
Tab. 10.12: Minimum Number of Individuals (MNI) in small mammal fossil assemblages from Divje babe I (layers 6 to 17a1). Shaded cells indicate presence of taxon in a layer. Also given are data on the Number of Identified Specimens (NISP) for individual taxa, number of samples per layer and total volume of sediment fraction (particle size 0.5 to 10 mm) per layer.

Taxon	**7**	**8**	**8/10**	**10**	**10/11**	**11**	**11/12**	**12/13**	**13**	**13/14**	**14**	**15**	**15/16**	**16**	**16 a**	**16a/17a1**	**17 a1**	**Σ MNI**	**Σ NISP**
Erinaceus sp.				1														1	1
S. araneus		1	▨	1														2	3
S. alpinus		1		1							1							3	4
S. araneus/alpinus		▨				▨					▨			▨				–	6
Talpa sp.		▨									1			1				2	5
V. murinus														1				1	1
M. glareolus	1	22	4	16	2	12	4	5	▨	6	18	7	2	48	4	▨	▨	151	874
A. terrestris	▨	3	▨	3		6	▨	▨	1	3	4	2	2	4	1			29	123
Ch. nivalis		5	3	13	2	7		1	2	2	10	4	5	26	2	1		83	243
M. agrestis/arvalis		1	1	8	1	2	1		2	3	19	9	4	53	15	3		122	226
M. multiplex/ subterr.				1		3					4			3				11	17
Arvicollinae indet.	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	–	845
Apodemus sp.														1				1	1
Sicista cfr. *subtilis*										1								1	1
G. glis	1																	1	1
M. avellanarius										1						1		2	2
TOTAL	2	33	8	44	5	30	5	6	5	16	57	22	13	137	22	5	0	410	2353
N of samples	15	338	27	58	17	49	12	14	27	7	25	12	11	37	6	2	4	–	–
Volume (x 10^3 ml)	9	194	14	34	10	29	7	8	14	4	15	6	6	25	4	1	24	–	–

na pestrost[8] in velike razlike v deležu različnih prehranjevalnih skupin (delež rastlinojedov presega 90 %). Praviloma je namreč pestrost združbe malih sesalcev v suhih habitatih s slabo vertikalno strukturiranostjo (npr. stepa z nizko travo, zaprti in suhi gozdovi) manjša kot v okolju z bolj raznoliko rastlinsko odejo (Popov 2000). Tako se v sesalskih združbah slabo strukturiranih habitatov pretežen del energije pretaka na relaciji med herbivori in njihovimi plenilci, medtem ko insektivori in omnivori (vključno s specializiranimi granivori) v skupni abundanci praviloma ne predstavljajo večjega deleža (Horáček, Ložek 1988).

Vrstna in abundančna sestava facije B navaja na misel, da je bila klima ob nastopu interpleniglaciala bistveno drugačna od zgodnjeglacialne. Sedimenti iz vmesnega obdobja (OIS 4) so v jami domnevno slabo zastopani, verjetno zaradi zastoja v sedimentaciji (poglavji 6 in 7 v tem zborniku). Z 12 vrstami ostaja sicer pestrost združbe malih sesalcev razmeroma skromna tudi v vzorcu iz facije B (sklop plasti 7 do 11/12). Bistveno nižji pa je delež vrst odprtih habitatov, ki je od 59 % v faciji C zdrknil na 39 % v faciji B. To je očitno posledica zmanjšanja relativne frekvence ostankov kompleksa *M.* ex gr. *agrestis-arvalis* (le še 10 % skupnega MNI). Po drugi strani je nekoliko povečan delež *Ch. nivalis* (*sl. 10.5*). Po Popovu (2000) lahko to interpretiramo kot odsev postopne vzpostavitve relativno uravnovešenega in vlažnega, a hkrati tudi hladnega podnebja.[9] Povečanje vlažnosti je domnevno omogočilo širitev gozdov (relativni delež *C. glareolus* je blizu 50 %), ki pa so bili verjetno pretežno iglasti. Na nižje temperature in večjo vlažnost okolja med nastajanjem facije B kaže tudi relativno večje število najdb rovk iz rodu *Sorex* (prim. Anděra 1999; Spitzenberger 1999a) ter relativno večje število arvikolidnih drugih zgornjih meljakov z dodatnim posterolingvalnim trikotnikom (*tab. 10.13*). Slednje lahko namreč z zanesljivostjo pripiševa k vrsti *M. agrestis*, ki je vezana na bolj vlažne habitate kot *M. arvalis* (Mitchell-Jones *et al.* 1999).

Mikrofavna iz facije A (plasti 2 do 6) izstopa po vrstni pestrosti (23 vrst, od katerih nobena izrazito ne

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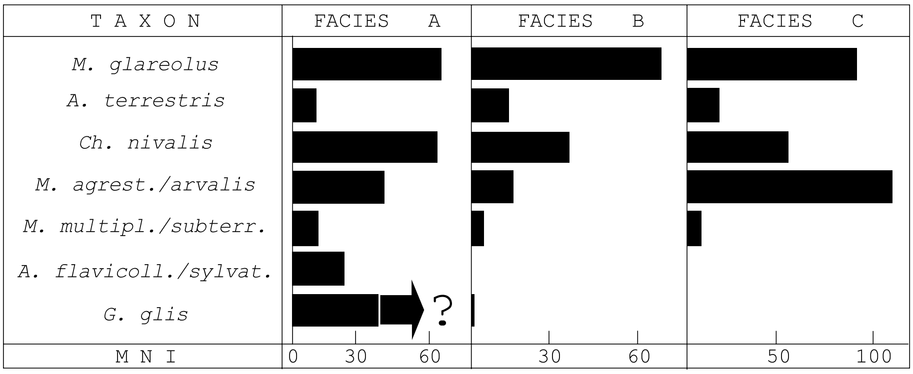
[8] Skupno je v faciji C zastopanih 13 vrst, od tega štiri z le po eno najdbo. Na drugi strani predstavljajo ostanki vrst *M. agrestis*, *M. arvalis*, *Ch. nivalis* in *C. glareolus* kar 89 odstotkov skupnega MNI.

[9] Skladni s tem so rezultati palinoloških študij, ki za facijo B kažejo na stalno prisotnost vlagoljubne jelše (*Alnus* sp.), relativno številčen pa je tudi pelod hladnoljubnih zelišč (Šercelj, Culiberg 1991).



Sl. 10.5: Najmanjše število osebkov (MNI) bolje zastopanih taksonov malih sesalcev iz Divjih bab I po facijah. Upoštevani so le taksoni, katerih skupen MNI (tj. MNI vseh treh facij skupaj) presega 10. Podatek za navadnega polha (*G. glis*) iz facije A je vprašljiv, saj ni mogoče povsem izključiti možnosti kontaminacije najbolj zgornjih pleistocenskih plasti z recentnimi osebki.
Fig. 10.5: Bar histogram of Minimum Number of Individuals (MNI) for abundant small mammal taxa from Divje babe I according to facies. Considered are only taxa with MNI > 10 in a total sample of pooled facies. Values for the edible dormouse (*G. glis*) in facies A are dubious, since possible contamination of the uppermost Pleistocene layers by recent animals cannot be excluded.

dominira) in razmeroma enakomerni zastopanosti različnih prehranjevalnih skupin (delež insektivorov presega 20 %). Na osnovi tega gradiva je Kryštufek (1997) sklepal, da je v srednjem interpleniglacialu v širši okolici Divjih bab I prevladoval mozaičen tip habitata z mešanimi, pretežno iglastimi gozdovi (na to kažejo najdbe frugivornih in granivornih polhov in rumenogrlih miši, ki pa so številčno razmeroma skromne) ter s travniki in kamenišči (travniška, poljska in snežna voluharica). Habitati so bili torej verjetno podobni današnjim na zgornjem robu gozdne meje (1.500 do 2.000 m nm. v.), najdemo pa jih tudi v nižjih legah, npr. na strmih skalnih pobočjih.

Tab. 10.13: Število drugih zgornjih meljakov travniške voluharice (*Microtus agrestis*) v vsaki od treh facij Divjih bab I. Za primerjavo je podano tudi število prvih spodnjih meljakov iz skupine *M. agrestis / arvalis*. Podatke za sklop plasti 2 do 5 podaja Kryštufek (1997).
Tab. 10.13: Number of 2nd upper molars of common vole (*Microtus agrestis*) in three different facies of Divje babe I. Given is also the number of first lower molars identified as *M. agrestis / arvalis*. Data for layers 2 to 5 are from Kryštufek (1997).

Facies	M^2 (*M. agrestis*)	M_1 (*M. agrestis/arvalis*)
A	3	41
B	11	23
C	19	203

KORESPONDENČNA ANALIZA

Rezultati korespondenčne analize so povzeti na *sliki 10.6* (glej tudi *tab. 10.14* ter *prilogi 10.2A in 10.2B*). Analiza temelji na MNI vrednostih taksonov glodalcev iz treh facij Divjih bab I ter iz 19 recentnih vzorcev iz Slovenije, Hrvaške, Srbije in Češke republike. Kot je razvidno iz porazdelitve navedenih 22 vzorcev vzdolž prvih dveh dimenzij korespondenčne analize[10] se vzorec iz facije A umešča med favne iz listnatih in mešanih gozdov Bele krajine, obrobja Ljubljanskega barja, Brkinov in neposredne okolice Divjih bab I na eni strani ter iglastih (predvsem smrekovih) gozdov Pece, Smrekovca in gorovja Orlické hory na drugi (*sl. 10.6*). Zaradi verjetne kontaminacije najbolj zgornjih pleistocenskih plasti Divjih bab I z ostanki recentnih navadnih polhov (Kryštufek 1997) sva v okviru predstavljene analize abundanco omenjene vrste arbitrarno ocenila na le petino dejansko ugotovljene (tj. MNI = 52 namesto MNI = 261). Takšna odločitev je v skladu s pičlostjo peloda in oglja plodonosnih listavcev v faciji A (Šercelj, Culiberg 1991). Polh je namreč odvisen od semen, plodov in podobne mehke ter hranljive hrane, tako da lahko njegovo prisotnost interpretiramo kot razmeroma zanesljiv dokaz obstoja listnatih oz. mešanih mozaičnih gozdov.

Skladna z zgornjimi ugotovitvami je tudi lega, ki jo ima na *sliki 10.6* vzorec iz facije B. Ta se namreč umešča blizu favnam iz iglastih gozdov višjih nadmorskih višin (tj. 1.000 do 1.500 m nm. v.) in tako potrjuje zgoraj predstavljeno tezo o relativno hladnejši prvi polovici OIS 3 v primerjavi z OIS 5a. Ni izključeno, da v visoki vrednosti vzorca iz facije B na ordinatni osi (druga dimenzija; koordinata = 1,98) odseva tudi razmeroma vlažna klima uvodnega dela OIS 3. Kot je razvidno iz *tabele 10.14,* gre namreč kar polovico inercije, ki jo povzema druga dimenzija korespondenčne analize, pripisati mednajdiščnim razlikam v abundanci gozdne voluharice. Omenjena vrsta namreč preferira vlažne mešane in iglaste gozdove (Spitzenberger 1999b). Podatki o abundanci velikega voluharja so za testiranje teze o povečani vlažnosti paleookolja manj primerni. Prispevek omenjene vrste k

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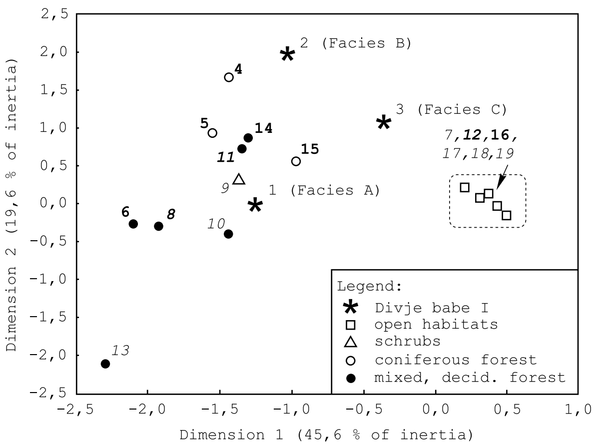
[10] Prvi dve dimenziji povzemata 65,2 odstotka celotne inercije (*priloga 10.2A*).

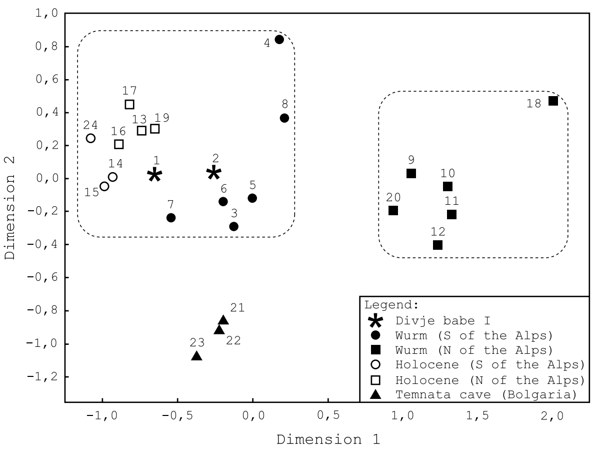


Sl. 10.6: Razporeditev treh vzorcev fosilnih ostankov glodalcev iz Divjih bab I (tj. facije A, B in C) in 19 vzorcev recentnih glodalcev iz Slovenije, Hrvaške, Srbije in Češke republike vzdolž prvih dveh dimenzij korespondenčne analize, izračunane na osnovi podatkov o najmanjšem številu osebkov (MNI) posameznega taksona. Pri treh vzorcih iz Divjih bab I so bili v analizo vključeni le taksoni z $\mathrm{MNI}_{\mathrm{tot.}}$ > 10. Izjemoma je bila iz analize izključena tudi snežna voluharica (*Chionomys nivalis*), saj je danes na pomembnem delu obravnavanega območja ni (Amori 1999), še skromnejši pa je bil njen areal razširjenosti v würmu (Kryštufek 2004). Vzorci: 1 – Divje babe I (facija A; Kryštufek 1997); 2 – Divje babe I (facija B); 3 – Divje babe I (facija C); 4 – Smrekovec, S Slovenija (smrekov gozd; Janžekovič, Čas 2001); 5 – Peca, S Slovenija (smrekov gozd; Janžekovič, Čas 2001); 6 – Bela krajina, JV Slovenija (mešan hrastov gozd; Kryštufek 1982a); 7 – dolina reke Mirne, Istra (zamočvirjeni travniki in trstišča; Lipej in Gjerkeš 1994); 8 – Brkini, JV Slovenija (pretežno bukovo-kostanjev gozd; Karajič, Kryštufek 1999); 9 – Brkini, JV Slovenija (grmišča, rob gozda; Karajič, Kryštufek 1999); 10 – okolica Divjih bab I, Z Slovenija (gozd bukve, bora in črnega gabra; Kryštufek 1997); 11 – zaledje Ljubljanskega barja, osrednja Slovenija (bukov in bukovo-jelov gozd; Kryštufek 1980; 1982b); 12 – Ljubljansko barje, osrednja Slovenija (travniki, nizko barje; Kryštufek 1980; 1982; Tome 1992); 13 – Sokolak pri Škocjanskih jamah, JZ Slovenija (gozd črnega gabra in hrasta; Lipej, Gjerkeš 1996); 14 – gorovje Orlické hory, Češka republika (pretežno bukov gozd s pomešano jelko; Gaisler 1983); 15 – gorovje Orlické hory, Češka republika (smrekov gozd; Gaisler 1983); 16 – gorovje Orlické hory, Češka republika (plantaža redko posejanih mladih jelk; Gaisler 1983); 17 – Baranja, Hrvaška (travniki, pašniki, polja; Mikuska, Vuković 1978–80); 18 – V Slavonija, Hrvaška (obdelane površine, travniki, trstišča; Mikuska *et al.* 1984-85); 19 – Z Bačka, Vojvodina (obdelane površine, travniki, trstišča; Purger 1989–90). Šifre vzorcev, ki so bili vzorčeni s pomočjo izbljuvkov sov, so na sliki označene z ležečo pisavo, šifre tistih, ki so bili vzorčeni s pastmi, pa s krepko.

Fig. 10.6: Projection of three fossil samples from Divje babe I (facies A, B and C) and 19 recent rodent assemblages from Slovenia, Croatia, Serbia and Czech Republic onto first two dimensions of correspondence analysis, the input data being the Minimum Number of Individuals (MNI) per taxon. In the material from Divje babe I only taxa with $\mathrm{MNI}_{\mathrm{tot.}}$ > 10 were considered. The only exception is the exclusion of the snow vole (*Chionomys nivalis*) which is absent from the majority of recent assemblages (Amori 1999). Samples: 1 – Divje babe I (facies A; Kryštufek 1997); 2 – Divje babe I (facies B); 3 – Divje babe I (facies C); 4 – Smrekovec, N Slovenia (spruce forest; Janžekovič, Čas 2001); 5 – Peca, N Slovenija (spruce forest; Janžekovič, Čas 2001); 6 – Bela krajina, SE Slovenija (mixed oak forest; Kryštufek 1982a); 7 – valley of the River Mirna, Istria (marshy meadows and reeds; Lipej and Gjerkeš 1994); 8 – Brkini, SW Slovenia (mainly forest of beech and chestnut; Karajič, Kryštufek 1999); 9 – Brkini, SW Slovenia (shrubs, forest edge; Karajič, Kryštufek 1999); 10 – vicinity of Divje babe I, W Slovenija (forest of beech, Austrian pine and hornbeam; Kryštufek 1997); 11 – surroundings of Ljubljansko barje, central Slovenia (beech and fir forest; Kryštufek 1980; 1982b); 12 – Ljubljansko barje, central Slovenia (meadows, marshes; Kryštufek 1980; 1982; Tome 1992); 13 – Sokolak near Škocjanske jame, SW Slovenia (oak and hornbeam forest; Lipej, Gjerkeš 1996); 14 – Mts. Orlické hory, Czech Republic (mainly beech forest with fir; Gaisler 1983); 15 – Mts. Orlické hory, Czech Republic (spruce forest; Gaisler 1983); 16 – Mts. Orlické hory, Czech Republic (young and sparse spruce plantation; Gaisler 1983); 17 – Baranja, Croatia (meadows, pastures, arable; Mikuska, Vuković 1978-80); 18 – E Slavonia, Croatia (arable, meadows, reeds; Mikuska *et al.* 1984-85); 19 – W Bačka, Voivodina (arable, meadows, reeds; Purger 1989-90). Samples from owl pellets are shown by identity number in italic; samples derived from trapping have identity numbers in bold.

Tab. 10.14: Prispevek posameznih taksonov glodalcev k skupni inerciji in k inerciji, ki jo povzema vsaka od prvih štirih dimenzij korespondenčne analize. Senčeno polje označuje podatek, ki je v besedilu eksplicitno omenjen.
Tab. 10.14: Contribution of individual rodent taxa to the total inertia and to the relative inertia summarized by each of the first four dimensions of correspondence analysis. Shaded cell indicate data discussed in the text.

Taxon	**Dimension 1-4**		**Dimension 1**			**Dimension 2**			**Dimension 3**		**Dimension 4**	
	Quality	**Relat. inertia**	**Coord.**	**Inertia**	**Cos²**	**Coord.**	**Inertia**	**Cos²**	**Inertia**	**Cos²**	**Inertia**	**Cos²**
M. glareolus	0.981	0.198	-1.26	0.185	0.426	1.36	0.498	0.493	0.012	0.009	0.107	0.052
A. terrestris	0.662	0.045	-0.20	0.001	0.009	0.82	0.035	0.152	0.051	0.180	0.148	0.320
M. agrest./arv.	0.992	0.120	0.46	0.183	0.699	-0.08	0.011	0.019	0.208	0.274	0.000	0.000
M. mult./ sub.	0.746	0.069	0.25	0.009	0.060	0.07	0.002	0.005	0.296	0.679	0.001	0.001
A. flavicollis	0.985	0.202	-1.68	0.332	0.747	-0.02	0.000	0.000	0.002	0.002	0.492	0.236
A. sylvaticus	0.816	0.092	0.34	0.019	0.093	-0.04	0.001	0.001	0.401	0.686	0.033	0.034
G. glis	0.994	0.229	-2.18	0.259	0.517	-1.87	0.445	0.382	0.003	0.002	0.218	0.092
M. avellanarius	0.246	0.045	-0.58	0.012	0.120	-0.31	0.008	0.033	0.026	0.092	0.000	0.000



Sl. 10.7: Končna razporeditev matrike, pridobljene z večdimenzionalnim skaliranjem evklidskih razdalj med 24 fosilnimi in subfosilnimi združbami glodalcev iz Evrope (*stress* = 0,139). Shepardov diagram je podan v *slikovni prilogi 10.2B*. Vzorci: 1 – Divje babe I (facija C, OIS 5a); 2 – Divje babe I (faciji A (Kryštufek, 1997) in B, OIS 3); 3 – Grotta della Ghiacciaia, S Italija (plast 2, OIS 5; Sala 1990); 4 – Grotta delle Cipolliane, S Italija (pozni glacial; Bon in Menon 2000); 5 – Potočka zijalka, S Slovenija (plast 8, OIS 3; Rabeder 2004); 6 – Grotta di San Leonardo 1, SV Italija (OIS 5; Bartolomei 2003); 7 – Caverna degli Orsi, SV Italija (plasti 10 do 14, OIS 5; Bartolomei 2003); 8 – spodmol Tagliente, S Italija (plasti 31 do 52, OIS 3 in 4; Bartolomei *et al.* 1985; Sala 1990); 9 – jama Obłazowa 2, J Poljska (OIS 3; Nadachowski *et al.* 1993); 10 – jama Obłazowa 1, J Poljska (serija B, OIS 5; Nadachowski *et al.* 2003); 11 – jama Brillenhöhle, J Nemčija (plast 7, > 25.000 p.s.; Storch 1992); 12 – jama Geißenklösterle 2, J Nemčija (plast 2, pribl. 31.000 p.s.; Storch 1992); 13 – severno obrobje Mittelgebirge (več najdišč), JV Nemčija (preboreal in atlantik; Storch 1992); 14 – Viktorjev spodmol, JZ Slovenija (režnji 8 do 19, zgodnji holocen; Toškan, Kryštufek 2004); 15 – jama Mala Triglavca, JZ Slovenija (zgodnji holocen; neobjavljeno); 16 – jama Felsställe, J Nemčija (plast 2a3, pribl. 8.200 p.s.; Storch 1992); 17 – jama Felsställe, J Nemčija (plasti 2b, 2b/2a3, preboreal; Storch 1992); 18 – severno obrobje Mittelgebirge (več najdišč), JV Nemčija (OIS 5; Storch 1992); 19 – severno obrobje Mittelgebirge (več najdišč), JV Nemčija (zgodnji atlantik; Storch 1992); 20 – jama Obłazowa 1, J Poljska (serija D, OIS 3; Nadachowski *et al.* 2003); 21 – jama Temnata, Bolgarija (sondi I in V: plast 3a, pribl. 20.000 do 10.000 p.s.; Popov 1994); 22 – jama Temnata, Bolgarija (sondi I in V: plasti 3c, 3d, pribl. 25.000 do 20.000 p.s.; Popov 1994); 23 – jama Temnata, Bolgarija (sondi I in V: plasti 3g, 3h, pribl. 29.000 do 25.000 p.s.; Popov 1994); 24 – spodmol pri Bjarču / Riparo di Biarzo, SV Italija (plasti 3B in 4, zgodnji holocen; Bartolomei 1996).

Fig. 10.7: Final distribution of matrix derived from multidimensional scaling of Euclidean distances among 25 European fossil and sub-fossil rodent assemblages (*stress* = 0.139). Shepard diagram is given in *Annex fig. 10.2B*. Samples: 1 – Divje babe I (facies C, OIS 5a); 2 – Divje babe I (facies A (Kryštufek, 1997) and B, OIS 3); 3 – Grotta della Ghiacciaia, N Italia (Layer 2, OIS 5; Sala 1990); 4 – Grotta delle Cipolliane, N Italia (Late Glacial; Bon and Menon 2000); 5 – Potočka zijalka, N Slovenija (Layer 8, OIS 3; Rabeder 2004); 6 – Grotta di San Leonardo 1, NE Italia (OIS 5; Bartolomei 2003); 7 – Caverna degli Orsi, NE Italia (layers 10 to 14, OIS 5; Bartolomei 2003); 8 – rock shelter Tagliente, N Italija (layers 31 to 52, OIS 3 and 4; Bartolomei *et al.* 1985; Sala 1990); 9 – cave Obłazowa 2, S Poland (OIS 3; Nadachowski *et al.* 1993); 10 – cave Obłazowa 1, S Poland (series B, OIS 5; Nadachowski *et al.* 2003); 11 – cave Brillenhöhle, S Germany (Layer 7, > 25,000 B.P.; Storch 1992); 12 – cave Geißenklösterle 2, S Germany (Layer 2, approx. 31,000 B.P.; Storch 1992); 13 – northern fringes of Mittelgebirge (pooled sites), SE Germany (Preboreal and Atlantic; Storch 1992); 14 – Viktorjev spodmol, SW Slovenia (spits 8 to 19, Early Holocene; Toškan, Kryštufek 2004); 15 – cave Mala Triglavca, SW Slovenia (Early Holocene; unpublished); 16 – cave Felsställe, S Germany (Layer 2a3, approx. 8,200 B.P.; Storch 1992); 17 – cave Felsställe, S Germany (layers 2b, 2b/2a3, Preboreal; Storch 1992); 18 – northern fringes of Mittelgebirge (pooled localities), SE Germany (OIS 5; Storch 1992); 19 - northern fringes of Mittelgebirge (pooled localities), SE Germany (early Atlantic; Storch 1992); 20 – cave Obłazowa 1, S Poland (series D, OIS 3; Nadachowski *et al.* 2003); 21 – cave Temnata, Bolgaria (test trenches I and V: Layer 3a, approx. 20,000 to 10,000 B.P.; Popov 1994); 22 – cave Temnata, Bolgaria (test trenches I and V: layers 3c, 3d, approx. 25,000 to 20,000 B.P.; Popov 1994); 23 – cave Temnata, Bolgaria (test trenches I and V: layers 3g, 3h, approx. 29,000 to 25,000 B.P.; Popov 1994); 24 – rock shelter Riparo di Biarzo, NE Italia (layers 3B and 4, Early Holocene; Bartolomei 1996).

inerciji, ki jo skupaj povzemajo prve štiri dimenzije korespondenčne analize (tj. 90,6 % celotne inercije, *pril. 10.2A*), namreč ne dosega niti petih odstotkov (*tab. 10.14*). Poleg tega najdemo danes v vlažnih habitatih le akvatično obliko velikega voluharja, medtem ko fosorialne populacije naseljujejo suhe ali kvečjemu zmerno vlažne travnike in jase (Saucy 1999). Vsi recentni veliki voluharji z območja Slovenije so prilagojeni življenju pod zemljo (Kryštufek 1991).

Vzorec iz facije C se vzdolž prve dimenzije korespondenčne analize umešča med favne gozdnatih in odprtih habitatov (*sl. 10.6*), vendar je statistično gledano takšen položaj slabo utemeljen. Prva dimenzija namreč zelo slabo povzema lastnosti vzorca iz facije C ($\cos^2$ ne dosega niti 7 odstotkov; *priloga 10.2C*). Te lastnosti bistveno bolje povzema druga dimenzija ($\cos^2 = 60,0$ %), vzdolž katere se obravnavani vzorec umešča blizu recentnim favnam iglastih gozdov.

MULTIDIMENZIONALNO SKALIRANJE

Vrstna sestava malih sesalcev iz sklopa plasti 2 do 5 (≈ facija A) Divjih bab I se praktično ne razlikuje od recentne favne z istega območja, zato na prehodu pleistocena v holocen ni hitrega obrata (Kryštufek 1997). Stanje severno od alpske poledenitve je v tem pogledu bistveno drugačno. Večja podobnost mlajšepleistocenske favne malih sesalcev iz Divjih bab I z recentno favno kot pa s sočasnimi (OIS 5 in OIS 3) favnami južne Nemčije in Poljske je jasno razvidna s *slike 10.7.* Na njej je prikazana končna razporeditev matrike, pridobljene z večdimenzionalnim skaliranjem evklidskih razdalj med 24 fosilnimi in subfosilnimi združbami glodalcev, vključno z vzorcema iz facij B in C Divjih bab I. Razlike so očitno posledica dejstva, da je bil v OIS 5 in OIS 3 refugij južno od Alp že poseljen z gozdnimi vrstami, kakršne so v istem obdobju naseljevale območje srednjega in južnega dela Balkanskega polotoka (Mayhew 1978; Kowalski, Nadachowski 1982; Dimitrijević 1996; Chatzopoulou 2003; Lenardić Mauch 2005).[11] Holocenski vzorci so vzdolž abscise (prva dimenzija) razporejeni pri nižjih vrednostih kot fosilne favne iz Slovenije in SV Italije. To interpretirava kot domnevno povečanje deleža na plodonosne listavce vezanih vrst malih sesalcev (rumenogrla miš, polh) ob koncu pleistocena. Te spremembe so verjetno bolj vplivale na medvrstne (abundančne odnose) kot pa na samo vrstno sestavo.

ZAHVALA

Hvaležna sva dr. Ivanu Turku, ki nama je omogočil obdelavo gradiva. Zahvala gre tudi Janezu Dirjecu za pripravo vzorcev malih sesalcev. B. Toškan je opravil delo v okviru podiplomskega usposabljanja, ki ga je financiralo Ministrstvo za šolstvo, znanost in šport.

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[11] To dokazuje tudi lega, ki jo na *sliki 10.7* zavzemajo trije vzorci fosilne mikrofavne iz bolgarske jame Temnata. Po vrednostih na abscisi (prva dimenzija korespondenčne analize) se namreč vsi trije umeščajo med vzorce iz sočasnih najdišč na Slovenskem in v SV Italiji. Njihovo nekoliko izolirano lego vzdolž ordinatne osi (druga dimenzija korespondenčne analize) pripisujeva najdbam na suhe stepe in polpuščave vezanih vrst (npr. *Mesocricetus newtoni*, *Lagurus lagurus*, *Alactaga major*), ki jih v sočasnih favnah srednje Evrope ni.

10. SMALL TERRESTRIAL MAMMALS (ERINACEOMORPHA, SORICOMORPHA, CHIROPTERA, RODENTIA) FROM DIVJE BABE I

BORUT TOŠKAN and BORIS KRYŠTUFEK

Abstract

The remains of at least 407 specimens of small mammals were found in the Upper Pleistocene layers of the Palaeolithic cave site Divje babe I. They belong to at least 17 different species: *Erinaceus* cfr. *romanicus*, *Sorex alpinus*, *S. araneus*, *Talpa europaea* seu *caeca*, *Vespertilio murinus*, *Marmota marmota*, *Chionomys nivalis*, *Arvicola terrestris*, *Myodes glareolus*, *Microtus agrestis*, *M. arvalis*, *M. liechtensteini*, *M. subterraneus*, *Apodemus* cfr. *sylvaticus*, *Glis glis*, *Muscardinus avellanarius* and *Sicista* cfr. *subtilis*. It can be inferred on the basis of the small mammal assemblages that open grassland habitats were more widespread than forest in OIS 5a. The small mammal fauna from OIS 3 shows a different picture, with a mosaic of mixed, predominantly coniferous forest, with meadows and accumulations of rocky boulders. Comparison between the Upper Pleistocene (OIS 5a and OIS 3) small mammal fauna from Divje babe I with contemporary faunas from regions north of the Alps highlighted major differences in the species composition. In the Würm, namely, recent forest species were already present on the southern edge of the Alpine glaciation, while more to the north, boreal and steppe species still predominated.

Besides the Pleistocene site Potočka zijalka (excavations between 1997 and 2000; Rabeder 2004), the cave Divje babe I represents the only Upper Pleistocene location in Slovenia where adequate attention was devoted also to remnants of small terrestrial mammals. Although single records of insectivores, bats and rodents are reported from several Quaternary sites throughout Slovenia (Rakovec 1973; Pohar 1976; 1985; 1991; Brodar, S. & M. 1983), small samples do not allow meaningful statistical elaborations.[1] Fossil small mammals from the five upper layers of Divje babe I were already elaborated and published (Kryštufek 1997; Toškan 2002). Hereafter we report on the remnants from deeper layers (6–17a1), which further document the Würmian small mammal species composition on the southern boundary of the Alpine glacier.

METHODS

The cave Divje babe I is situated in the pre-Alpine region of western Slovenia (450 m a.s.l.). For detailed information on the site and on methodology of excavations see Turk (chapter 1, this volume). Small mammal remnants were found in layers 2-17a1 and are dated to approximately 80,000–40,000 yr. ago (Turk *et al.* 2001a; Chapter 6 and 7, this volume). Layers 12–17a1 supposedly accumulated at the end of the last glacial (OIS 5a), while uppermost layers (2–11/12) correspond to interpleniglacial (OIS 3). The stadium OIS 4 (i.e. pleniglacial I) is only barely represented in the cave sediments due to stagnancy in sedimentation (Introduction and Chapter 1, this volume). Because sample sizes per layer were frequently small, we pooled layers, at least in some analyses, into three categories (facies): facies A (layers 2–6), facies B (layers 7–11/12) and facies C (layers 12/13–17a1). Such pooling is based on sedimentological data and on vertical distribution of cave bear remnants (Turk 2003a; Chapter 5 and 12, this volume).

The basic sample during excavations was a 1 x 1 m square with a depth of 12 cm. The sediment was thieved (mesh sizes of 10 mm, 3 mm, and 0.5 mm, respectively). Samples of same volumes of sediments represented the standard units for all analyses. During the excavations, approximately 3 dm^3 fractions of the sediment (particles 0.5–3.0 mm) were removed.[2] Small mammal remnants were extracted under the dissecting microscope. The material consisted of isolated teeth, maxillae, mandibles, and postcranial fragments. Postcranial material was not included into this paper. All samples are labeled with the number of their quadrat and cut expressed as quadrat/cut. The cuts are labeled from the surface downwards (for depth of cuts see Chapter 1: footnote 5, this volume).

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[1] The only exceptions are the relatively numerous remnants of Alpine marmot (*Marmota marmota*).

[2] The only exception are 11 samples, which were extremely rich in small mammal remnants. These samples are (quadrat/cut): 26/33, 28/32, 32/31, 26/35, 28/35, 29/35, 32/33, 28/34, 29/36, 29/34 and 32/34.

Small mammal remnants were identified under the stereomicroscope at varying magnifications. Comparative recent material originates from Slovenia and adjacent regions of the Balkan Peninsula (mammal collection of Slovenian Museum of Natural History, Ljubljana). Quantitative comparisons among taxa are based on the *Number of Identified Specimens* (NISP) and on the *Minimum Number of Individuals* (MNI). Within the frame of biometrical comparisons we tested heterogeneity among samples using One Way Analysis of Variance, while the largest homogeneous sets were identified using Scheffé test. Nonparametric testing was done by Kruskal-Wallis test (StatSoft Inc. 2001). Allopatric and allochronous rodent faunas were compared by *Multidimensional scaling* on rectangular symmetric matrix of Euclidean distances. On the base of their abundance, taxa were arbitrarily grouped into five classes: class 0 (taxon absent), class 1 (MNI < 5 % of total MNI), class 2 (MNI 6 - 20 % of total MNI), class 3 (MNI 21 - 50 % of total MNI) and class 4 (MNI > 50 % of total MNI).

Conclusions on possible past habitats were derived from Correspondence analysis of three fossil rodent faunas from Divje babe I (facies A, B, and C) and 19 recent assmeblies with known habitat types. In this analysis, the abundance was expressed as MNI.

Statistical analyses were preformed using program package STATISTICA for Windows, version 6.0 (StatSoft Inc. 2001). Nomenclature of arvicoline molars follows Van Der Meulenu (1973).

Fossil material of small mammals from Divje babe is deposited in the National Museum of Slovenia (Ljubljana).

RESULTS AND DISCUSSION

TAXONOMY

In total, 2,337 small mammal molars were obtained from layers 6-17a1; 1,492 of these molars allowed identification to the generic level at least. Material belonged to at least 407 specimens, belonging to 17 species from nine families. Share of rodents among identifiable items exceeds 98%, while bats, on the other hand, are represented by a single specimen. All species in the sample are still extant and majority of them still occur in Slovenia. The only exceptions are southern birch mouse (*Sicista subtilis*) and blind mole (*Talpa caeca*); identity of the later is posing certain doubt.

Taxonomy and nomenclature follow Wilson & Reeder (2005).

Order: Hedgehogs and moonrats (Erinaceomorpha)
Family: Hedgehogs and moonrats (Erinaceidae)

Erinaceus cfr. *roumanicus* Barrett-Hamilton, 1900

Material: Layer 10: mandible (sample 6/32).

Mandibular fragment from sample 6/32 allows identification only at generic level. Because of missing *ramus ascendens* we could not judged whether the material belongs to West European hedgehog (*Erinaceus europaeus* Linnaeus, 1758) or to its sibling, a northern white-breasted hedgehog (*Erinaceus concolor/roumanicus*). The West European hedgehog is restricted mainly to western portion of the continent, to the west of the line Gulf of Triest – estuary of the Odra River. In Slovenia it is known only from the vicinity of Nova Gorica, i.e. close to the border with Italy (Petrov 1989). Contrary to this, the northern white-breasted hedgehog is widespread in the country (Kryštufek 1991). Fossil records of hedgehogs are scarce and reports are particularly exceptional for the northern white-breasted species, which was recognized as a species on its own right relatively late. The strongest evidence for its status of a species on its own right was derived from karyological data (Král 1967). Not surprisingly, earlier authors uniformly ascribed hedgehogs to *E. europaeus*. Although the presence of the northern white-breasted hedgehog in the Upper Pleistocene of Europe is beyond doubt (Rzebik-Kowalska 2003), great majority of fossil specimens were ascribed to *E. europaeus*. The latter species is reported for the Upper Pleistocene of NE Italy (Bon *et al.* 1991), southern Austria (Fladerer 2000), Hungary (Jánossy) and former Yugoslavia (Malez 1986a). In Slovenia, fossil remnants of a hedgehog were so far reported from a single site, i.e. Parska golobina near Pivka. They were identified as *E. europaeus* and date to the Würm II + Würm III (Rakovec 1961). These remnants are thus geologically younger than Divje babe I specimen, since Layer 10 supposedly accumulated at the beginning of OIS 3 (Turk *et al.* 2001a).

Order: Shrews and moles (Soricomorpha)

Family: Shrews (Soricidae)

Sorex alpinus Schinz, 1837

Material: Layer 8: mandible (sample from a profile: y = -1.00 z = -3.06 to -3.14); Layer 10: mandible (sample 32/29); Layer 14: mandible (sample 28/32); Layer 15/16: mandible (sample 31/32).

Four mandibles belong to the Alpine shrew. Low coronoid height (<4.5 mm; *Tab. 10.1*) allows reliable separation of *S. alpinus* from *S. araneus* in recent material from Slovenia (Kryštufek 1991).

Sorex araneus Linnaeus, 1758

Material: Layer 8: mandible (sample 26/27); Layer 8/10: rostrum (sample 30/28); Layer 10: mandible (sample 29/29).

Common shrew is represented by three specimens. Coronoid height of both mandibles exceeds 4.5 mm and is thus within the range of recent *S. araneus* (*Tab. 10.2*). Identification of the rostral part is based on pigmented hypocone of the first upper molar (Kryštufek 1991).

Sorex alpinus / araneus

Material: Layer 8: mandible (sample from a profile: y = –1.00 z = –3.06 do –3.14), mandible (sample 36/27), tooth (sample 13/26-27); Layer 11: tooth (sample 31/30); Layer 14: mandible (sample 28/32); Layer 16: tooth (sample 29/35).

Six remnants of *Sorex* shrews do not allow identification to the species level (*Tab. 10.12*). Isolated teeth from layers 11 and 16 are the only finds of shrews in those layers.

Family: Moles (Talpidae)

Talpa europaea / caeca

Material: Layer 8: tooth (2x; sample 13/26-27); Layer 14: tooth (2x; samples 31/31 and 32/31); Layer 16: tooth (sample 26/35).

Genus *Talpa* is represented by a small number of isolated teeth and several parts of postcranial skeleton. The two recent species, European mole (*Talpa europaea* Linnaeus, 1758) and the blind mole (*Talpa caeca* Savii, 1822) cannot be reliably distinguished on the basis of molars alone. In spite of size differences (the European mole is larger), dimensions of molar length and breadth broadly overlap. Length of the first lower molar from sample 32/31 (Layer 14, *Annex 10.1B*) is within the range for the recent European mole from western Slovenia (and thus exceeds the maximal values for blind moles from Bosnia and Herzegovina, Montenegro and Kosovo; Toškan 2002). Dimensions of the remaining lower molars from layers 14 and 16 are from the overlapping zone of ranges for both species (*Fig. 10.1*). Material from Layer 8 is severely fragmented.

Currently, the European mole populates the majority of Europe and is also widespread in Slovenia (Kryštufek 1999a). The blind mole, on the other hand, shows a Mediterranean type of distribution with several isolates further north and is not a member of recent Slovenian fauna (Kryštufek 1999b). From the Upper Pleistocene of Slovenia, Rakovec (1973), Pohar (1976) and Rabeder *et al.* (2004a) report only *T. europaea*.[3] Remnants of *T. caeca* are known from the Würmian layers of NE Italy (e.g. Brecce di Soave near Veroni; Bon *et al.* 1991) and former Yugoslavia (Malez 1986), however they are rare. Both mole species are present in the early Holocene fauna of Viktorjev spodmol near Divača (Toškan and Kryštufek 2004).

Oreder: Bats (Chiroptera)
Family: Vespertilionids (Vespertilionidae)

Vespertilio murinus Linnaeus, 1758

Material: Layer 16: rostrum (sample 32/33).

A damaged rostral portion of a parti-coloured bat is the only chiropteran record in layers 6–17a1 of Divje babe I. This bat is a member of recent Slovene fauna, however it is rare with only five known records (Kryštufek, Režek Donev 2005). Main habitat is likely to be mountains and steppes (Kryštufek 1991).

Order: Rodents (Rodentia)
Family: Squirrels (Sciuridae)

Marmota marmota (Linnaeus, 1758)

Remnants of the Alpine marmot which are abundant in layers from Divje babe I (NISP = 234), are elaborated in the chapter of large mammal fauna (Chapter 11, this volume).

Family: Hamsters, voles and lemmings (Cricetidae)
Subfamily: Voles and lemmings (Arvicolinae)

Chionomys nivalis (Martins, 1842)

Material: Layer 8: 17 teeth; Layer 8/10: 6 teeth; Layer 10: 34 teeth; Layer 10/11: 4 teeth; Layer 11: mandible and 24 teeth; Layer 13: 7 teeth; Layer 13/14: 5 teeth; Layer 14: 35 teeth; Layer 15: mandible and 7 teeth; Layer 15/16: 10 teeth; Layer 16: 80 teeth; Layer 16a: 10 teeth; Layer 16a/17a1: 2 teeth. Corresponding numbers of most of the samples with snow vole remnants are given in Toškan (2002). The remaining samples are: Layer 11: mandible (sample 12/33); Layer 15: mandible (sample 29/33).

We ascribed to snow vole 243 isolated molars from the layers 6–17a1 of Divje babe I. Specimens from facies C (layers 12/13-17a1; OIS 5a) correspond in M_1 length to recent *Ch. nivalis* from the Julian Alps, as well as to a sub-fossil conspecifics from Viktorjev spodmol

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[3] All fossil moles from the Upper Pleistocene of Divje babe I were ascribed to *T. europaea* (Kryštufek 1997).

on Karst, but do not attain high values of recent *Chionomys nivalis* from Mt. Snežnik or of fossil specimens from the interpleniglacial (= OIS 3) layers of Divje babe I (*Tab. 10.3*). Although specimens from colder phases of Würm tend to have longer M_1 than those from warmer parts of the Upper Glacial (i.e. OIS 3) and from the Holocene, it would be still premature to speculate on the causal relation between snow vole size and the climate. Analysis of fossil material from the Bulgarian site Bacho Kiro (N = 298) demonstrated a gradual decline in size of first lower molars throughout the entire Würm, the trend however did not correlate to fluctuations in temperature (Nadachowski 1984a). Available fossil material from Slovenia points on possible small scale geographic divergence of synchronous populations. E.g. dimensions of six M_1 specimens from the interpleniglacial layers of the high Alpine Paleolitic site Potočka zijalka in the Savinja Alps[4] are on average significantly smaller than the somewhat older sample from Divje babe I.

Material from Divje babe I involved all five morphotypes of M_1 as listed by Nadachowski (1984a). The morfotype *nivalid* strongly predominated (*Tab. 10.4*) what is also characteristic of recent *Ch. nivalis* populations from the Julian Alps and from Mt. Snežnik (Kryštufek 1990), for sub-fossil material from Viktorjev spodmol (Toškan, Kryštufek 2004), as well as for fossil *Ch. nivalis* samples from Potočka zijalka (Rabeder 2004) and from Mujina pećina in Dalmatia (Mauch Lenardić 2005).

Arvicola terrestris (Linnaeus, 1758)

Material: Layer 7: tooth; Layer 8: 8 teeth; Layer 8/10: tooth; Layer 10: 8 teeth; Layer 11: 19 teeth; Layer 11/12: 2 teeth; Layer 12/13: tooth; Layer 13: mandible and 3 teeth; Layer 13/14: 7 teeth; Layer 14: 26 teeth; Layer 15: 6 teeth; Layer 15/16: 2 teeth; Layer 16: 35 teeth; Layer 16a: 3 teeth. Corresponding numbers of most of the samples with water vole remnants are given in Toškan (2002). The remaining samples are: Layer 8: tooth (sample 16/26); Layer 13: mandible (sample 22/34); Layer 15/16: tooth (sample 32/32); Layer 16: mandible (sample 25/35); from the profile: tooth (y = –2,0 z = –3,21 to –3,30), tooth (y = –1,0 z = –3,14 to –3,19), tooth (y = –2,0 z = –3,37 to –3,43), 2 teeth (y = –2,0 z = –3,21 to –3,30).

Water vole was represented in layers 6-17a1 of Divje babe I with 123 finds. On the basis of the enamel thickness pattern of the first lower molar, i.e. thinner enamel on the convex (lee) side and the thick enamel on the concave (luft) side, this material is ascribed to a recent *A. terrestris*. As we can judge from length of M_1 and M^3, water voles from the Upper Glacial (facies C) of Divje babe I exceeded in size specimens from the interpleniglacial (facies A and B) and of the Holocene age (Kruskal-Wallisov test: $p < 0,05$; *Tab. 10.5*). Similar trend in decline of the molar length between the Würm and the Holocene samples is reported also by Nadachowski (1984a) in the case of M^3 from the Bulgarian site Bacho Kiro (N = 41) and Mauch Lenardić (2005) for M_2 (but not for M_1) from the Croatian site Vindija (M_1: N = 302; M_2: N = 133). Because of recent taxonomic changes in the genus *Arvicola* (Wilson, Reeder 2005) we found it difficult to comment these differences. Traditional interpretation on intraspecific trends can be replaced by a hypothesis of the alternation of two biological species, the larger *A. amphibius* (Linnaeus, 1758) and the smaller *A. scherman* (Shaw, 1801). This problematic requires more extensive approach.

Analysis of morphotypes of Divjih bab I specimens (layers 6–17a1) allocated seven M^3 specimens of a total ten to a more complex morphotype *exitus* (*sensu* Nadachowski 1984a); the remaining three belonged to a more simplified type *terrestris*. Nadachowski (1984a) linked the latter morphotype with a milder climate which, however, contradicts our results. Namely, morfotype *terrestris* dominates the interpleniglacial (= OIS 3) facies A and B, while *exitus* dominates in the Early Glacial facies C (= OIS 5), which accumulated in the period of milder climate (*Tab. 10.6*). The morphotype *terrestris* predominates also in a sample of recent *A. terrestris* (*A. scherman sensu* Wilson, Reeder 2005) from Žirovski vrh (N = 14), in sub-fossil specimens from Viktorjev spodmol (N = 7; Toškan, Kryštufek 2004) and in fossil material from Vindija (Würm II and Würm III; N = 71; Mauch Lenardić 2005).

Myodes glareolus (Schreber, 1780)

Material: Layer 7: tooth; Layer 8: 3 mandibles and 87 teeth; Layer 8/10: 9 mandibles, 5 rostral fragments and 22 teeth; Layer 10: 69 teeth; Layer 10/11: 8 teeth; Layer 11: 50 teeth; Layer 11/12: 10 teeth; Layer 12/13: 14 teeth; Layer 13: mandible and 14 teeth; Layer 13/14: 26 teeth; Layer 14: 130 teeth; Layer 15: 32 teeth; Layer 15/16: 18 teeth; Layer 16: 301 teeth; Layer 16a: 68 teeth; Layer 16a/17a1: 5 teeth; Layer 17a: teeth. Corresponding numbers of most of the samples with bank vole remnants are given in Toškan (2002). The remaining samples are: Layer 8: 9 teeth (samples 35/26, 13/26-27, 36/27, 35/26, 16/26); Layer 10: 4 mandibles and a maxilla (sample 18/31); Layer 10/11: 2 teeth (samples 22 in 25/31); Layer 14: mandible (sample 46/32); from the profile: mandible (y = –1,0 z = –3,19 to –3,29), 5 mandibles and 5 maxillae (y = –2,0 z = –3,37 to –3,43), 2 mandibles (y = –2,0 z = –3,21 to –3,30), tooth (y = –1,0 z = –3,14 to –3,19), 2 teeth (y = –2,0 z = –3,69 to –3,75), tooth (y = –1,0 z = –3,06 to –3,14), tooth (y = –2,0 z = –3,96 to –4,05), 2 teeth (y = –2,0 z = –3,37 to –3,43), 3 teeth (y = –2,0 z = –3,21 to –3,30).

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[4] Length of M_1: Me = 2.83; range: 2.55-2.94 (Rabeder 2004).

Bank vole was represented in layers 6–17a1 of Divje babe I by 874 remnants and was thus the most abundant small mammal taxon in the material studied. Such a perception is biased to some degree because characteristic molar morphology of this vole (rooted molars with rounded salient angles) allowed secure identification of all *M. glareolus* molars, contrary to *Microtus* and *Chionomys* voles which where safely ascribed to a genus/species only in the case of M_1 specimens.

Fossil bank voles from Divje babe I show longer M_1 than recent specimens from Slovenia, but correspond closely to a sub-fossil material from Viktorjev spodmol (*Tab. 10.7*). In spite of positive correlation between bank voles and the climate, as was demonstrated in recent populations from Slovenia and adjacent regions by Janžekovič (1996), size changes (length of M_1) during climatic oscillations do not follow strictly Bergmann response. This is evident in material from Divje babe I when length of M_1 of specimens from facies C (= OIS 5) is compared to those from the interpleniglacial facies A and B (= OIS 3; *Tab. 10.7*). In spite of clear climatic differences (the OIS 5 was warmer), size differences among samples are not significant (F test: $F = 0.200$; $p = 0.655$).

In the fossil material from Divje babe I, the predominating M^3 morphotype was *complex* (particularly its *typica* expression), which accords with the situation in recent bank voles from Slovenia, as well as with a sub-fossil specimens from Viktorjev spodmol (Toškan and Kryštufek 2004) and fossil material from Vindija (Mauch Lenardić 2005; *Tab. 10.8*).

Microtus ex gr. *agrestis* - *arvalis*

Material: Layer 8: teeth; Layer 8/10: teeth; Layer 10: 8 teeth; Layer 10/11: teeth; Layer 11: 9 teeth; Layer 11/12: 3 teeth; Layer 13: 5 teeth; Layer 13/14: 6 teeth; Layer 14: 35 teeth; Layer 15: 16 teeth; Layer 15/16: 7 teeth; Layer 16: 115 teeth; Layer 16a: 16 teeth; Layer 16a/17a1: 3 teeth. Corresponding numbers of most of the samples with field / common vole remnants are given in Toškan (2002). The remaining sample is: Layer 8: tooth (sample 13/26-27).

Shape of the anteroconid complex of M_1 with separate dentine fields of triangles T4 and T5 allocated numerous arvicoline first lower molars (226 specimens) from layers 6–17a1 either to a filed vole *Microtus arvalis* (Pallas, 1779) or to a common vole *M. agrestis* (Linnaeus, 1761). Reliable distinguishing between these two species is possible only on the basis of M^2, which displays an additional postero-lingual triangle (T5) in *M. agrestis*. Note however, that even this trait is subjected to a temporal and geographic variation (Kowalski 1970; Nadachowski 1985; Kryštufek 1986). Relatively high number of M^2 with the additional triangle T5 ($N = 33$) confirms beyond doubt the presence of the common vole in Divjih bab I.

Species identification of first lower molars is based on characters proposed by Nadachowski (1984b). Triangles T4 and T5 are subequal in *M. arvalis* while *M. agrestis* is characterized by a larger T5 in comparison to T4. Consequently, a quotient between lengths of these two triangles (T4/T5), when plotted against the M_1 length, distinguishes fairly reliably these two voles. This approach confirmed the presence of both species in a fossil material from Divje babe I; *M. arvalis* was more abundant (*Fig. 10.2*). Fossil specimens from each of the three facies of Divje babe I do not differ in M_1 length from sub-fossil material from Viktorjev spodmol, or from recent *M. arvalis* from Slovenia (Ljubljansko barje, Kranjska gora, Julian Alps; *Tab. 10.9*), recent *M. agrestis* from central Slovenia (Ljubljansko barje) being significantly larger (F-test: $F = 130$; $p < 0.001$).

Microtus ex gr. *liechtensteini* - *subterraneus*

Material: Layer 10: 2 teeth (sample 18/31); Layer 11: 4 teeth (samples 29/30, 32/30, 40/30); Layer 14: 7 teeth (samples 32/31, 28/32); Layer 16: 4 teeth (samples 32/33, 29/34, 28/35, 29/36).

Pitymoid first lower molars ($N = 17$) likely belong either to common pine vole *Microtus subterraneus* (de Salys-Longchamps, 1836) or Liechtenstein's pine vole *M. liechtensteini* (Wettstein, 1927). Such molars were collected from 10 samples coming from four different layers.

Microtus subterraneus and *M. liechtensteini* clearly differ in their chromosomal sets however resemble each other most closely in their morphologies. Although *Microtus liechtensteini* tends towards larger size, length of isolated molars overlaps broadly (Kryštufek 1997). Great majority of M_1 specimens from Divje babe I tentatively match in their length the common pine vole (*Tab. 10.10*), a species which is present also in the interpleniglacial (= OIS 3) material from Potočka zijalka (Rabeder 2004) and from Vindija (Mauch Lenardić 2005).

Family: Mice and rats (Muridae)

Apodemus cfr. *sylvaticus* (Linnaeus, 1758)

Material: Layer 16: tooth (sample 29/34).

First upper molar from Layer 16 is the only recorded remnant of the genus *Apodemus* from the layers 6–17a1 of Divje babe I. Species identification is based on metrical properties[5] (*Fig. 10.3*) and is thus not

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[5] Reliable distinguishing between *Apodemus sylvaticus* and *Apodemus flavicollis* (Melchior, 1834) on the basis of cheeck-teeth morphology was shown not to be possible (Mayhew 1978;

entirely reliable since recent populations of *A. sylvaticus* and *A. flavicollis* are known to be characterized by a considerable size variation (Alcántra 1991; Kryštufek, Stojanovski 1996). *Apodemus sylvaticus* was likely represented also in layers 2–5 of Divje babe I however it was clearly outnumbered by *A. flavicollis* (Kryštufek 1997).

Family: Dormice (Gliridae)

Glis glis (Linnaeus, 1766)

Material: Layer 7: mandible (sample 3/21).

A single edible dormouse mandible was found in layers 6–17a1 of Divje babe I[6] while this species had nearly 50 percent MNI share in layers 2–5 (Kryštufek 1997). Great majority of specimens are from the uppermost layers, still of Pleistocene age but just below the surface, which cannot exclude a possibility of contamination by recent dormice. While excavating in Divje babe I, lethargic edible dormice were found twice below the dripstone of the Holocene age, approximately 20 cm deep (I. Turk, personal communication). It is known that edible dormice do enter deep into caves where they also hibernate (Polak 1996). Although contamination of the Pleistocene layers is thus plausible, we feel that at least part of Divje babe I material is of Pleistocene age. Approximately contemporary reports of the edible dormouse are known also from Italy (Bon *et al.* 1991; Bartolomei 2003), Austria (Fladerer 2000) and Slovenia (Potočka zijalka; Brodar, S. & M., 1983).

Muscardinus avellanarius (Linnaeus, 1758)

Material: Layer 13/14: tooth (sample 26/33); Layer 16a/17a1: tooth (sample 32/35).

Common dormouse is represented in Divje babe I layers 6–17a1 by merely two isolated cheek-teeth, one of them being fragmentary. Dimensions (length x breadth) of the complete first lower molar (layers 16a/17a1) are below the range for recent *M. avellanarius* from Slovenia. Size difference becomes even more evident in comparison with a sample of ten fossil M_1 specimens from the uppermost layers of Divje babe I (*Fig. 10.4*).

Family: Birch mice and jerboas (Dipodidae)

Sicista cfr. *subtilis* (Pallas, 1773)

Material: Layer 13/14: tooth (sample 26/33).

A single first lower molar of *Sicista* was found in Layer 13/14. Discrimination between southern birch mouse (*S. subtilis*) and northern birch mouse (*Sicista betulina* [Pallas, 1779]) on the basis of isolated cheek-teeth is most difficult, consequently determination of the Divje babe I specimen is not reliable. *S. subtilis* differs to some extent from *S. betulina* in a more simplified structure of the molar chewing surface (Kowalski, Nadachowski 1982) however Chaline (1972) does not consider these differences to be of taxonomic significance. Dimensions of molars (larger in the southern species) appear to be more reliable. Breadth of the first lower molar of Divje babe I specimen falls within the range for recent *S. subtilis* from Romania and its length even exceeds the maximum for recent sample (*Tab. 10.11*). Because molar dimensions of fossil material exceed ranges for recent populations in both birch mice species (Terzea 1974; Kowalski, Nadachowski 1982; Popov 1994), we compared M_1 from Divje babe I with fossil specimens of the two species in question. Since the values for both linear variables (length and breadth) of Divje babe I first lower molar fall within the range for fossil *S. subtilis* (*Tab. 10.11*), we are most likely dealing with the southern birch mouse.

The southern birch muse seems to be fairly eurytopic, able of finding suitable habitats in a natural steppe, on meadows, in open woodland, in agrocenoses and along the margins of arable land (Pucek 1999). It is not a member of recent mammal fauna of Slovenia any longer (Kryštufek 1991), but occurs in the Pannonian Plain, in Romania, Bulgaria, and in southern Poland (Pucek 1999). Its more extensive distribution range during the Upper Pleistocene is evident from records in France (Chaline, Brochet 1989), possibly in northern Italy (Bon *et al.* 1991), Swiss, Germany (Kowalski, Nadachowski 1982), Austria (Fladerer 2000), former Czechoslovakia (Kurtén 1968), Serbia (Dimitrijević 1996) and Greece (Mayhew 1978). Rakovec (1973) does not report it for the Pleistocene of Slovenia. Further remnants from Slovenia came from the interpleniglacial layers of Potočka zijalka (Toškan, Kryštufek 2006).

TAPHOCENOSIS

The minimum number of small mammal specimens per taxon in fossil material from the layers 6–17a1 of Divje babe I is summarized in *table 10.12*. Number of remnants per sediment unit differs considerably among layers. In spite of a considerable large area covered by excavations (= 83 m^2) the great majority (= 85%) of maxillae, mandibles and isolated cheek teeth were collected on four squares only (i.e. squares 26, 28, 29 and 32).

Similarly as is the case elsewhere, owls were evidently responsible for the bulk of accumulated bones and teeth also in Divje babe I. Composition of samples thus reflect, among others, preferences of predator to-

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Kowalski and Nadachowski 1982; Popov 1989; Janžekovič, Kryštufek 2004).

[6] The mandible originates from layer 7, where beech charcoal was also found (see chapter 8, this volume).

wards various prey categories. As a consequence, the available material unlikely reflects the actual composition of past small mammal assemblages (Andrews 1990; Popov 1994; Chaline *et al.* 1995). Diet composition varies in owls even among specimens of the same species where they inhabit different habitats (ex.gr. Purger 1989-90; Tome 1992; Lipej and Gjerkeš 1994; 1996). Diet also varies according to season and reflects the age of both predator and its prey. Interpretation of taphocenoses is additionally complicated due to different solubility of various prey items during digestion (Andrews 1990; Chaline *et al.* 1995). In spite of the above limitations we believe that differences among temporal faunas from Divje babe I do reflect environmental conditions in the vicinity of the site. Namely, a large time scale of small mammal accumulation for each facies presumably compensated for at least some of the sampling bias.

Species composition in facies C (layers 12/13–17a1) suggests a moderate climate at the termination of the OIS 5 period in the vicinity of Divje babe I. This is evident from the presence of a mole, a species which cannot tolerate deeply frozen ground. Two species at least (*M. glareolus* and *M. avellanarius*) clearly point onto the presence of forest habitat. Presence of a shrew *S. alpinus* (and possibly also of *S. araneus*), along with the absence of frugivorous rodents (*G. glis*, *A. flavicollis*) further suggest these forests to be dominated by coniferous trees. Percentage of forest dwelling species is evidently lower than the share of small mammals which depend on open habitats (*Fig. 10.5*). Indicative of the later are voles of the genus *Microtus* (*M.* ex gr. *agrestis-arvalis* making up to 40 % of a total MNI) but noteworthy is also the high number of snow voles *Ch. nivalis* (with 19 % of a total MNI). The supposed prevailence of meadows and rocky sites over woodlands in OIS 5a[7] was unlikely a consequence of low temperatures (note the presence of a mole) but possibly reflects arid climate. Records of the southern birch mouse and of parti-coloured bat might be indicative of aridity. Although these two species occur also in open woodlands (Kryštufek, Červeny 1997; Pucek 1999), they prefer steppic habitats and mountains (*V. murinus*; Kryštufek 1991) and steppes and meadows (*S. subtilis*; Pucek 1999), respectively.

The predominance of open habitats in the vicinity of Divje babe I is suggested also by the low species diversity[8] and unbalanced composition of trophic groups (share of herbivores > 90%). Diversity in small mammal assemblages tend to be lower in habitats with poor vertical stratification of vegetation layers (e.g. short grass steppe, dry forests; Popov 2000). The bulk of energy flow in such habitats is in between herbivores and carnivores, while insectivores and omnivores (incl. specialized granivores) contribute little to a total abundance (Horáček, Ložek 1988).

Species composition and their abundances in facies B suggest fundamentally different climatic conditions at the beginning of OIS 3 than it was the case during OIS 5a. Sediments from the intermediate period (OIS 4) are evidently only poorly represented in the cave, most likely due to some standstill in sedimentation (Chapter 6 and 7, this volume). Twelve species as found in facies B indicate small mammal assembly of low species richness (layers 7–11/12). Clearly evident is also a decline in species associated with open habitats. Their share dropped down from 59 % in facies C to 39 % in facies B, which is clearly a consequence of a decreased relative frequency of *M.* ex gr. *agrestis-arvalis* (10 % of total MNI). On the other hand, share of *Ch. nivalis* is slightly higher in facies B (*Fig. 10.5*). In line with Popov (2000) these changes could be interpreted as a response to a gradual shift towards relatively stable mesic and cold climate.[9] Increased humidity is likely to have stimulated the expansion of forest (relative abundance of *M. glareolus* is close to 50%), which were most likely coniferous ones. Environment of lower temperatures and higher humidity is indicated also by an increased relative abundance of *Sorex* shrews (*cfr.* Anděra 1999; Spitzenberger 1999a). Noteworthy is also a high number of arvicoline 2nd upper molars with an additional postero-lingual enamel triangle (*Tab. 10.13*), which can be reliably ascribed to *M. agrestis*; this vole is more dependent on wet habitats that *M. arvalis* (Mitchell-Jones *et al.* 1999).

Small mammal fauna from faciesa A (layers 2–6) is outstanding by its species richness (23 species with no clearly dominating ones) and by fairly balanced representation of trophic groups (share of insectivorous species > 20 %). These same samples led Kryštufek (1997) to a conclusion that the landscape in the vicinity of Divje babe I during the OIS 3 was a habitat mosaic of mixed but predominantly coniferous forests (which is evident from low abundance of frugivorous dormice and yellow-necked field mouse), meadows and rocky situations (which can be deduced from field vole and snow vole finds). The situation was possibly analogous to a recent landscape at the forest lines (1.500 to 2.000 m a.s.l.) or at lower altitudes on steep rocky slopes.

CORRESPONDENCE ANALYSIS

Results of correspondence analysis are summarized in *figure 10.6* (see also *Tab. 10.14* and *Annexes 10.2A* and

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[7] Such a conclusion is in agreement with palynological analyses. Share of herbaceous pollen increased from 10 % at the beginning of OIS 5a to 80 % latter on (Šercelj, Culiberg 1991).

[8] Altogether remnants of 13 species of small mammals were found in facies C. While four of them are represented with a single tooth each, remnants of *M. agrestis*, *M. arvalis*, *Ch. nivalis* and *C. glareolus* account for 89 % of total MNI.

[9] Such a conclusion is in line with palynological evidence. Facies B is characterised by high share of alder (*Alnus* sp.), a tree prefering mesic environment, and by relatively high percentage of cold adapted plants (Šercelj, Culiberg 1991).

10.2B). The analysis is based on MNI values of rodent taxa from three facies of Divje babe I, as well as on 19 recent samples from Slovenia, Croatia, Serbia and Czech Republic. Dispersion of 22 samples along the first two axes of correspondence analysis[10] places the sample from facies A between clusters of recent small mammal assemblages of deciduous / mixed forests from Slovenia (Bela krajina, area of Ljubljansko barje, Brkini, vicinity of Divje babe I) and of coniferous forests (mainly Norway spruce) from Peca, Smrekovec and Mt. Orlické hory (*Fig. 10.6*). Since the upper-most layers of Divje babe I have been most likely contaminated by recent dormouse (Kryštufek 1997) we arbitrarily adjusted its abundance in the sample to one fifth of the actual one (i.e. MNI = 52 instead of MNI = 261). Such an adjustment is tentatively in balance with lack of pollen and charcoal of fruit-bearing woody plants in facies A (Šercelj, Culiberg 1991). Namely, the edible dormouse strongly depends on seeds, fruits and similar soft but nutritious food and is thus indicative of deciduous and mixed forests.

The position of the sample from facies B in *figure 10.6* is in line with the above presented suggestion of relatively colder climate during the first half of OIS 3 in comparison with OIS 5a. Namely, this sample is placed close to a cluster of small mammal assemblages from coniferous forests of higher altitudes (1.000 to 1.500 m a.s.l.) and is thus indicative of cold climate. We cannot exclude the possibility that the high value of facies B along the y axis (2nd dimension; coordinate = 1.98) suggests also a relatively humid climate of the early OIS 3. As it is evident from *table 10.14* approximately half of the inertia which is summarized by the 2nd dimension of the correspondence analysis is due to among-sample differences in abundance of the bank vole. Bank vole prefers mesic and coniferous forests (Spitzenberger 1999b). Data on the abundance of the water vole are less suitable for testing of a presumption on increased humidity of the palaeoenvironment. Water voles contribute <5% to the inertia accounted for by the first four dimensions of the correspondence analysis (= 90.6 % of total inertia, *Annex 10.2A*). Of the two ecological forms of recent water voles, only the aquatic one is closely tied to wet habitats while the fossorial form populates dry to moderately mesic meadows and forest clearings (Saucy 1999). All recent voles from Slovenia show fossorial adaptations (Kryštufek 1991).

Sample from facies C is placed between assemblages of forested and of open habitats along the 1st dimension of the correspondence analysis (*Fig. 10.6*) but statistical support for such a position is weak. Namely, the 1st dimension only poorly summarizes peculiarities of facies C ($\cos^2 < 7\%$; *Annex 10.2C*). More powerful in this respect is the 2nd dimension ($\cos^2 = 60.0\ \%$), which placed facies C close to recent assemblages of coniferous forests.

MULTIDIMENSIONAL SCALING

Species composition in small mammal assemblages from layers 2–5 (≈ facies A) of Divje babe I is nearly identical to the recent sympatric fauna. Thus, the Pleistocene-Holocene boundary near Divje babe I was not characterized by a rapid turnover in species composition (Kryštufek 1997). This is in sharp contrast with the contemporary situation to the north of the Alpine glacier. The Upper Pleistocene small mammal assemblages of Divje babe I resemble more closely the recent one, than synchronic (OIS 5 and OIS 3) assemblages from southern Germany and Poland, which is clearly evident from *figure 10.7.* Phenogram summarizes diagonal similarity matrix derived from a multidimensional scaling of Euclidean distances among 24 fossil and sub-fossil rodent assemblages, including samples from facies B and C of Divje babe I. The above discrepancies are evidently a consequence of different environmental history on the two sides of the Alpine glacier. During OIS 5 in OIS 3 the glacial refuge in the south was already inhabited by forest species which were also characteristic for central and southern parts of the Balkan Peninsula (Mayhew 1978; Kowalski, Nadachowski 1982; Dimitrijević 1996; Chatzopoulou 2003; Lenardić Mauch 2005).[11] Holocen samples cluster along the x-axis (1st dimension) at lower values than fossil assemblages from Slovenia and NE Italy. This might be a consequence of a presumed increase of the number of species remains depending on fruit-bearing trees and shrubs at the end of the Pleistocene (yellow-necked mouse, edible dormouse). Such differences possibly affected abundances of small mammals to a larger degree than the species composition.

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[10] First two dimensions were responsible for 65.2 % of total inertia (*Annex 10.2A*).

[11] This statement is also supported by the position of three fossil small mammal samples from the Bulgarian site Temnata (*Fig. 10.7*). Along the x-axis (1st dimension of correspondence analysis) they all cluster with contemporary assemblages from Slovenia and NE Italy. Their semi-isolated position along the y-axis (2nd dimension of correspondence analysis) is most likely due to several species of dry steppes (*Mesocricetus newtoni, Lagurus lagurus, Allactaga major*) which were absent from contemporary faunas of Central Europe.

PRILOGE / ANNEXES

Pril. 10.1A: Koronoidna višina spodnjih čeljustnic gorskih rovk (*Sorex alpinus*) in gozdnih rovk (*S. araneus*) iz Divjih bab I (sklop plasti 7 do 17a1). Mere so izražene v mm.
Annex 10.1A: Coronoid height of mandible (in mm) in Alpine shrews (*Sorex alpinus*) and common shrews (*S. araneus*) from Divje babe I (layers 7-17a1).

Species	Period	Facies	Measure
S. araneus	OIS 3	A+B	4.69
S. araneus	OIS 3	A+B	4.80
S. alpinus	OIS 3	A+B	4.16
S. alpinus	OIS 3	A+B	4.19
S. alpinus	OIS 5	C	4.33

Pril. 10.1B: Dolžina in širina prvega oz. drugega spodnjega meljaka krtov (*Talpa europaea / caeca*) iz Divjih bab I (sklop plasti 13 do 17a1). Zvezda (*) označuje primerek iz vzorca 32/31, ki je bil na osnovi metričnih podatkov pripisan vrsti *T. europaea*. Mere so izražene v mm.
Annex 10.1B: Length and breadth of first and second lower molar (in mm) in moles (*Talpa europaea / caeca*) from Divje babe I (layers 13-17a1). Asterisk (*) marks the sprecimen from sample 32/31, whose metrical data alowed its determination as *T. europaea*.

Tooth	Period	Facies	Length	Breadth
M_1*	OIS 5	C	2.50	1.32
M_2	OIS 5	C	2.16	1.40
M_2	OIS 5	C	2.32	1.37

Pril. 10.1C: Dolžina prvega spodnjega meljaka snežnih voluharic (*Chionomys nivalis*) iz Divjih bab I. Mere so izražene v mm.
Annex 10.1C: Length of first lower molar (in mm) in snow voles (*Chionomys nivalis*) from Divje babe I.

Period	Facies	M_1 length											
OIS 3	A	2.98	3.26	3.02	2.81	3.02	3.05	3.16	3.05	3.32	2.74	2.98	3.02
		3.12	3.19	3.12	2.53	2.98	3.12	3.02	2.95	2.98	3.19	3.16	3.02
		2.95	3.12	2.91	2.95	3.09	2.88	2.88	3.02	3.02	3.33	2.88	3.02
		3.05	2.91	3.19	3.02	2.84	2.95	3.23	2.88	3.09	2.81	3.37	2.91
		3.26	3.33	3.02	3.05	2.98	3.19	3.02	2.88	3.26	2.98	2.84	2.91
		2.74	2.84	3.09	3.16	3.3	2.84	3.02	2.95	2.81	2.98	2.95	2.95
		2.91	2.91	2.67									
OIS 5	B	2.66	2.74	2.89	2.89	2.93	2.96	2.96	3.00	3.04	2.89	2.81	2.89
		2.85	3.00	2.70	3.04	2.85	3.04	3.08	2.93	3.15	3.04	2.96	2.89
		3.00	3.04	2.70	2.77	2.85	3.08	3.04	3.00	3.04	3.12	2.85	2.85
	C	2.74	2.85	3.04	3.00	3.04	3.08	3.15	2.85	3.15	2.66	3.04	2.81
		2.85	2.85	3.04	2.85	2.85	2.89	3.00	2.93	2.93	2.70	2.85	2.66
		3.00	3.08	2.70	2.85	2.89	3.15	2.85	2.85	3.00	3.08	2.85	2.74
		2.70	2.74	2.89	2.62	2.96	2.70	2.81	2.66	3.04	3.04	2.81	3.00
		2.96	2.55	2.85	2.81	2.93	2.93	3.04	2.89	2.77	2.93	2.70	2.93
		2.74	2.93										

Pril. 10.1D: Dolžina prvega spodnjega in tretjega zgornjega meljaka velikih voluharjev (*Arvicola terrestris*) iz Divjih bab I. Mere so izražene v mm.
Annex 10.1D: Length of first lower and third upper molar (in mm) in water voles (*Arvicola terrestris*) from Divje babe I.

Period	Facies	M_1 length											
OIS 3	B	3.61	4.03	3.65	3.80	3.95	3.65	3.95	3.88	3.95	3.72	4.26	3.72
		3.80											
OIS 5	C	4.45	4.26	4.22	4.03	3.88	3.69	4.26	3.76	3.88	4.03	3.91	3.72
		3.88	3.95	3.91	3.91	3.84							
Period	**Facies**	**M^3 length**											
OIS 3	B	2.70	2.55										
OIS 5	C	2.43	2.66	2.66	2.55	2.20	2.70	2.51					

Pril. 10.1E: Dolžina prvega spodnjega meljaka gozdnih voluharic (*Myodes glareolus*) iz Divjih bab I. Mere so izražene v mm.
Annex 10.1E: Length of first lower molar (in mm) in bank voles (*Myodes glareolus*) from Divje babe I.

Period	**Facies**	**M_1 length**											
OIS 3	A	2.11	2.35	2.42	2.60	2.46	2.67	2.49	2.63	2.28	2.42	2.32	2.28
		2.32	2.60	2.49	2.42	2.60	2.46	2.11	2.46	2.49	2.49	2.42	2.25
		2.35	2.39	2.42	2.39	2.56	2.60	2.49	2.63	2.60	2.35	2.39	2.56
		2.39	2.53	2.28	2.46	2.56	2.35	2.49	2.21	2.32	2.46	2.49	2.21
		2.49	2.21	2.49	2.49	2.60	2.63	2.32	2.60	2.56	2.28	2.18	2.39
		2.42	2.63	2.76	2.67	2.56	2.28	2.28	2.56	2.46	2.39	2.46	2.42
		2.18	2.35	2.39	2.35	2.63	2.18	2.32	2.14	2.74	2.32	2.46	2.25
		2.60	2.39	2.35	2.70	2.46	2.56						
	B	2.21	2.28	2.18	2.18	2.35	2.35	2.32	2.39	2.46	2.39	2.49	2.25
		2.21	2.18	2.21	2.42	2.32	2.14	2.39	2.25	2.49	2.42	2.14	2.39
		2.14	2.11	2.25	2.47	2.09	2.17	2.47	2.43	2.47	2.55	2.05	2.36
		2.17	2.96	2.43	2.36	2.28	2.36	2.66	2.13	2.24	2.20	2.47	2.17
		2.47	2.43	2.32	2.66	2.55	2.28	2.28	2.36	2.17	2.32	2.39	2.39
		2.36	2.28	2.43	2.36	2.32	2.39	2.20	2.89	2.36	2.55	2.66	2.47
		2.58	2.36	2.36	2.51	2.43	2.58	2.39	2.39	2.51	2.62	2.66	2.47
OIS 5	C	2.13	2.13	2.17	2.17	2.17	2.17	2.17	2.20	2.20	2.24	2.24	2.32
		2.32	2.32	2.32	2.32	2.39	2.39	2.43	2.43	2.43	2.47	2.47	2.47
		2.47	2.51	2.51	2.51	2.51	2.55	2.55	2.55	2.58	2.58	2.58	2.62
		2.74	2.81	2.58	2.62	2.43	2.58	2.43	2.36	2.32	2.47	2.39	2.47
		2.47	2.43	2.05	2.05	2.36	2.96	2.43	2.36	2.36	2.47	2.47	2.43
		2.66	2.55	2.28	2.28	2.36	2.17	2.28	2.89	2.28	2.58	2.47	2.58
		2.20											

Pril. 10.1F: Dolžina prvega spodnjega meljaka voluharic kompleksa *Microtus* ex gr. *agrestis* – *arvalis* iz Divjih bab I. Mere so izražene v mm.
Annex 10.1F: Length of first lower molar (in mm) in voles of *Microtus* ex gr. *agrestis* - *arvalis* group from Divje babe I.

Period	**Facies**	**M_1 length**											
OIS 3	A	2.88	2.67	2.84	2.63	2.97	2.60	2.67	2.60	2.81	2.65	2.46	2.39
		2.83	2.42	3.02	2.98	2.74	2.61	2.77	2.47	2.77	2.67	2.60	2.95
		3.26	3.02	2.77	2.63	2.67	2.81	2.81	2.53	3.02	2.46	2.60	2.65
		2.74	2.76										
	B	2.66	2.81	2.66	3.15	2.32	2.85	2.58	2.66	2.66	2.43	2.43	2.81
		2.62	2.46	2.63	3.12	2.63	2.91	2.81	2.81	2.74	2.77	2.74	
OIS 5	C	3.00	2.32	2.89	2.85	2.66	3.15	2.70	2.77	2.66	2.66	2.66	2.77
		2.77	2.58	2.66	2.66	2.66	2.77	2.36	2.85	2.77	2.47	2.85	2.85
		2.85	2.85	2.89	3.00	2.43	2.81	3.04	2.62	2.62	2.96	2.85	3.04
		2.85	2.66	2.55	2.66	2.51	2.74	2.89	2.70	2.70	3.04	2.66	2.70
		2.43	2.62	2.89	2.77	2.47	3.12	2.85	2.85	2.55	2.74	2.62	2.66
		2.43	2.81	2.89	2.66	2.89	2.66	2.66	2.66	2.89	2.81	2.93	2.81
		2.85	2.66	3.12	2.77	3.08	2.85	2.66	2.43	2.85	2.96	2.70	2.66
		2.77	3.04	2.77	2.66	2.66	2.55	2.47	2.96	2.85	2.70	2.96	2.58
		2.66	2.81	2.74	2.58	3.08	2.43	2.55	2.47	2.62	2.62	2.70	2.62
		2.55	2.66	2.43	2.70	2.47	2.47	2.77	2.66	2.77	2.77	3.00	2.66
		2.09	2.74	2.81	2.51	2.55	2.93	2.74					

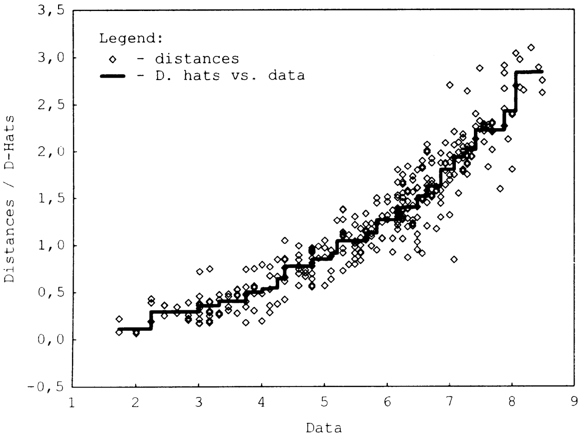
Pril. 10.1G: Dolžina prvega spodnjega meljaka voluharic kompleksa *Microtus* ex gr. *liechtensteini* – *subterraneus* iz Divjih bab I. Mere so izražene v mm.
Annex 10.1G: Length of first lower molar (in mm) in voles of *Microtus* ex gr. *liechtensteini* - *subterraneus* group from Divje babe I.

Period	**Facies**	**M_1 length**											
OIS 3	A	2.56	2.84	2.84	2.70	2.67	2.42	2.74	2.39	2.74	2.49	2.56	2.67
		2.74	2.88	2.70	2.74	2.81	2.74	3.16	2.67	2.67	2.81		
	B	2.47	2.77	2.39									
OIS 5	C	2.77	2.70	2.51	2.70	2.93	2.66	2.58	2.66	2.62			

Pril. 10.2A: Lastne vrednosti (*eigenvalues*) in deleži inercije, ki jih povzema prvih sedem dimenzij korespondenčne analize.
Annex 10.2A: Eigenvalues and relative inertia summarised by first seven dimensions of correspondence analysis.

Dimension	Eigenvalue	Percent of inertia	Cumulative percent
1	0.664	45.6	45.6
2	0.286	19.6	65.2
3	0.229	15.7	80.9
4	0.141	9.7	90.6
5	0.068	4.7	95.3
6	0.049	3.4	98.7
7	0.017	1.3	100

Pril. 10.2B: Shepardov diagram za končno razporeditev matrike, pridobljene z večdimenzionalnim skaliranjem evklidskih razdalj med 24 fosilnimi in subfosilnimi združbami glodalcev iz Evrope.
Annex 10.2B: Shepard diagram for final distribution of matrix derived from multidimensional scaling of Euclidean distances among 24 fossil and subfossil rodent assemblages from Europe.



Pril. 10.2C: Prispevek posameznih vzorcev fosilnih in subfosilnih ostankov glodalcev k skupni inerciji in k inerciji, ki jo povzema vsaka od prvih treh dimenzij korespondenčne analize. Senčeni polji označujeta podatka, ki sta v besedilu eksplicitno omenjena.
Annex 10.2C: Contribution of individual fossil and sub-fossil rodent samples to the total inertia and to the inertia summarised by the first dimension of correspondence analysis. Shaded cells indicate data discussed in the text.

Sample	Dimension 1-3		Dimension 1		Dimension 2		Dimension 3	
	Quality	Relative inertia	Inertia	Cos²	Inertia	Cos²	Inertia	Cos²
1	0.618	0.046	0.062	0.618	0.000	0.000	0.000	0.001
2	0.734	0.050	0.017	0.157	0.147	0.576	0.000	0.001
3	0.699	0.038	0.006	0.067	0.116	0.600	0.008	0.033
4	0.939	0.032	0.028	0.398	0.086	0.529	0.002	0.011
5	0.842	0.031	0.043	0.619	0.036	0.221	0.000	0.001
6	0.583	0.053	0.068	0.572	0.003	0.009	0.001	0.002
7	0.963	0.098	0.096	0.444	0.022	0.044	0.296	0.475
8	0.865	0.024	0.045	0.845	0.002	0.020	0.000	0.000
9	0.475	0.012	0.011	0.429	0.001	0.024	0.002	0.023
10	0.746	0.093	0.142	0.692	0.026	0.053	0.000	0.000
11	0.934	0.024	0.039	0.727	0.026	0.207	0.000	0.000
12	0.966	0.002	0.005	0.873	0.001	0.051	0.001	0.041
13	0.945	0.183	0.204	0.509	0.404	0.433	0.004	0.003
14	0.857	0.080	0.104	0.592	0.106	0.259	0.003	0.005
15	0.705	0.008	0.009	0.500	0.007	0.164	0.002	0.041
16	0.912	0.001	0.001	0.103	0.003	0.110	0.023	0.698
17	0.625	0.008	0.006	0.343	0.000	0.004	0.014	0.278
18	0.689	0.058	0.019	0.151	0.000	0.000	0.198	0.537
19	0.728	0.069	0.016	0.102	0.005	0.013	0.270	0.613
20	0.837	0.014	0.004	0.143	0.000	0.000	0.063	0.694
21	0.893	0.028	0.029	0.476	0.001	0.004	0.074	0.412
22	0.736	0.038	0.044	0.536	0.008	0.043	0.037	0.157

11. OSTANKI VELIKIH SESALCEV IZ DIVJIH BAB I STRATIGRAFIJA, TAKSONOMIJA IN BIOMETRIJA

BORUT TOŠKAN

Izvleček

V mlajšepleistocenskih (OIS 3 in OIS 5) plasteh paleolitskega jamskega najdišča Divje babe I je bilo (ob najdbah jamskega medveda) najdenih še 995 ostankov velikih sesalcev iz vsaj 20 različnih vrst: *Lepus timidus* seu *europaeus*, *Marmota marmota*, *Ursus arctos*, *Canis lupus*, *Vulpes vulpes*, *Alopex lagopus*, *Mustela putorius*, *Martes martes*, *Lutra lutra*, *Felis silvestris*, *Lynx lynx*, *Panthera pardus*, *Panthera spelaea*, *Sus scrofa*, *Cervus elaphus*, *Alces alces*, *Capreolus capreolus*, *Rupicapra rupicapra*, *Capra ibex* in *Mammuthus primigenius* seu *Dicerorhinus* seu *Coleodonta*. Število in mesto pojavljanja urezov, zasekanin, odtisov zob in sledi udarcev s kamnitim orodjem na dolgih kosteh kopitarjev kaže, da so bili za nastanek tafocenoze v jami odgovorni tako paleolitski človek kot tudi zveri. Zdi se, da so bila trupla jelenov, gamsov, kozorogov in srn običajno najprej dostopna človeku, njemu nezanimive odpadke (predvsem gre tu za z maščobo prepojene fragmente spongiozne kosti ob epifizah) pa naj bi naknadno uživale še zveri. Malo verjetno je, da bi bili ljudje pri iskanju mrhovine uspešnejši od volkov, medvedov, jamskih levov, leopardov in risov, zato naj bi glavnina kosti kopitarjev v Divjih babah I predstavljala ostanek človekovega plena.

Med večletnimi izkopavanji na najdišču Divje babe I (zahodna Slovenija, 450 m n. m. v.) je bilo poleg drugega zbrano tudi mnogo ostankov velikih sesalcev. Po pričakovanju (Miracle 1991) jih velika večina pripada jamskemu medvedu (*Ursus spelaeus*) in ti so bili v preteklosti že predmet več preliminarnih raziskav (npr. Turk *et al.* 1988–1989; 1990; 1992; Turk, Dirjec 1989; 1991; Debeljak 1996; 2002a). Drugače je z najdbami drugih velikih sesalcev, ki jim je bilo doslej namenjeno zelo malo pozornosti (glej npr. Turk, Dirjec 1997b). V nadaljevanju tako najprej podajam taksonomski pregled sesalske makrofavne, sledijo pa še ugotovitve o značilnostih nekdanjega okolja ter o vlogi posameznih dejavnikov akumulacije pri nastajanju preučevane tafocenoze.

METODE

Obravnavano gradivo je bilo zbrano v dveh zaporednih fazah izkopavanj, pri katerih so bile uporabljene različne terenske tehnike in metode. V prvem obdobju (tj. med letoma 1980 in 1986) so na konvencionalen način raziskali vhodni del jame, pri čemer sedimenta niso spirali skozi sito. Posamezne najdbe so dokumentirali vertikalno po plasteh, ki so jim sledili med približno meter oddaljenimi sosednjimi profili. Z začetkom druge faze izkopavanj (obdobje med letoma 1989 in 1999), ko so raziskali osrednji in notranji del jame, se je metodologija bistveno spremenila. V globino so odtlej kopali po horizontalnih izkopih (režnjih) debeline 12 cm, pri čemer so osnovno območno enoto predstavljali kvadri 1 x 1 x 0,12 m. Od leta 1990 naprej so bile vse odkopane usedline sprane in pregledane na sitih s premerom odprtin 10 mm, 3 mm in 0,5 mm. Podrobnejše podatke o najdišču in metodologiji terenskega raziskovanja podaja Turk (poglavje 1 v tem zborniku). Najstarejše izkopane plasti (tj. pl. 21 do 26) naj bi nastale v riško-würmskem interglacialu (OIS 5e), plasti 12 do 20 so domnevno nastale v zgodnjem glacialu (OIS 5a-5d), večina preo-stalih (tj. 2 do 11) pa v t. i. interpleniglacialu oz. srednjem virmu-würmu (OIS 3); plast 1 je holocenska (OIS 1). Starost najstarejših preučenih sedimentov je ocenjena na več kot 115.000 let pred sedanjostjo (p.s.), tistih iz plasti 2 pa na približno 40.000 let p.s. (Turk *et al.* 2001a; poglavje 1 v tem zborniku).

Pri determinaciji mi je bilo v pomoč fosilno in recentno gradivo iz Slovenije (zbirki Inštituta za arheologijo ZRC SAZU ter Katedre za paleontologijo NTF Univerze v Ljubljani) in Hrvaške (zbirka Zavoda za geologijo in paleontologijo kvartarja iz Zagreba). Pri sistematskem razvrščanju sem se držal sistema, kot ga podajata Guérin, Patou-Mathis (1996). Starostno strukturo živali sem ocenjeval z analizo obrabe žvekalne površine kočnikov. Merjene dimenzije so povzete po Torresu (1988; dimenzije medvedje lobanje) in Von Drieschevi (1976; preostale dimenzije); metrični podatki so podani v *prilogi 11.1.* Pri iskanju urezov, zasekanin, sledi udarcev z orodjem in odtisov zverskih zob sem uporabljal stereomikroskop (15x povečava) in močan vir svetlobe (prim. Blumenschine *et al.* 1996).

Kot kazalec abundance sem uporabil najmanjše število določenih ostankov (*Number of Identified Specimens*; NISP), saj je število najdb razmeroma skromno.

V čeljustnice vključene zobe sem obravnaval kot izolirane (npr. primerek mandibule z ohranjenim M_1 sem upošteval kot NISP = 2). S tem sem zmanjšal moteč vpliv različne intenzivnosti razpadanja ostankov v različnih obdobjih würma. Pri analizi zastopanosti posameznih anatomskih regij uplenjenih in/ali poginulih živali sem število ostankov izrazil z najmanjšim številom skeletnih elementov (*Minimum Number of Elements*; MNE). Ta prikaže abundanco najštevilčnejšega dela posameznega skeletnega elementa danega taksona v obravnavanem vzorcu (npr. proksimalna epifiza stegnenice volka). Če se takšen element v skeletu živali pojavlja v paru (npr. kosti okončin), predstavlja MNE vsoto vseh levih in desnih fragmentov (Stiner 1994). Zob pri ugotavljanju najmanjšega števila elementov nisem upošteval. Zaradi večje trdnosti namreč ti praviloma bistveno bolj kot kosti kljubujejo različnim destruktivnim poodložitvenim dejavnikom (Lyman 1999).

Pri statistični obdelavi sem uporabljal neparametrične teste (npr. Spearmanov R koeficient korelacije, χ^2-test, Mann-Whitney U test; StatSoft, Inc. 2001), saj porazdelitev analiziranih metričnih podatkov praviloma odstopa od normalne. Statistična obdelava je bila narejena s programskim paketom StatSoft 2001, STATISTICA za Windows, verzija 6.0.

Vse kostne najdbe iz Divjih bab I hrani Narodni muzej Slovenije v Ljubljani.

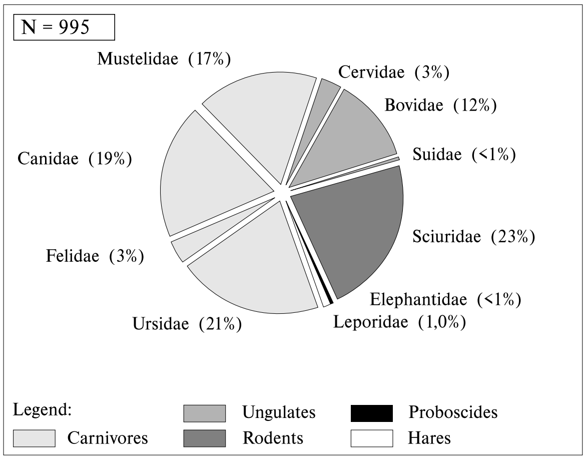
TAKSONOMIJA

Ob najdbah jamskega medveda je bilo do nivoja rodu mogoče določiti še 995 ostankov velikih sesalcev, ki sem jih pripisal 20 vrstam iz 10 družin (*sl. 11.1*). Večina jih območje Slovenije naseljuje še danes, čeprav nekatere le zaradi ponovnega vnosa po predhodnem lokalnem izumrtju (npr. *Capra ibex*, *Lynx lynx*, *Marmota marmota*). Od skupno petih vrst, ki jih danes na Slovenskem ne najdemo več, sta ob koncu pleistocena globalno izumrli dve (*Mammuthus primigenius* (?) in *Panthera spelea*). Preostale tri (*Alces alces*, *Alopex lagopus* in *Panthera pardus*) so se umaknile drugam.

Red: Zajci in žvižgači (Lagomorpha)
Družina: Zajci in kunci (Leporidae)

Lepus timidus / europaeus

Gradivo: sklop plasti 2–5: ulna, vertebra lumbalis, ossa coxae (2x);[1] plast 6: dens; plast 8: phalanges (2x); plast 13: humerus; plast 2–11/12: astragalus; plast 12–22: metapodium.



Sl. 11.1: Deleži posameznih družin velikih sesalcev, zastopanih v Divjih babah I. Najdbe jamskega medveda (*Ursus spelaeus*) niso vključene.
Fig. 11.1: Shares of individual families of large mammals represented at Divje babe I. Finds of cave bear (*Ursus spelaeus*) are not included.

Ločevanje med poljskim zajcem (*Lepus europaeus* Pallas, 1778) in planinskim zajcem (*Lepus timidus* Linnaeus, 1758) je težavno. Zanesljivo specifično determinacijo naj bi dopuščal le desni zgornji sekalec (Rakovec 1961; Malez 1963; Kryštufek 1991), ki pa ga v tukaj obravnavanem vzorcu ni. Vrsti naj bi bilo mogoče razlikovati tudi na podlagi razvitosti postero-lingvalne skleninske pentlje drugih zgornjih predmeljakov (Chaline 1966), vendar je edini razpoložljivi P^2 iz Divjih bab I na tem delu poškodovan. Neuporabni so tudi metrični podatki, saj sta obe razpoložljivi dolgi kosti fragmentirani. Največja širina distalne epifize nadlahtnice iz plasti 13 (inv. št. D. b. 1303) se z 12 mm sicer uvršča znotraj variacijske širine za recentne poljske zajce z območja nekdanje Sovjetske zveze (razpon: 7,5–15 mm; N ni naveden; Gromova 1950), vendar pa hkrati ne odstopa niti od vrednosti iste dimenzije pri fosilnih planinskih zajcih z južne Moravske (razpon: 11–13 mm; N = 22; Rakovec 1959).

Najdbe rodu *Lepus* iz Divjih bab I izvirajo iz plasti 2 do 13, ki so domnevno nastale v OIS 3. Takrat naj bi bila klima hladna in kot taka primernejša za planinskega zajca. Danes namreč največji del areala omenjene vrste prekrivata tundra in tajga[2] (Lequatre 1994), medtem ko poljski zajec preferira polja, travnike in pašnike (Kryštufek 1991). Poleg tega so iz paleolitskih najdišč na Slovenskem ostanki vrste *L. europaeus* znani le iz Potočke zijalke (Brodar, S. in M. 1983), medtem ko naj bi bila vrsta *L. timidus* v istem obdobju splošno razširjena (Rakovec 1959; 1961; 1962-63; 1973; Osole 1976).

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[1] Ledveno vretence in oba fragmenta medenice (po en levi in en desni) izhajajo iz istega kvadrata in izkopa, zato gre verjetno za ostanke iste živali.

[2] V Alpah obsega areal vrste *L. timidus* planinske pašnike, ruševje in visoka barja (Kryštufek 1991).

Red: Glodalci (Rodentia)
Družina: Veverice (Sciuridae)

Marmota marmota (Linnaeus, 1758)

Gradivo: Alpski svizec je v vzorcu iz Divjih bab I zastopan z 234 ostanki. Celoten seznam najdb po plasteh in skeletnih elementih je podan v *prilogi 11.2A*.

V würmu sta Evropo naseljevali dve alopatrični vrsti svizca: alpski svizec in bobak (*M. bobac* Müller, 1776). Na osnovi števila korenin četrtih spodnjih predmeljakov in barve sekalcev sem vse primerke iz Divjih bab I pripisal k vrsti *M. marmota* (Rakovec 1935; Chaline 1966); vsi razpoložljivi P_4 imajo namreč po tri korenine (in ne le dve kot pri *M. bobac*), pa tudi sekalci so intenzivno oranžno obarvani (pri bobaku so znatno svetlejši). Isti vrsti so bile pripisane tudi najdbe svizcev z drugih paleolitskih najdišč Slovenije, SV Italije, JV Avstrije, Z Madžarske, Hrvaške ter Bosne in Hercegovine (Rakovec 1973; Jánossy 1986; Malez 1986a; Bon *et al.* 1991; Fladerer 2000; Toškan 2004).

Recentni alpski svizci naseljujejo odprte planinske travnike. V zemljo si kopljejo rove, v katerih prenočujejo, prezimijo in se skrivajo pred plenilci. Zato se lahko naselijo le tam, kjer so tla vsaj tri metre globoka ali pa je vsaj toliko nanosov (Kryštufek 1991). Kot je razvidno iz *tabele 11.14* so najdbe svizcev v Divjih babah I najštevilčnejše v plasteh 2-5. Čeprav so te nastale pred globoko zamrznitvijo tal v predelu za jamskim vhodom,[3] pa svizčevih najdb v jami ni utemeljeno povezovati z nezmožnostjo kopanja rovov na planem. Res je, da si recentni svizci zatočišče včasih iščejo tudi v skalnih razpokah in podzemnih votlinah (Turk *et al.* 1996); to ne nazadnje dokazujejo tudi fosilni rovi v nekaterih mlajšepleistocenskih jamskih najdiščih (npr. Pohar 1989; Pohar, Brodar 2000). Res je tudi, da v zimskih rovih med pet- do šestmesečnim hiberniranjem pogine razmeroma veliko število živali (Kryštufek 1991). Ker pa vodijo ti rovi pri recentnih alpskih svizcih v globino vsaj 2 do 3 m (Vidic 1994), predstavljajo najdbe omenjene vrste v Divjih babah I najverjetneje predvsem ostanek plena človeka in/ali manjših zveri (npr. lisice, risa, kune).[4] Večina svizčevih ostankov namreč izvira iz zgornjega enega metra sedimenta (tj. sklop plasti 2 do 5), kar je za zimske rove preplitvo.

Red: Zveri (Carnivora)

Zveri so v vzorcu iz Divjih bab I zastopane z 12 vrstami iz štirih družin. 14 ostankov (predvsem prstnice, sekalci, zapestne in nartne kosti) je bilo mogoče določiti le do nivoja redu. Preostale najdbe podrobneje predstavljam v nadaljevanju.

Družina: Medvedi (Ursidae)

Ursus spelaeus Rosenmüller, 1794

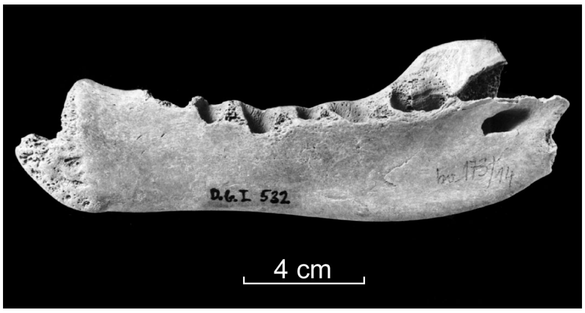
V Divjih babah I predstavljajo ostanki jamskega medveda daleč največji delež najdb velikih sesalcev (>99 % NISP), zato so v zborniku obravnavani ločeno (glej poglavja 12, 15–18 v tem zborniku).

Ursus arctos Linnaeus, 1758

Gradivo: Rjavi medved je v vzorcu iz Divjih bab I zastopan s 192 ostanki. Celoten seznam najdb po plasteh in skeletnih elementih je podan v *prilogi 11.2B*.

Fosilne najdbe rjavega medveda nastopajo običajno skupaj z najdbami jamskega medveda, vendar praviloma v veliko manjšem številu. Nesorazmerje v deležih obeh vrst je najverjetneje posledica manjše navezanosti rjavega medveda na hiberniranje v jamah (Couturier 1954; Argant 1996a). Rod *Ursus* izkazuje veliko morfološko variabilnost (Kryštufek 1991), zato je determinacija pogosto problematična. Kar tretjino od skupno 191 medvedjih kosti in zob iz Divjih bab I sem tako k vrsti *U. arctos* pripisal le pogojno. Večinoma gre za izolirane predmeljake, saj se ti pri vrsti *U. spelaeus* pojavljajo le izjemoma (Ewer 1973; Torres 1988). Manj problematična je določitev meljakov, kjer so razlike med vrstama večje (*tab. 11.1*).

Zanimiva je najdba lobanje iz plasti 6 (inv. št. D. b. 1606a), saj je skoraj nepoškodovana (glej poglavje 15 v tem zborniku, *sl. 15.4b*). V velikosti nekoliko presega mlajšepleistocenske primerke z Iberskega polotoka (*pril. 11.1C*; glej Torres 1988). Posebno obravnavo zasluži spodnja čeljustnica iz plasti 14 (inv. št. D. b. 532). Gre za poškodovan primerek, od katerega je ohranjeno le spodnječeljustnično telo (*corpus mandi-*



Sl. 11.2: Medvedja spodnja čeljustnica iz plasti 14 (inv. št. D.b. 532). Fotografija: T. Lauko.
Fig. 11.2: Lower jaw of a bear from Layer 14 (inv. no. D.b. 532). Photograph T. Lauko.

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[3] To dokazujeta krioturbacija in soliflukcija dela usedlin (Turk 1997).

[4] Možnost, da bi bili zimski rovi v jami plitvejši od tistih na planem, se glede na etologijo recentnih alpskih svizcev in geološko sestavo sklopa plasti 2 do 5 ne zdi verjetna (F. Frey-Roos, ustno poročilo).

Tab. 11.1: Opisna statistika za dolžino in širino meljakov rjavega medveda (*Ursus* cf. *arctos*) iz Divjih bab I ter ustrezne mere rjavega in jamskega medveda z nekaterih drugih paleolitskih najdišč Slovenije, Španije in Francije. Podani so povprečje (x), velikost vzorca (N) in variacijska širina (min-max). Identifikacija vzorcev: D. b. I – Divje babe I (podatki za jamskega medveda so povzeti po Debeljak (2002b)), MOKR. J. – Mokriška jama v Savinjski dolini (Rakovec 1967), ESP – več pleistocenskih najdišč Španije (Torres 1988), FRA – več pleistocenskih najdišč SV Francije (Argant 1991). Vsi primerki so datirani v OIS 3. Vse mere so v mm.

Tab. 11.1: Descriptive statistics for the length and breadth of molars of brown bear (*Ursus* cf. *arctos*) from Divje babe I and corresponding measurements of brown and cave bear from some other Palaeolithic sites in Slovenia, Spain and France. Shown are the average (x), size of sample (N) and range (min-max). Identification of samples: D. b. I – Divje babe I (data for cave bear are taken from Debeljak (2002b)), MOKR. J. – Mokriška jama in the Savinja valley (Rakovec 1967), ESP – a number of Pleistocene sites in Spain (Torres 1988), FRA – a number of Pleistocene sites in south-east France (Argant 1991). All specimens are dated to OIS 3. All measurements are in mm.

Tooth	**Dimension**	**D.b. I** *U.* **cf.** *arctos*		**D.b. I** ***U. spelaeus***	**MOKR. J.** ***U spelaeus***	**ESP** ***U. spelaeus***	**ESP** ***U. arctos***	**FRA** ***U. arctos***
				x (N) **min-max**	**min-max**	**x (N)** **min-max**	**x (N)** **min-max**	**x (N)** **min-max**
M^1	Length	24.0 D.b.1861		28.8 (464) 24.7-33.9	25.7-33.2	28.9 (411) 23.2-33.3	22.1 (47) 19.4-24.4	25.0 (16) 22.3-29.0
	Breadth	16.0 D.b.1861		19.7 (464) 16.6-23.1	16.8-22.8	19.9 (376) 15.9-25.0	16.6 (45) 13.6-19.7	–
M^2	Length	35.0 D.b.1457		44.1 (261) 38.3-49.7	40.8-53.0	45.2 (409) 38.0-53.3	35.2 (53) 28.0-41.7	38.4 (15) 36.0-41.0
	Breadth	22.0 D.b.1457		23.2 (261) 19.8-27.0	20.8-27.0	23.2 (447) 19.2-28.5	18.6 (51) 16.3-21.5	–
M_2	Length	26.0 D.b.111	24.0 D.b.571	30.8 (399) 26.6-34.4	27.8-35.6	30.4 (624) 24.1-35.8	24.5 (40) 21.2-29.2	27.7 (13) 25.5-29.8
	Breadth	14.0 D.b.111	14.5 D.b.571	18.7 (399) 15.2-22.0	15.7-21.9	18.5 (587) 14.3-22.0	15.1 (40) 12.2-18.6	–
M_3	Length	23.0 D.b.2540		26.6 (280) 20.7-33.2	22.7-31.2	26.5 (502) 20.6-32.8	20.9 (38) 16.3-24.6	22.5 (16) 20.5-25.7
	Breadth	18.0 D.b.2540		18.9 (280) 16.1-22.9	16.2-21.4	18.3 (451) 13.8-22.5	12.3 (34) 12.0-16.0	–

bulae) z alveolarnim delom. Zobje manjkajo, po alveolah sodeč pa sta imela podočnik in tretji spodnji meljak že izoblikovani korenini. Morfološko je mandibula med rjavim in jamskim medvedom (*sl. 11.2*). S slednjim jo družita odsotnost alveole prvega predmeljaka ter izbočena spodnji rob in labialna stena spodnječeljustničnega telesa. Po drugi strani vitek distalni del spodnječeljustničnega telesa, ki je povezan z gracilno grajenim podočnikom, obravnavani primerek povezuje z rjavim medvedom (Torres 1988; Capasso Barbato *et al.* 1990). Alveolarna dolžina P_4-M_3 znaša 97,3 mm, kar najdbo umešča znotraj variacijske širine primerkov vrste *U. spelaeus* iz Mokriške jame v Savinjskih Alpah (Rakovec 1967).

V Sloveniji so najstarejši ostanki rjavega medveda znani iz Jame pod Herkovimi pečmi na Kozjaku (würm I; Pohar 1981), vrsta pa je zastopana tudi v favni številnih drugih mlajšepleistocenskih najdišč v regiji (Toškan 2004). Upoštevaje razpoložljive ESR-datacije (Turk *et al.* 2001a; poglavje 6 v tem zborniku) lahko primerke iz najglobljih plasti Divjih bab I uvrstim ob bok tistim iz Jame pod Herkovimi pečmi kot najstarejše doslej znane ostanke rjavega medveda na Slovenskem.

Družina: Psi (Canidae)

Canis lupus Linnaeus, 1758

Gradivo: Volk je v vzorcu iz Divjih bab I zastopan s 167 ostanki. Celoten seznam najdb po plasteh in skeletnih elementih je podan v *prilogi 11.2C.*

Volk je zastopan v favni večine slovenskih paleolitskih najdišč (Toškan 2004), čeprav praviloma le s skromnim številom ostankov. V primeru Divjih bab I pa ni tako, saj vrsta po številu najdb zaostaja le za medvedom in svizcem. Determinacija v splošnem ni bila problematična. Izjemo predstavljajo le nekateri manjši in dokaj fragmentirani ostanki (predvsem prstnice), čeprav tudi ti izkazujejo značilno kanidno morfologijo. V tem smislu velja omeniti še podočnika iz plasti 5 do 6 (inv. št. D. b. 95; *sl. 11.3*) in 17a (inv. št. D. b. 476). Zoba se morfološko sicer ne razlikujeta od tistih vrste *C. lupus*, se pa po velikosti[5] oba umeščata znotraj variacijske širine fosilnih alpskih volkov (*Cuon alpinus* [Thenius 1954]). Omenjena vrsta

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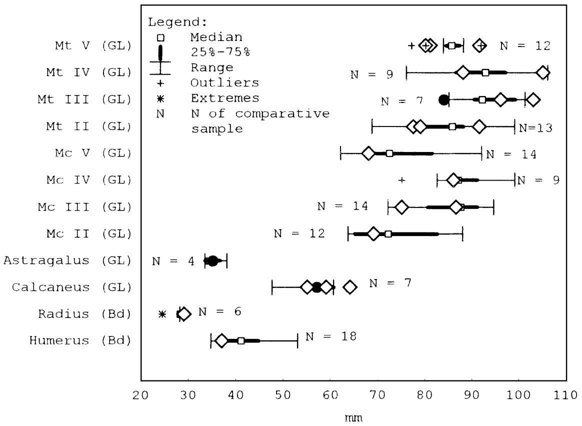
[5] Dimenzije: labialno-lingvalna širina: 10,2 in 12,5 mm; anteriorno-posteriorna širina: 6,5 in 7,8 mm.

Sl. 11.3: Kanidni levi spodnji podočnik (C_1) iz plasti 5 do 6 (inv. št. D. b. 95). Fotografija: T. Lauko.
Fig. 11.3: Canid left lower canine (C_1) from layers 5 to 6 (inv. no. D. b. 95). Photograph T. Lauko.



Sl. 11.4: Mere izmerljivih ostankov volka (*Canis lupus*) iz Divjih bab I (● – ostanki iz OIS 5a–5d; ◇ – ostanki iz OIS 3). Za primerjavo so navedene meritve fosilnih volkov z več zgornjepleistocenskih evropskih najdišč. Legenda: Mc – metacarpus, Mt – metatarsus, Bd – največja širina distalne epifize, GL – največja dolžina. Podatki za primerjalni vzorec so povzeti po naslednjih avtorjih: Musil (1960), Malez (1963), Rakovec (1965), Bonifay (1966a), Pohar (1981), Castaños (1987), Argant (1991) in Münzel *et al.* (1994). Vse mere so v mm.
Fig. 11.4: Measurements of measurable remains of wolf (*Canis lupus*) from Divje babe I (● – remains from OIS 5a–5d; ◇– remains from OIS 3). Measurements of wolf remains from a number of Early Pleistocene European sites are stated for comparison. Legend: Mc – metacarpus, Mt – metatarsus, Bd – breadth of distal end, GL – greatest length. Data for comparison are taken from the following authors: Musil (1960), Malez (1963), Rakovec (1965), Bonifay (1966a), Pohar (1981), Castaños (1987), Argant (1991) and Münzel *et al.* (1994). All measurements are in mm.

je zastopana v moustérienskih plasteh Apnarjeve jame pri Celju (Malez, Turk 1991) ter v več mlajšepleistocenskih najdiščih na Avstrijskem, Madžarskem in Hrvaškem (Malez 1965; 1986a; Mottl 1975; Jánossy 1986).

Velikost volkov naj bi se v zahodni Evropi razmeroma enakomerno povečevala od konca predzadnjega glaciala (= riss) pa vse tja do nastopa holocena (Crégut-Bonnoure 1996a). Ali lahko podoben trend pričakujemo tudi za območje južno od alpske poledenitve, je le na podlagi najdb iz Divjih bab I nemogoče reči. Iz maloštevilnih metričnih podatkov namreč izhaja le to, da se tukaj obravnavani ostanki umeščajo znotraj variacijske širine fosilnih primerkov iste vrste iz srednje Evrope (*sl. 11.4*). Fosilni volkovi iz Divjih bab I sicer presegajo recentne primerke z območja nekdanje Sovjetske zveze (Gromova 1950; 1960).

Vulpes vulpes (Linnaeus, 1758)

Gradivo: sklop plasti 2–5: dentes (C_1 in M_1); plast 16: dens (P_2), ulna; plast neznana: mandibula.

Navadna lisica je v vzorcu iz Divjih bab I zastopana s skromnim številom ostankov, kar je sicer značilno za večino sočasnih najdišč v regiji (Toškan 2004). Ker je razlikovanje med navadno in polarno lisico (*Alopex lagopus*) le na osnovi morfologije izoliranih zob težavno (npr. Rakovec 1959; Poplin 1976; Altuna 2004), sem pri določevanju izhajal predvsem iz metričnih podatkov (*tab. 11.2*). Specifična determinacija nekaterih najdb ostaja kljub temu vprašljiva, saj vrsta *V. vulpes* izkazuje veliko variabilnost v velikosti posameznih skeletnih elementov (Kryštufek 1991; Crégut-Bonnoure 1996a). Zaradi nepopolne ohranjenosti je do neke mere vprašljiva tudi določitev obeh zob iz sklopa plasti 2 do 5. Prvi spodnji meljak (inv. št. D. b. 1462) sem tako pripisal k vrsti *V. vulpes* navkljub temu, da se po svoji dolžini uvršča znotraj (na zgornjo mejo) variacijske širine za fosilne in recentne polarne lisice iz Evrope (Poplin 1976). Zaradi fragmentiranosti mezialnega dela je bilo namreč dejansko največjo dolžino zoba nemogoče izmeriti, zgoraj omenjena meritev pa predstavlja le njen nekoliko podcenjeni približek. Podobno velja za podočnik iz istega sklopa plasti (inv. št. D. b. 458), ki ima že nekoliko zbrušeno konico krone.

Manj problematična je determinacija komolčnice in spodnje čeljustnice. Pri vrsti *V. vulpes* leži namreč bradna odprtina (*foramen mentale*) na mandibuli pod prvim spodnjim predmeljakom (kar velja tudi za primerek iz Divjih bab I), medtem ko je pri vrsti *A. lagopus* ta po-

Tab. 11.2: Opisna statistika za mere izoliranih zob lisice (*Vulpes* cf. *vulpes*) iz Divjih bab I. Navedeni so tudi primerjalni podatki za vrsti *V. vulpes* in *A. lagopus*. Podani so povprečje (x), velikost vzorca (N) in variacijska širina (min-max). Primerjalni podatki so povzeti po naslednjih avtorjih: Rakovec (1961; dimenzije zgornjepleistocenskih P_2 iz Evrope), Poplin (1976; dimenzije recentnih C_1) ter Castaños (1987; dimenzije zgornjepleistocenskih M_1 iz Španije). Zvezda (*) označuje primerke z obrušeno oz. poškodovano krono. Vse mere so v mm.

Tab. 11.2: Descriptive statistics for measurements of teeth of fox (*Vulpes* cf. *vulpes*) from Divje babe I. Comparative data for *V. vulpes* and *A. lagopus* are also shown. Given are the average (x), size of sample (N) and range (min-max). Comparative data are taken from the following authors: Rakovec (1961; dimensions of Upper Pleistocene P_2 from Europe), Poplin (1976; dimensions of recent C_1) and Castaños (1987; dimensions of Upper Pleistocene M_1 from Spain). Asterisk (*) denotes specimens with worn or damaged crown. All measurements are in mm.

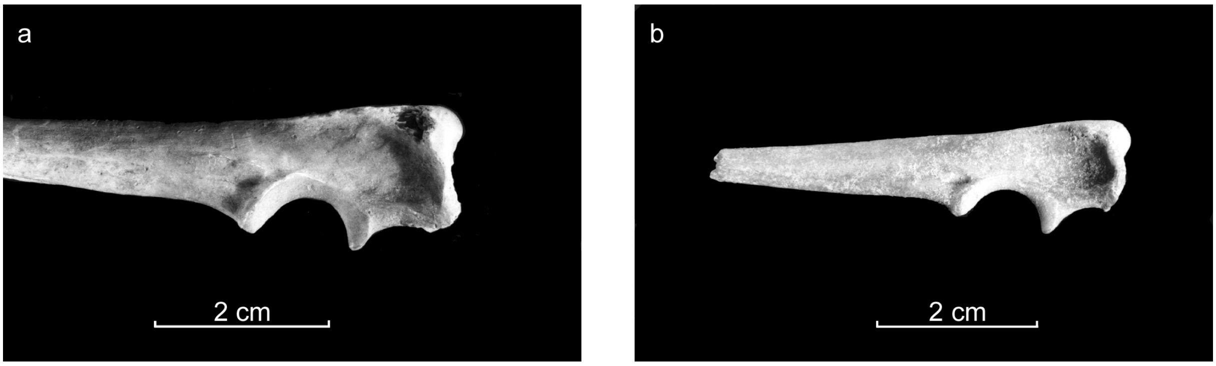
Tooth	**Dimension**	**Divje babe I** ***V.* cf. *vulpes***	**Recent** ***V. vulpes***	**Recent** ***A. lagopus***	**Europe** ***V. vulpes***	**Europe** ***A. lagopus***
			x **min-max**	**x** **min-max**	**(N)** **min-max**	**(N)** **min-max**
C_1	Crown height on buccal side	15.0*	17.0 16.0-20.0	13.0 12.0-14.0	–	–
P_2	Length	9.0	–	–	(11) 7.5-9.0	(8) 7.0-8.3
	Breadth	3.0	–	–	(11) 2.9-3.3	(7) 3.0-3.1
M_1	Length	–	–	–	(26) 14.3-17.6	(35) 13.0-15.5
	Breadth	6.0	–	–	(23) 5.8-7.2	(33) 4.7-6.4

maknjena nekoliko posteriorno, tj. pod korenino drugega predmeljaka (Poplin 1976). Podobno velja za komolčnico iz plasti 16 (inv. št. D. b. 457). Ta je namreč zaradi manj izraženih mišičnih narastišč (prim. Malez 1963) ter sedlaste depresije med kljukico (*olecranon*) in posteriornim delom kljukičinega podaljška (*processus olecrani*; prim. Beneš 1975) prav tako bliže navadni lisici (*sl. 11.5a*). To potrjuje tudi njena velikost (*tab. 11.3*).

Alopex lagopus (Linnaeus, 1758)

Gradivo: plast 6-7: dens (C_1); plast 8: mandibula, dentes (I_3, P_2, P_4), vertebrae (3x), ulna, metacarpus, phalanx II (2x), ossa coxae, calcaneus.

Polarna lisica je v vzorcu zastopana s 14 najdbami. Z izjemo petnice so bili vsi ostanki iz plasti 8 najdeni blizu skupaj, zato jih je verjetno utemeljeno pripisati istemu osebku. Determinacija spodnje čeljustnice (inv. št. D. b. 2039) temelji na legi bradne odprtine (*foramen mentale*; *sl. 11.6*), razmeroma malo ukrivljenem bazalnem robu spodnječeljustničnega telesa (*corpus mandibulae*) ter sami velikosti primerka (Poplin 1976; Argant 1991). Prav tako ni vprašljiva determinacija komolčnice (inv. št. D. b. 2040; *sl. 11.5b*), saj ta ne dosega niti dimenzij recentnih polarnih lisic (*tab. 11.3*). Skromna je tudi velikost predmeljakov (dolžina P_2: 8,0 mm), zato sem navedene lisičje ostanke pripisal razmeroma majhnemu osebku (samici?) vrste *A. lagopus*.



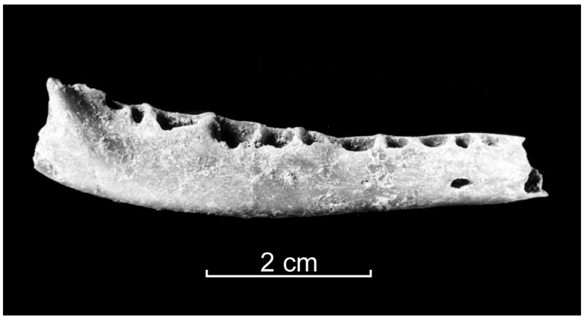
Sl. 11.5a, b: Proksimalna fragmenta komolčnic lisic iz Divjih bab I: a – *Vulpes vulpes* (D. b. 457; plast 16); b – *Alopex lagopus* (D. b. 2040; plast 8). Fotografija: T. Lauko.

Fig. 11.5a, b: Proximal fragments of ulna of fox from Divje babe I: a – *Vulpes vulpes* (D. b. 457; Layer 16); b – *Alopex lagopus* (D. b. 2040; Layer 8). Photograph T. Lauko.

Tab. 11.3: Mere komolčnice lisice (*Vulpes vulpes*) in polarne lisice (*Alopex lagopus*) iz Divjih bab I. Navedena je tudi opisna statistika za fosilne in recentne primerke obeh vrst. Primerjalni podatki so povzeti po naslednjih avtorjih: Gromova (1950; dimenzije recentnih primerkov iz nekdanje Sovjetske zveze; N ni naveden), Malez (1963; dimenzije zgornjepleistocenskih primerkov *A. lagopus* z Moravske; N = 19) ter Castaños (1987; dimenzije zgornjepleistocenskih primerkov *V. vulpes* iz Španije; N = 5). Vse mere so v mm.
Tab. 11.3: Measurements of ulna of fox (*Vulpes vulpes*) and arctic fox (*Alopex lagopus*) from Divje babe I. Descriptive statistics for fossil and recent specimens of both species are also given. Comparative data are taken from the following authors: Gromova (1950; dimensions of recent specimens from the former Soviet Union; N not stated), Malez (1963; dimensions of Upper Pleistocene specimens of *A. lagopus* from Moravia; N = 19) and Castaños (1987; dimensions of Upper Pleistocene specimens of *V. vulpes* from Spain; N = 5). All measurements are in mm.

Skeletal element	**Dimension**	**D. babe I** ***V. vulpes***	**D. babe I** ***A. lagopus***	**Recent** ***V. vulpes***	**Recent** ***A. lagopus***	**Fossil** ***V. vulpes***	**Fossil** ***A. lagopus***
Ulna	Smallest anter.-poster. breadth of *olecranion*	14.0	10.5	–	–	11.7–13.4	10.0–12.0
	Anter.-poster. breadth of *proc. coracoideus*	17.0	11.5	14.5–18.0	13.0–16.0	14.6–19.0	–
	Smallest breadth of *inc. semilunaris*	9.5	7.0	9–12.5	8.0–11.0	–	–

Determinacija podočnikov iz plasti 6-7 in petnice iz plasti 8 temelji izključno na njuni velikosti. Petnica iz plasti 8 se namreč umešča znotraj variacijske širine recentnih in fosilnih primerkov vrste *A. lagopus* (največja dolžina: 27 mm; največja širina: 11,0 mm), podočnik pa v višini krone na bukalni strani (11,5 mm) vrednosti recentnih polarnih lisic sploh ne dosega (prim. Gromova 1960; Castaños 1987; Altuna 2004).



Sl. 11.6: Spodnja čeljustnica polarne lisice (*Alopex lagopus*) iz plasti 8 (inv. št. 2039). Fotografija: T. Lauko.
Fig. 11.6: Mandible of arctic fox (*Alopex lagopus*) from Layer 8 (inv. no. 2039). Photograph T. Lauko.

Polarna lisica se v okviru evropskih mlajšepleistocenskih najdišč pojavlja sporadično. Njeni ostanki postanejo nekoliko številčnejši šele v plasteh, ki so nastale v OIS 2 (Kurtén 1968). Za razliko od ubikvistične navadne lisice je namreč vrsta *A. lagopus* tesno vezana na okolja s hladno klimo in danes naseljuje območje tundre z arktičnimi otoki (Pulliainen 1999). V najmrzlejših obdobjih würma je njen areal obsegal tudi Iberski polotok (Altuna 2004), južno Francijo (Bonifay 1971), Italijo (Bartolomei *et al.* 1992), Hrvaško (Malez 1963), Madžarsko (Jánossy 1986) in celo Bolgarijo (Wiszniowska 1982). Najdbe iz plasti 8 Divjih bab I je mogoče časovno umestiti v obdobje med 60.000 in 50.000 let p.s. (Turk *et al.* 2001a; poglavji 6 in 7 v tem zborniku), tako da predstavljajo doslej geološko najstarejši dokaz za prisotnost omenjene vrste na Slovenskem. Skupaj s tistimi iz Betalovega spodmola pri Postojni (würm II+III; Rakovec 1959) so tudi edine, ki časovno ne sodijo v OIS 2 (Toškan 2004).

Vulpes vulpes seu *Alopex lagopus*

Gradivo: plast 5: phalanx II; plast 8: dens (I^3); plast 12/13: phalanx I; plast 16: dens (I^3).

Štirih lisičjih najdb iz Divjih bab I mi ni uspelo določiti do nivoja vrste, morfološko pa sicer ne odstopajo od ustreznih elementov navadne lisice (primerjalnega gradiva za polarno lisico nisem imel na razpolago). Prstnice zaradi fragmentiranosti ni mogoče izmeriti.

Družina: Kune (Mustelidae)

Mustela putorius Linnaeus, 1758

Gradivo: Navadni dihur je v vzorcu iz Divjih bab I zastopan s 50 ostanki. Celoten seznam najdb po plasteh in skeletnih elementih je podan v *prilogi 11.2D.*

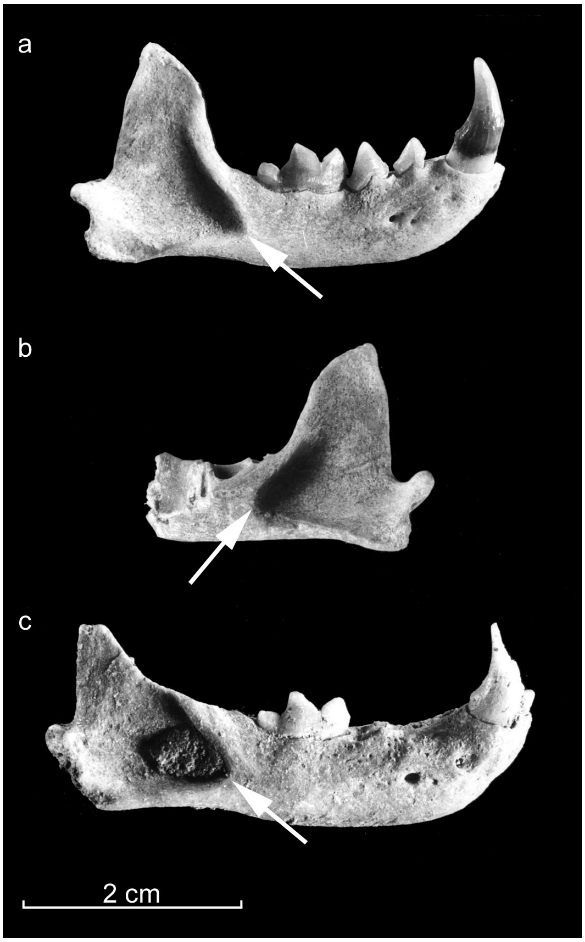
Z izjemo podočnika in metapodija so vsi ostanki iz sklopa plasti 2 do 5 verjetno pripadali istemu osebku, saj so bili najdeni blizu skupaj. Pri določevanju sem se oprl predvsem na tri spodnje čeljustnice, saj je razlikovanje med navadnim in stepskim dihurjem (*Mustela eversmanni* [Lesson, 1827]) na podlagi postkranialnih skeletnih elementov problematično (Crégut-Bonnoure 1996b). Navadni dihur naj bi se od stepskega sorodnika najbolje ločil po višini mandibule med zadnjim pred-

Tab. 11.4: Mere spodnjih čeljustnic navadnega dihurja (*Mustela putorius*) iz Divjih bab I. Navedena je tudi opisna statistika za fosilne in recentne primerke iste vrste (Malez 1963). Velikost vzorcev v izvirnem članku ni navedena. Vse mere so v mm.
Tab. 11.4: Measurements of mandibles of common polecat (*Mustela putorius*) from Divje babe I. A descriptive statistic for fossil and recent specimens of the same species is given (Malez 1963). The size of sample is not stated in the original article. All measurements are in mm.

Skeletal elememt	**Dimension**	**Divje babe I**			**Europe**	
		D.b.1076	**D.b.1082**	**D.b.2510**	**Fossil**	**Recent**
Mandibula	Length of P_2-M_2	–	–	20.0	17.1-21.0	–
	Height behind P_4	7.8	–	8.9	–	< 8
	Breadth under M_1	4.2	4.8	5.0	3.8-5.5	–
	Length of M_1	8.8	–	9.0	7.8-9.5	7.5-8.6
	Breadth of M_1	3.5	–	3.5	3.2-3.5	–

meljakom in prvim meljakom (Koby 1951). Medtem ko naj bi bila navedena dimenzija pri prvem namreč vedno manjša od 8 mm, se pri recentnih stepskih dihurjih giblje med 8,4 in 9,3 mm (*tab. 11.4*). Pri tem pa ne gre spregledati, da so recentni dihurji v velikosti zelo variabilni. Naletimo lahko celo na t.i. pritlikave in orjaške primerke, kar naj bi bila posledica bolj ali manj ugodnih razmer v obdobju hitre telesne rasti (Buchalczyk, Ruprecht 1977). Prav zaradi navedenega sem spodnjo čeljustnico iz plasti 8 (inv. št. D. b. 2510) pripisal k vrsti *M. putorius,* pa čeprav njena višina presega 8 mm. Ne nazadnje obravnavani primerek po nobeni od drugih merjenih dimenzij ne odstopa od fosilnih in recentnih navadnih dihurjev (*tab. 11.4*), podobnost pa je očitna tudi na morfološki ravni. Tako se jama za zunanjo žvekalko (*fossa masseterica*), ki naj bi pri stepskem dihurju segala vse do sredine prvega meljaka (Pohar 1981), pri obravnavanem primerku anteriorno konča že pod drugim meljakom (*sl. 11.7c*). Poleg tega je na bazalnem robu spodnječeljustničnega telesa (*corpus mandibulae*) pod četrtim predmeljakom in prvim meljakom pri stepskem dihurju izboklina (Crégut-Bonnoure 1996b), ki je v primeru mandibule iz plasti 8 ni oz. ni nič bolj izrazita kot pri tipičnih primerkih navadnega dihurja.

Na Slovenskem je edina najdba vrste *M. eversmanni* znana s konca riško-würmskega interglaciala (Jama pod Herkovimi pečmi; Pohar 1981), zastopana pa je tudi v favni več sočasnih najdišč zahodnega dela panonskega bazena (Malez 1963; 1979; Jánossy 1986). Danes stepski dihur naseljuje polpuščave ter gozdno in travno stepo na območjih z mrzlimi zimami in toplimi do vročimi poletji (Wolsan 1999). V nasprotju s tem naj bi plast 8 iz Divjih bab I, kjer je bila med drugim najdena tudi "sporna" spodnja čeljustnica z inv. št. D. b. 2510, nastala v obdobju razmeroma vlažne klime (Šercelj, Culiberg 1991; Turk, Bastiani 2000; Turk *et al.* 2002b; poglavje 10 v tem zborniku). Takratno okolje je bilo skladnejše z ekološkimi potrebami navadnega dihurja, ki danes naseljuje predvsem nižine in doline rek, z (umetno) izsušene zemlje pa se umakne (Kryštufek 1991).



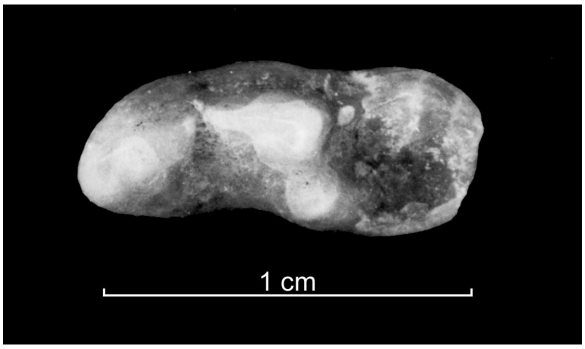
Sl. 11.7a-c: Spodnje čeljustnice dihurjev iz Divjih bab I: a - *Mustela putorius* (D. b. 1076; sklop plasti 2-5); b - *Mustela putorius* (D. b. 1082; sklop plasti 2-5); c - *Mustela* cf. *putorius* (D. b. 2510; plast 8). Puščica označuje anteriorni rob jame za zunanjo žvekalko (*fossa masseterica*). Fotografija: T. Lauko.
Fig. 11.7a-c: Mandibles of polecat from Divje babe I: a - *Mustela putorius* (D. b. 1076; complex of layers 2-5); b - *Mustela putorius* (D. b. 1082; complex of layers 2-5); c - *Mustela* cf. *putorius* (D. b. 2510; Layer 8). Arrow marks the anterior edge of the *fossa masseterica*. Photograph T. Lauko.

Martes cf. *martes* (Linnaeus, 1758)

Gradivo: Kuna zlatica je v vzorcu iz Divjih bab I zastopana s 139 ostanki. Celoten seznam najdb po plasteh in skeletnih elementih je podan v *prilogi 11.2E.*

Taksonomsko relevantne morfološke razlike med kuno zlatico in kuno belico (*M. foina* [Erxleben, 1777]) so omejene na nekaj detajlov v okviru lobanje, spodnje čeljustnice in zob. Zaradi navedenega in pa zavoljo velike variabilnosti v velikosti obeh vrst je specifična determinacija fosilnih ostankov rodu *Martes* v splošnem dokaj težavna (Bonifay 1971; Castaños 1987). Tako sem lahko izmed vseh 139 kosti in zob pravih kun iz Divjih bab I do vrste z gotovostjo določil le 27 primerkov: pet prvih zgornjih in sedem prvih spodnjih meljakov, 14 spodnjih čeljustnic ter fragment lobanje. Vse sem pripisal kuni zlatici. Najzanesljivejši taksonomski znak pri spodnjih čeljustnicah je razdalja med bradnima odprtinama (*foramen mentale*); ta pri kuni belici praviloma ne dosega 3 mm, pri kuni zlatici pa vedno presega 4 mm (Kryštufek 1991; *tab. 11.5*). Nadalje ima jezični rob prvega spodnjega meljaka pri vrsti *M. foina* na sredini jasno zajedo, medtem ko je pri vrsti *M. martes* M_1 na tem mestu le rahlo vbočen (Kryštufek 1991; *sl. 11.8*). Obe vrsti ločimo tudi po obliki prvega zgornjega meljaka. Ta ima pri kuni belici slabo razvit notranji lobus, tako da je dolžina zoba v sagitalni ravnini veliko krajša od njegove širine; pri kuni zlatici je dolžina zoba v sagitalni ravnini skoraj enaka širini (Pucek 1981). Fragment lobanje sem k vrsti *M. martes* pripisal zaradi lege tilniških odprtin (*foramen jugale*): razdalja med njima je namreč pri kuni zlatici manjša od dolžine bobničnega mehurja (*bulla tympanica*), pri kuni belici pa večja (Pucek 1981).

Ob zgoraj navedenih pripadajo kuni zlatici verjetno tudi vsi preostali fosilni ostanki rodu *Martes* iz Divjih bab I. Kot navaja Crégut-Bonnoure (1996b), naj bi bila kuna zlatica v mlajšem pleistocenu celo edini predstavnik pravih kun v Evropi, saj naj bi se kuna belica pojavila šele v holocenu (a glej tudi Malez 1963; Castaños 1987; Bon *et al.* 1991). Enako mnenje zagovarjata Argant (1991) za zahodno Evropo ter Wolsan (1993) za srednjo. V favni paleolitskih najdišč s Slovenskega je kuna belica znana le iz Potočke zijalke v Savinjskih Alpah, vendar pa je stratigrafski kontekst najdbe problematičen (Döppes 2004). Kuna zlatica je na Slovenskem znana iz več mlajšepleistocenskih najdišč (Toškan 2004).



Sl. 11.8: Prvi spodnji meljak kune zlatice (*Martes martes*) iz plasti 5 (inv. št. D. b. 2497). Fotografija: T. Lauko.
Fig. 11.8: First lower molar of pine marten (*Martes martes*) from Layer 5 (inv. no. D. b. 2497). Photograph T. Lauko.

Tab. 11.5: Opisna statistika za razdaljo med bradnima odprtinama (*foramen mentale*) pri kuni zlatici (*Martes martes*) iz Divjih bab I. Navedeni so tudi primerjalni podatki za recentne primerke *M. martes* in *M. foina* iz Nemčije. Primerjalni podatki so povzeti po Winterfeldu (1885; *cf.* Malez 1963). Vse mere so v mm.
Tab. 11.5: Descriptive statistics for the distance between the *foramen mentale* in pine marten (*Martes martes*) from Divje babe I. Comparative data for recent specimens of *M. martes* and *M. foina* from Germany. Comparative data are taken from Winterfeld (1885; *cf.* Malez 1963). All measurements are in mm.

Dimension	***M. martes*** **Divje babe I**	***M. martes*** **Recent**	***M. foina*** **Recent**
	Me (N) min-max	**(N) min-max**	**(N) min-max**
Distance between the two mental foramens	6.8 (9) 6.0-8.5	(17) 5.0-9.6	(26) 2.0-3.4

Lutra lutra (Linnaeus, 1758)

Gradivo: sklop plasti 2-5: dens (C_1).

Podočnik vidre iz Divjih bab I (inv. št. D. b. 1354) je prva znana najdba omenjene vrste s katerega od slovenskih mlajšepleistocenskih najdišč. Vrsta je sicer znana iz zgodnjeholocenskih plasti Brega pri Ljubljani (Pohar 1984), Pod Črmuklje pri Šembijah (Pohar 1986) in Viktorjevega spodmola pri Famljah (Toškan, Dirjec 2004a) ter iz mlajšepleistocenskih najdišč sosednjih Hrvaške (Malez 1986b), Madžarske (Jánossy 1986) in SV Italije (Bon *et al.* 1991).

Pri determinaciji C_1 iz sklopa plasti 2-5 sem izhajal predvsem iz njegove morfologije. Podočniki vidre se namreč bistveno ne razlikujejo od podočnikov jazbeca (*Meles meles* [Linnaeus, 1758]), katerega ostanki so dobro znani s kar nekaj mlajšepleistocenskih najdišč v regiji (Rakovec 1973). Primerek sem določil za vidro predvsem zato, ker ima spodnji podočnik pri jazbecu na mezio-lingvalni strani močno izražen rob; ta se od baze krone vleče skoraj do njene konice. Za razliko od tega ima C_1 vidre na tem delu le manjši greben, ki je omejen na bazalni del zobne krone (*sl. 11.9*). Poleg tega je obravnavan podočnik tudi po svoji velikosti očitno manjši od C_1 fosilnih jazbecev (*tab. 11.6*).

V posutem sedimentu iz Divjih bab I je bil najden še en spodnji podočnik, ki bi ga lahko pogojno pripisal

Sl. 11.9: Desni spodnji podočnik vidre (*Lutra lutra*) iz sklopa plasti 2–5 (inv. št. D. b. 1354). Puščica označuje greben na mezio-lingvalni strani krone. Fotografija: T. Lauko.
Fig. 11.9: Right lower canine of otter (*Lutra lutra*) from the complex of layers 2–5 (inv. no. D. b. 1354). Arrow marks the ridge on the meziolingual side of the crown. Photograph T. Lauko.

k vrsti *L. lutra*. Žal je krona na mezialnem delu poškodovana, zaradi obrušenosti pa manjka tudi njen vrh. Glede na morfologijo ohranjenega dela bi ga sicer lahko pripisal tudi jazbecu, po velikosti pa je vendarle bliže vidri (*tab. 11.6*).

Družina: Mačke (Felidae)

Felis silvestris Schreber, 1777

Gradivo: plast 8: mandibula, dens (P^4).

Obe najdbi divje mačke iz Divjih bab I sta verjetno pripadali isti živali, saj izvirata iz istega kvadrata in izkopa. Od spodnje čeljustnice je ohranjen le kronski odrastek (*processus coronoideus*) s spodnječeljustnično glavo (*caput mandibulae*), na P^4 pa manjkajo baze vseh treh korenin. Ohranjeni deli korenin so tako kot tudi krona votli. Pri domači mački izraste stalni četrti zgornji predmeljak pri starosti štirih do petih mesecev (Silver 1972). Ker primerek iz Divjih bab I že kaže rahle sledi obrabe žvekalne površine, ocenjujem, da je pripadal sicer juvenilni, a verjetno nad leto dni stari živali.

Lynx lynx (Linnaeus, 1758)

Gradivo: sklop plasti 2–5: dens (M_1); plast 6: dens (P_4); plast 2–11/12: dens (M_1).

Rod risov je v Divjih babah I zastopan s 3 izoliranimi zobmi. Na četrtem spodnjem predmeljaku iz plasti 6 (inv. št. D. b. 2072) je parakonid prisoten in dobro razvit. Enako velja za hipokonid in bazalni cingulum na posteriornem delu krone. Pripis navedenega primerka k rodu *Lynx* se zato kljub dodatnemu parastilidu posteriorno od hipokonida (*sl. 11.10a*) ne zdi sporen.

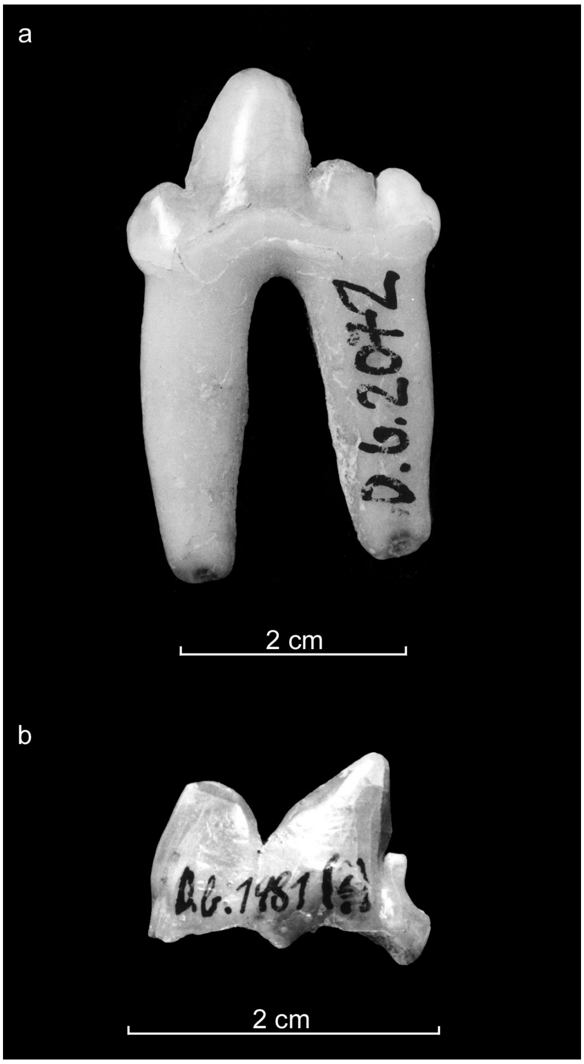
Bolj problematična od generične je specifična determinacija obravnavanih najdb. Iz mlajšega pleistocena Evrope je namreč poleg evrazijskega ali severnega risa znan še iberski ris (*Lynx pardinus* [Temminck, 1827]), pri čemer so razlike v morfologiji in velikosti skeletnih elementov med obema vrstama minimalne. Podatek o največji dolžini četrtega spodnjega meljaka iz Divjih bab I ima tako le omejeno taksonomsko vrednost, pa čeprav se zob umešča znotraj variacijske širine recentnih primerkov evrazijskega risa iz severne Evrope in s tem presega velikost P_4 fosilnih iberskih risov iz Španije

Tab. 11.6: Mere spodnjega podočnika (C_1) vidre (*Lutra lutra*) iz Divjih bab I. Navedena je tudi opisna statistika za fosilne primerke jazbeca (*Meles meles*) iz Evrope (Malez 1963; Argant 1991). Determinacija primerka z inventarno številko D. b. 1523 ni zanesljiva. Vse mere so v mm.
Tab. 11.6: Measurements of lower canines (C_1) of otter (*Lutra lutra*) from Divje babe I. Descriptive statistics for fossil specimens of badger (*Meles meles*) from Europe (Malez 1963; Argant 1991) are also stated. Identification of specimen with inventory number D. b. 1523 is not reliable. All measurements are in mm.

Dimension	**Divje babe I** *L. lutra*		**Europe** *M. meles* **(fossil)**
	D.b. 1354	**D.b. 1523**	**(N)** **min-max**
Ant.-post. breadth at the base of C_1 crown	5.1	5.6	(7) 8.0–9.5
Medio-lat. breadth at the base of C_1 crown	3.5	3.5	(7) 6.0–7.0

Tab. 11.7: Mere četrtega spodnjega predmeljaka (P_4) in prvega spodnjega meljaka (M_1) evrazijskega risa (*Lynx lynx*) iz Divjih bab I. Navedena je tudi opisna statistika za recentne primerke *L. lynx* iz severne Evrope (Schmid 1940) ter fosilne *L. pardinus* iz Španije (Ficcarelli in Torre 1977). Vse mere so v mm.
Tab. 11.7: Measurements of the fourth lower premolar (P_4) and first lower molar (M_1) of Eurasian lynx (*Lynx lynx*) from Divje babe I. Descriptive statistics of *L. lynx* from northern Europe (Schmid 1940) and fossil *L. pardinus* from Spain are also given (Ficcarelli and Torre 1977). All measurements are in mm.

Tooth	**Dimension**	**Divje babe I**	**N Europe** ***L. lynx* (recent)**	**Spain**
		L. lynx	**x (N)** **min–max**	***L. pardina* (fossil)**
P_4	Greatest length	13.8	12.2 (29) 11.2–13.9	< 11.5
M_1	Greatest length	18.3	15.7 (31) 14.0–17.3	< 14.0
	L. of protoconid	12.7	9.8 (32) 8.9–10.9	–
	L. of paraconid	8.1	7.6 (31) 6.7–8.2	–
	Greatest breadth	6.0	6.9 (32) 6.3–7.5	–
	L. of paraconid as % of protoconid length	65.3	77.1 (31) 69.8–83.5	–



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Sl. 11.10a, b: Kočnika evrazijskega risa (*Lynx lynx*) iz Divjih bab I: a – četrti spodnji predmeljak (D. b. 2072; plast 6); b – prvi spodnji meljak (D. b. 70; sklop plasti 2–5). Fotografija: T. Lauko.
Fig. 11.10a, b: Cheek teeth of lynx (*Lynx lynx*) from Divje babe I: a – fourth lower pre-molar (D. b. 2072; Layer 6); b – first lower molar (D. b. 70; complex of Layers 2–5). Photograph T. Lauko.

(*tab. 11.7*). Metrični podatki (zob) namreč ne veljajo za zanesljiv taksonomski znak (Argant 1996b). Na Slovenskem je sicer vrsta *L. lynx* zastopana v fosilni favni treh najdišč (Pavšič, Turk 1989; Dirjec. Turk 1992; Pohar, Brodar 2000), medtem ko dokazov o prisotnosti iberskega risa ni.[6] Slednji manjka tudi v mlajšepleistocenski favni SV Italije, JV Avstrije in Madžarske (Jánossy 1986; Rustioni *et al.* 1995; Fladerer 2000), na Hrvaškem pa je znana le iz jame Veternica v Medvednici (Malez 1963). Zaradi navedenega sem četrti spodnji predmeljak iz plasti 6 Divjih bab I pogojno vendarle pripisal evrazijskemu risu.

Isti vrsti sem pripisal tudi prvi spodnji meljak iz interpleniglacialnega sklopa plasti 2 do 11/12 (inv. št. D. b. 70). Pri iberskem risu namreč M_1 na posteriornem delu nima razvitih metakonida in bazalnega cinguluma (Bonifay 1966; 1971; Castaños 1987), medtem ko sta na primerku iz Divjih bab I prisotna oba (*sl. 11.10b*). Prvi spodnji meljak iz sklopa plasti 2–11/12 izstopa tudi

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[6] Rakovec (1961) je sicer vrsti *L. pardinus* pripisal tri podočnike iz Parske golobine v Pivški kotlini, vendar je poznejša revizija pokazala na zmotnost takšne determinacije (Krofel *et al.* 2005).

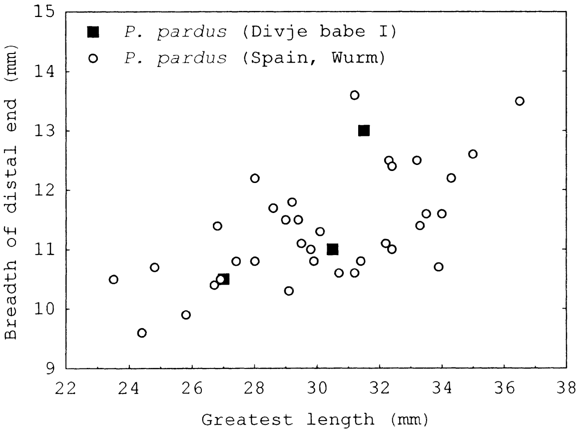
po podaljšanem talonidu, česar pri iberskem risu ni (Argant 1996b). Prav zaradi nadpovprečno podaljšanega metakonida-talonida se M_1 iz Divjih bab I znotraj variacijske širine recentnih evrazijskih risov iz severne Evrope umešča le v tistih dimenzijah, ki se ne nanašajo na skrajni distalni del zoba (tj. največja širina krone in dolžine parakonida; *tab. 11.7*).

Determinacija prvega spodnjega meljaka iz sklopa plasti 2 do 5 (D. b. I, kv. 41c/2) je bolj problematična, saj je od zoba ohranjen le del krone. Na osnovi velikosti ohranjenega fragmenta ter kota med posteriornim grebenom parakonida in mezialnim grebenom protokonida sem tudi ta primerek pripisal k rodu *Lynx*.

Panthera pardus (Linnaeus, 1758)

Gradivo: sklop plasti 2-5: dens (M_1), vertebra, os carpale, phalanx II (3x), phalanx III; plast neznana: phalanx III.

Leopard je v fosilni favni Divjih bab I zastopan z osmimi najdbami, ki so vse interpleniglacialne starosti. Repno vretence, zapestna kost ter po ena druga in tretja prstnica so verjetno pripadali istemu osebku, saj so bili najdeni blizu skupaj. Morfološko se v celoti ujemajo z ustreznimi skeletnimi elementi recentnih in fosilnih leopardov, tako da njihova determinacija ni bila problematična (*sl. 11.11*). Enako velja za preostali prstnici iz istega sklopa plasti, ki se s fosilnimi primerki vrste *P. pardus* ujemajo tudi po velikosti (*sl. 11.12*).



Sl. 11.12: Grafični prikaz razmerja med največjo dolžino in širino distalnega konca druge prstnice leoparda (*Panthera pardus*) iz Divjih bab I in z več mlajšepleistocenskih najdišč Španije. Podatke za španska najdišča podaja Castaños (1987).
Fig. 11.12: Graphic presentation of the ratio between the greatest length and the breadth of the distal end of the second phalanxes of leopard (*Panthera pardus*) from Divje babe I and a number of Upper Pleistocene sites in Spain. Data for the Spanish sites provided by Castaños (1987).

Sl. 11.11a-c: Prstnice leopardov (*Panthera pardus*) iz Divjih bab I: a - fragment tretje prstnice (inv. št. D. b. 740; sklop plasti 2-5); b - druga prstnica (inv. št. D. b. 835; sklop plasti 2-5); c - druga prstnica (inv. št. D. b. 1132; sklop plasti 2-5).
Fig. 11.11a-c: Phalanxes of leopards (*Panthera pardus*) from Divje babe I: a - fragment of third phalanx (inv. no. D. b. 740; complex of layers2-5); b - second phalanx (inv. no. D. b. 835; complex of layers 2-5); c - second phalanx (inv. no. D. b. 1132; complex of layers 2-5).

Prvi spodnji meljak iz sklopa plasti 2 do 5 (inv. št. D. b. 646) je poškodovan; ohranjena sta le parakonid in del mezialne korenine. V največji dolžini parakonida se obravnavani primerek kljub vsemu umešča znotraj variacijske širine za recentne leoparde iz Afrike in Azije, obenem pa odstopa od metričnih podatkov za recentne rise iz Severne Evrope in Rusije (*tab. 11.8*).

Panthera spelaea Goldfuss, 1810

Gradivo: sklop plasti 2-5: dentes (dP_3, dP_4, P^4); plast 6-7: phalanx II (?); plast 7: phalanx III, vertebra; plast 8: dentes (dP_3, M_1), vertebra; plast 17a: dens (P_4), vertebra, phalanx III; plast 21: vertebra; sklop plasti 12/13-22: metatarsus III, astragalus, phalanx II, phalanx III; plast neznana: fibula.

Jamskemu levu sem pripisal 18 ostankov, od tega šest zob. Najdbe so v morfološkem smislu značilno felidne, pri specifični determinaciji pa sem se v veliki meri naslonil na metrične podatke (*tab. 11.9* in *tab. 11.10*). Jamski lev namreč po svoji velikosti bistveno presega pripadnike drugih velikih mačk, ki so v mlajšem pleistocenu naseljevale srednjeevropski prostor. Nekoliko problematična je le determinacija druge prstnice iz plasti

Tab. 11.8: Dolžina parakonida prvega spodnjega meljaka (M_1) leoparda (*Panthera pardus*) iz Divjih bab I. Navedena je tudi opisna statistika za recentne primerke *P. pardus* iz Afrike in Azije ter *L. lynx* iz severne Evrope in Rusije (Schmid 1940). Definicija dimenzije je povzeta po Schmidovi (1940). Vse mere so v mm.
Tab. 11.8 : Length of paraconide of the first lower molar (M_1) of leopard (*Panthera pardus*) from Divje babe I. Descriptive statistics for recent specimens of *P. pardus* from Africa and Asia and *L. lynx* from northern Europe and Russia are also given (Schmid 1940). The definition of the dimension is taken from Schmid (1940). All measurements are in mm.

Dimension	**Divje babe I**	**Africa. Asia** ***P. pardus* (recent)**	**N Europe. Russia** ***L. lynx* (recent)**
	P. pardus	**x (N)** **min-max**	**x (N)** ***min-max***
Length of paraconid	9.8	9.2 (167) 7.3-11.5	7.6 (31) 6.7-8.2

6 do 7 (inv. št. D. b. 1783; *sl. 11.13a*). Primerek je namreč izrazito kratek in robusten. Od jamskih levov z različnih evropskih najdišč (*tab. 11.10*) se razlikuje tako v svoji največji dolžini (tj. 33,0 mm) kot tudi v širini distalne epifize (tj. 26,0 mm).

Biometrične raziskave zobovja jamskih levov z različnih evropskih najdišč so izpostavile precejšnje razlike med posameznimi alopatričnimi populacijami. Turner (1984) ugotovljeno heterogenost razlaga (predvsem) v kontekstu spolnega dimorfizma, Schütt, Hemmer

Tab. 11.9: Mere stalnih zob jamskega leva (*Panthera spelaea*) iz Divjih bab I. Navedena je tudi opisna statistika za fosilne primerke iste vrste iz različnih najdišč Evrope ter recentne primerke *P. leo*, *P. tigris* in *P. pardus.* Dimenzije so povzete po Schmidovi (1940). Podatki za primerjalne vzorce so povzeti po naslednjih avtorjih: fosilni *P. spelaea* – Rakovec (1951), Schütt (1969), Tichy (1985), Sala (1990a), Gužvica (1998); recentni *P. leo* in *P. tigris* – Schütt (1969) ter recentni *P. pardus* – Schmid (1940). Vse mere so v mm.
Tab. 11.9: Measurements of permanent teeth of cave lion (*Panthera spelaea*) from Divje babe I. Descriptive statistics are also given for fossil specimens of the same species from various sites in Europe and recent specimens of *P. leo*, *P. tigris* and *P. pardus.* Dimensions are given according to Schmid (1940). Data for comparative specimens are taken from the following authors: fossil *P. spelaea* – Rakovec (1951), Schütt (1969), Tichy (1985), Sala (1990a), Gužvica (1998); recent *P. leo* and *P. tigris* – Schütt (1969) and recent *P. pardus* – Schmid (1940). All measurements are in mm.

Tooth	**Dimension**	**D. babe I**	***P. spelaea* (fossil)**	***P. leo* (recent)**	***P. tigris* (recent)**	***P. pardus* (recent)**
		P. spelaea	**(N) min-max**	**x (N) min-max**	**x (N) min-max**	**x (N) min-max**
P^4	Greatest length	33.2	(21) 35.5-42.3	35.5 (159) 31.0- 40.0	31.5 (68) 28.5-37.5	25.1 (12) 22.1-26.3
	Length to deuterocone	30.5	(21) 35.1-42.1	34.0 (159) 29.5-40.5	31.0 (68) 27.0-36.5	25.2 (12) 22.6-26.2
	Length of protocone	13.0	(9) 14.0-16.9	13.0 (159) 11.0-16.0	11.5 (68) 8.5-14.5	10.0 (12) 8.9-10.8
P_4	Greatest length	28.0	(31) 21.9-31.4	25.5 (159) 20.5-29.5	21.5 (68) 18.5-25.0	17.8 (12) 16.2-18.9
	Length of protoconid	14.1	(24) 11.0-15.1	11.0 (159) 9.5-14.0	9.5 (68) 7.5-12.0	8.8 (12) 8.5-10.1
	Breadth of distal part	13.3	(11) 10.0-14.0	11.0 (159) 9.0-15.5	9.5 (68) 8.0-12.0	8.3 (12) 7.6-8.9
	Breadth of middle part	13.0	(24) 10.0-12.9	10.0 (159) 7.5-13.0	8.5 (68) 7.0-10.5	8.6 (12) 7.6-9.2
M_1	Greatest length	27.7	(53) 26.2-32.7	26.5 (159) 22.5-32.5	24.0 (68) 19.5-28.0	17.5 (167) 14.6-21.1
	Length of protoconid	18.8	(43) 14.5-20.9	15.5 (159) 13.5-18.5	14.0 (68) 11.5-17.5	10.5 (170) 8.6-12.6
	Length of paraconid	14.0	(42) 12.5-17.6	14.0 (159) 11.0-17.5	12.5 (68) 10.0-16.0	9.2 (167) 7.3-11.5
	Greatest breadth	13.3	(45) 12.5-17.0	13.0 (159) 11.0-16.5	10.5 (68) 8.5-13.0	8.2 (170) 6.8-10.2
	Height between protoconid & paraconid	9.2	(39) 7.0-10.5	7.5 (159) 6.0-10.5	7.0 (68) 5.5-10.0	5.2 (167) 4.3-6.9

Tab. 11.10: Mere tretje stopalnice in druge prstnice jamskega leva (*Panthera spelaea*) iz Divjih bab I. Navedena je tudi opisna statistika za fosilne primerke iste vrste iz različnih najdišč Evrope. Primerjalni podatki so povzeti po naslednjih avtorjih: Rakovec (1965), Altuna (1981), Argant (1991) in Nagel (1996). Vse mere so v mm.

Tab. 11.10: Measurements of the third metatarsus and second phalanx of cave lion (*Panthera spelaea*) from Divje babe I. Descriptive statistics for fossil specimens of the same species from various sites in Europe are also given. Comparative data are taken from the following authors: Rakovec (1965), Altuna (1981), Argant (1991) and Nagel (1996). All measurements are in mm.

Skeletal element	**Dimension**	**Divje babe I**	**Europe *P. spelaea***
		P. spelaea	**Me (N) min-max**
Metatarsus III (D.b. 564; OIS 5a-5d)	Greatest length	143.0	140.2 (11) 130.0-162.0
	Anterior-posteror breadth of diaphysis	18.1	20.0 (9) 18.0-20.0
Phalanx II (D.b. 588; OIS 5a-5d)	Greatest length	45.0	41.5 (10) 37.0-55.8
	Breadth of distal end	17.0	19.95 (10) 16.1-23.8

(1978) pa jo pripisujeta izolaciji zaradi ponavljajočih se poledenitev v würmu. Jamski levi iz vzhodnoalpskega prostora naj bi po njunem predstavljali ločeno vejo v razvoju vrste. Od tistih iz sosednjih populacij naj bi se razlikovali predvsem po večji masi ter relativno širših predmeljakih in meljakih. Vendar pa sta v tem smislu oba nepoškodovana kočnika iz Divjih bab I bliže primerkom z najdišč SZ Hrvaške, ki jih Gužvica (1998) povezuje z zahodnoevropsko linijo jamskega leva. To je pri prvem spodnjem meljaku (inv. št. D. b. 1864; *sl. 11.13b*) razvidno tako iz odebeljenega roba baze krone in poudarjenega cinguluma na lingvalni strani, kot tudi iz razmerja med največjo širino in dolžino zoba (ta znaša komaj 0,505). Podobno velja za četrti zgornji predmeljak (inv. št. D. b. 728), kjer znaša razmerje med dolžino zoba do devterokona in njegovo največjo dolžino le 0,919 (prim. Gužvica 1998).

Sestavo veredostojne starostne strukture onemogoča skromno število najdb (prim. Lyman 1987), velja pa opozoriti na enako število stalnih in mlečnih zob. Determinacija slednjih temelji na njihovih morfoloških značilnostih. Tako se mlečni P_3 (inv. št. D. b. 631; *sl. 11.13c*) s parom razmeroma močnih, očitno poševno izraščajočih korenin bistveno razlikuje od stalnega P_3 iste vrste (Smuts *et al.* 1978). Poševno izraščajoči korenini, od katerih je mezialna bistveno robustnejša od distalne, sta značilni tudi za mlečni četrti spodnji meljak (inv. št. D. b. 1355; *sl. 11.13d*); ta ima sicer že povsem molariformno oblikovano krono. Morfološko bi naveden zob lahko ustrezal tudi mlečnemu P_4 leoparda. Vendar pa je največja dolžina zoba iz Divjih bab I kar 18,5 mm, medtem ko je po Schmidovi (1940) razpon vrednosti iste dimenzije pri stalnih (!) P_4 recentnih leopardov komaj 13,5-20,4 mm (povprečna vrednost: 16,9; N = 157). Mere stalnih P_4 vrst *P. spelaea* in *P. leo* so navedene v *tabeli 10.9*, dolžina mlečnega P_4 pri vrsti *P. spelaea* iz Nemčije pa znaša 18,75 mm (Heller 1983). Tudi mlečni tretji zgornji meljak (inv. št. D. b. 2073; *sl. 11.13e*) morfološko povsem ustreza enakemu zobu jamskega leva (Smuts *et al.* 1978). Ima tri korenine, od katerih sta dve močneje razviti, krono pa od krone stalnih zob loči predvsem lega devterokona. Ta namreč pri mlečnem tretjem zgornjem predmeljaku ne leži lingvo-distalno od parastila, kot je to značilno za stalni P_3, temveč je pomaknjena mezialno na samo vzdolžno (tj. mezio-distalno) os zoba (prim. Rabeder 1992). Na osnovi smernic, ki jih podajajo Smuts in sodelavci (1978), so navedeni trije mlečni zobje pripadali do 17 mesecev starim osebkom.

Red: Sodoprsti kopitarji ali parkljarji (Artiodactyla)

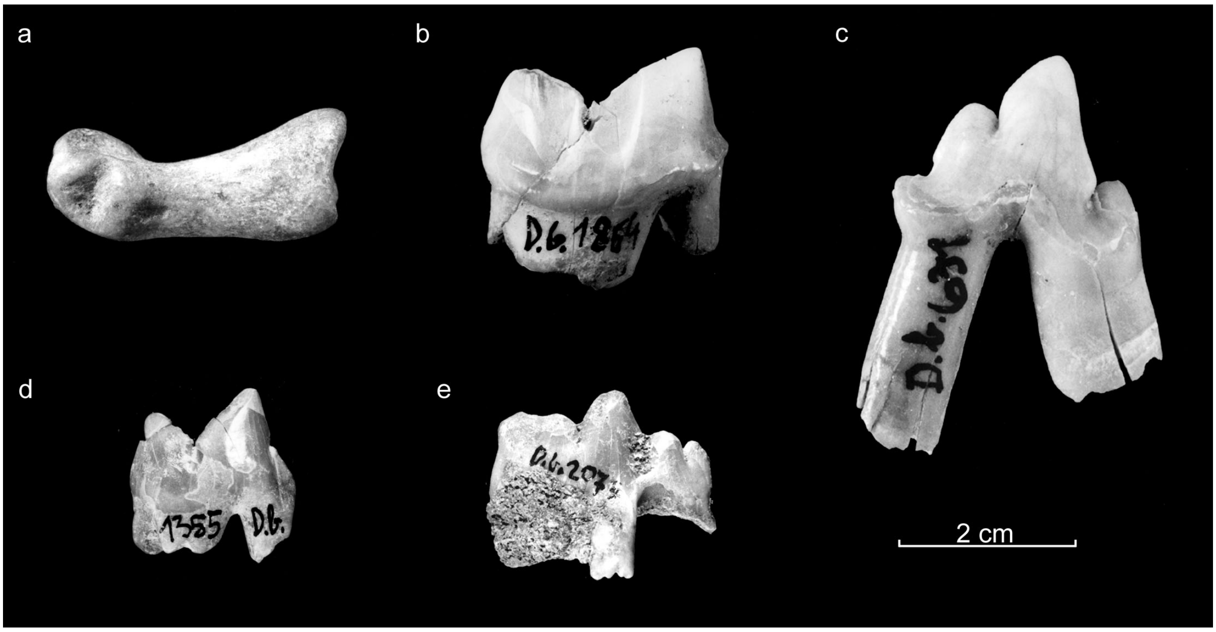
Parkljarji so v vzorcu iz Divjih bab I zastopani s šestimi vrstami iz dveh družin. Večino najdb sem določil vsaj do nivoja rodu, 13 ostankov pa sem determiniral le do nivoja družine. Od slednjih sem jih večji del pripisal votlorogom (Bovidae), fragment metapodija pa jelenom (Cervidae).

Družina: Prašiči ali svinje (Suidae)

Sus scrofa Linnaeus, 1758

Gradivo: sklop plasti 2-5: maxilla (vključujoč P^4 in M^1), dens ($I_{inf.}$), phalanx I.

Divji prašič je v favni Divjih bab I zastopan s tremi najdbami, ki vse izvirajo iz sklopa plasti 2 do 5. Struktura in stopnja obrabe zob kažeta, da so verjetno pripadali do 18 let starima osebkoma (prim. Schmid 1972; Rolett, Chiu 1994). Prstnica je ostanek vsaj eno do dve leti stare živali (Schmid 1972). Divji prašič velja za razmeroma toploljubno vrsto, tako da bi lahko bile najdbe iz sklopa plasti 2 do 5 Divjih bab I pravzaprav v drugotni legi. Po drugi strani pa kaže omeniti, da je vrsta zastopana tudi v favni nekaterih sočasnih najdišč SV Italije



Sl. 11.13a-e: Ostanki jamskega leva (*Panthera spelaea*) iz Divjih bab I: a – phalanx II (D. b. 1783; plast 6-7); b – M_1 (D. b. 1864; plast 8), c – mlečni P_3 (D. b. 631; sklop plasti 2–5); d – mlečni P_4 (D. b. 1355; sklop plasti 2–5); e – mlečni P^3 (D. b. 2073; plast 8). Fotografija: T. Lauko.
Fig. 11.13a-e: Remains of cave lion (*Panthera spelaea*) from Divje babe I: a – phalanx II (D. b. 1783; Layer 6-7); b – M_1 (D. b. 1864; Layer 8), c – deciduous P_3 (D. b. 631; complex of layers 2–5); d – deciduous P_4 (D. b. 1355; complex of layers 2–5); e – deciduous P^3 (D. b. 2073; Layer 8). Photograph T. Lauko.

(Bon *et al.* 1991), Slovenije (Rakovec 1973), Madžarske (Jánossy 1986), Hrvaške (Malez 1986) in morda celo JV Avstrije (Fladerer 2000).

Družina: Jeleni (Cervidae)

Cervus elaphus Linnaeus, 1785

Gradivo: sklop plasti 2–5: metacarpus*, metatarsus, metapodium*, phalanx II; plast 7/8: phalanx II; plast 10: os carpale, os tarsale; plast 13: dens ($I_{inf.}$), metacarpus; plast 14: os carpale; plast 17: metacarpus; plast 20: os carpale; sklop plasti 2–11/12: os carpale*; sklop plasti 12/13–22: os carpale; plast neznana: metacarpus, phalanx III. Z zvezdico (*) so označeni izrazito fragmentirani primerki, katerih specifična determinacija ni zanesljiva.

Jelen je v vzorcu iz Divjih bab I zastopan s 17 ostanki. Determinacija treh izmed njih je pogojna; morfološko sicer v ničemer ne odstopajo od tipičnih cervidnih primerkov, so pa vse izrazito fragmentirane. Število ostankov zgodnjeglacialne starosti je primerljivo s številom interpleniglacialnih najdb, česar v gradivu iz Divjih bab I ne izkazuje noben drug takson velikih sesalcev.

(?) *Alces alces* (Linnaeus, 1758)

Gradivo: sklop plasti 4–6: phalanx II.

Cervidna proksimalna epifiza druge prstnice iz sklopa plasti 4 do 6 (inv. št. D. b. 100) je verjetno pripadala losu. Primerek namreč v največji medio-lateralni širini proksimalne epifize ne odstopa od vrednosti za postglacialne lose vzhodne Francije in Švice ter tako v velikosti presega fosilne primerke vrste *C. elaphus* z različnih evropskih najdišč (*tab. 11.11*). Slovenski prostor naj bi sicer v würmu naseljevala tudi večja oblika (podvrsta?) jelena, ki ga Poharjeva (1994) povezuje z maralom (*C. elaphus maral*). Ker pa za dimenzijami prstnic postglacialnih losov zaostajajo tudi ustrezne vrednosti fosilnih maralov (Mottl 1951; Malez 1963; Chaix in Desse 1981), sem primerek iz sklopa plasti 4 do 6 pogojno vendarle

Tab. 11.11: Mediolateralna širina proksimalnega konca (Bp) druge prstnice losa (*Alces alces*) iz Divjih bab I. Navedena je tudi opisna statistika za postglacialne primerke iste vrste iz vzhodne Francije in Švice (Chaix, Desse 1981). Vse mere so v mm.
Tab. 11.11: Mediolateral breadth of proximal end (Bp) of the phalanx II of moose (*Alces alces*) from Divje babe I. Descriptive data for post-glacial specimens of the same species from eastern France and Switzerland are also given (Chaix, Desse 1981). All measurements are in mm.

Dimension	**Divje babe I**	**W Europe *A. alces***
	(?) A. alces	**x (N) min-max**
Bp	27.5	28.9 (36) 23.6–33.2

pripisal k vrsti *A. alces*. Skladne s takšno determinacijo so morfološke značilnosti najdbe. Za lose značilna razširitev na antero-medialnem robu proksimalne sklepne površine je namreč (kljub fragmentiranosti) nakazana tudi na obravnavani drugi prstnici iz Divjih bab I (*sl. 11.14*).

Na Slovenskem so najdbe losa znane že s konca mindelško-riškega intergalciala (Brodar 1970), zastopan pa je tudi v favni več mlajšepleistocenskih najdišč (Toškan 2004). V nasprotju s tem so najdbe marala znane izključno s treh najdišč mlajšega würma (Rakovec 1962–63; Pohar 1985; 1992).

Opomba: V plasti 8 je bil poleg drugega najden tudi fragment cervidne sezamoidne kosti. Ker ta morfološko ne odstopa od enake kosti jelena, je pa od slednje očitno večja, gre morda tudi v tem primeru za losa.

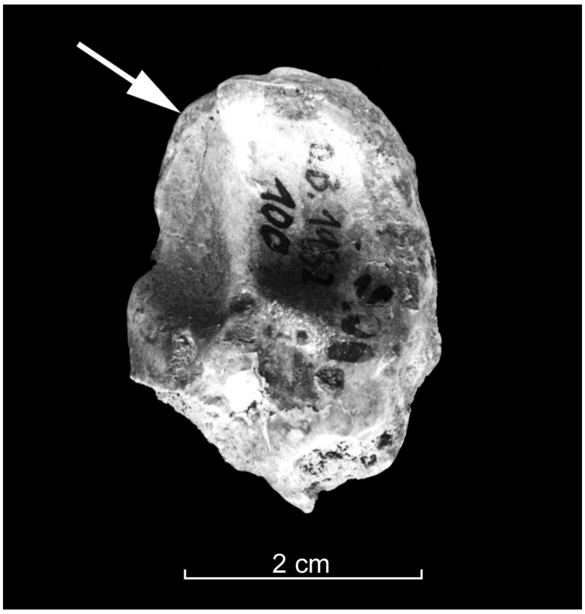
Capreolus capreolus (Linnaeus, 1758)

Gradivo: sklop plasti 2–5: ulna, os tarsale, phalanx I; plast 6: phalanx II; plast 8: phalanx I (2x), phalanx II, phalanx III, os carpale; plast 11: phalanx I; plast 14: phalanx I; plast neznana: phalanx I.

Skupno sem srni pripisal 14 ostankov, od katerih le eden izvira iz zgodnjeglacialnega sklopa plasti. Sicer maloštevilne izmerljive najdbe vrste *C. capreolus* iz Divjih bab I se po velikosti umeščajo znotraj variacijske širine subfosilnih primerkov iste vrste iz osrednje Slovenije (*tab. 11.12*).

Rupicapra rupicapra (Linnaeus, 1758)

Gradivo: Gams je v vzorcu iz Divjih bab I zastopan s 112 ostanki. Celoten seznam najdb po plasteh in skeletnih elementih je podan v *prilogi 11.2F.*

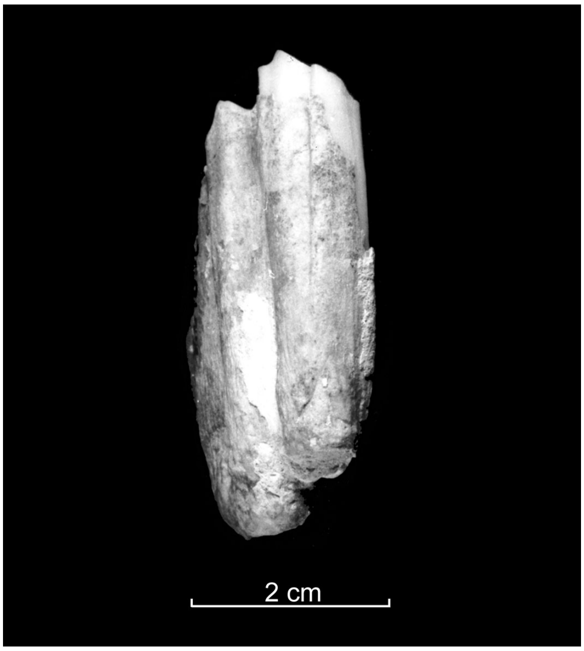


Sl. 11.14: Proksimalna epifiza druge prstnice losa (*Alces alces*) iz sklopa plasti 4–6 (inv. št. D. b. 100). Puščica označuje nakazano razširitev sklepne površine na njenem antero-medialnem robu.
Fig. 11.14: Proximal epiphysis of the phalanx II of moose (*Alces alces*) from the complex of layers 4–6 (inv. no. D. b. 100). Arrow marks the enlargement of the articular surface at its antero-medial edge.

Gams je daleč najbolje zastopan rastlinojed v Divjih babah I. Pri determinaciji sem se oprl na smernice, ki so jih objavili Prat (1966), Crégut-Bonnoure in Guérin (1996c), Pucher in Engl (1997) ter Gamble (1997). Razpoložljivi metrični podatki kažejo, da se fosilni gamsi v velikosti niso bistveno razlikovali od subfosilnih pri-

Tab. 11.12: Mere nekaterih kosti srne (*Capreolus capreolus*) iz Divjih bab I. Navedena je tudi opisna statistika za subfosilne primerke iste vrste iz osrednje Slovenije (eneolitik; Toškan in Dirjec 2004b). Dimenzije so povzete po von den Driesch (1976) in so razložene v *prilogi 11.1.* Vse mere so v mm.
Tab. 11.12: Measurements of some bones of roe deer (*Capreolus capreolus*) from Divje babe I. Descriptive data for sub-fossil specimens of the same species from central Slovenia are also given (Eneolithic; Toškan and Dirjec 2004b). Dimensions are taken from von den Driesch (1976) and are explained in *Annex 11.1*. All measurements are in mm.

Skeletal element	**Dimension**	**Divje babe I**				**Slovenia** ***C. capreolus* (subfossil)**
		C. capreolus				**Me (N)** **min–max**
Ulna	BPC	17.0 D.b. 677				– (2) 14.0–15.0
Phalanx I	GL	–	–	39.0 D.b. 14	–	38.5 (10) 32.0–42.0
	Bp	11.0 D.b. 2479	–	11.0 D.b. 14	12.0 D.b. 1994	11.0 (9) 9.5–11.5
	Bd	–	9.0 D.b. 2481	10.5 D.b. 14	–	9.5 (13) 8.0–13.0
Phalanx II	Bp	11.0 D.b. 2476		–		10.0 (10) 8.0–11.0
	Bd	–		8.0 D.b. 2478		7.0 (10) 6.0–7.5



Sl. 11.15: Tretji spodnji meljak alpskega kozoroga (*Capra ibex*) iz sklopa plasti 2–5 (inv. št. D. b. 850). Fotografija: T. Lauko.
Fig. 11.15: Third lower molar of alpine ibex (*Capra ibex*) from the complex of layers 2–5 (inv. no. D. b. 850). Photograph T. Lauko.

merkov z istega območja (*pril. 11.1i*). Ostanki iz najglobljih plasti Divjih bab I domnevno izvirajo iz obdobja prehoda riško-würmskega interglaciala v würmski glacial (Turk *et al.* 2001a), s čimer se uvrščajo med najstarejše znane najdbe vrste *R. rupicapra* na Slovenskem.

Capra ibex Linnaeus, 1758

Gradivo: sklop plasti 2–5: dentes (C_1, M_3), femur, tibia (2x), phalanx II (2x), phalanx III; plast 6: dens (M_2).

Alpski kozorog je bil v vzorcu zastopan z devetimi ostanki. Morfološko vsi ustrezajo opisom, ki jih je za posamezne kosti vrste *C. ibex* podal Prat (1966). Nekoliko odstopa le tretji spodnji meljak iz sklopa plasti 2 do 5 (inv. št. D. b. 850). Njegov distalni (tj. tretji) stebriček namreč ne kaže za vrsto *C. ibex* značilne odebelitve na bazi krone (*sl. 11.15*). Metrično se navedeni primerek umešča znotraj variacijske širine fosilnih alpskih kozorogov z več evropskih najdišč (*tab. 11.13*).

Na osnovi obrabe žvekalne ploskve M_3 iz sklopa plasti 2 do 5 in M_2 iz plasti 6 bi lahko obe najdbi pripisal stari živali (Gamble 1997; Payne 1973; Deniz, Payne 1982). Pri kosteh je bilo mogoče starost ob uplenitvi/poginu oceniti le pri dveh primerkih, pri katerih epi- in diafiza še nista zraščeni. Tibia iz sklopa plasti 2 do 5 je pripadala subadultnemu osebku (starost ob zakolu < 5 let), femur iz posutega sedimenta pa juvenilni, največ poldrugo leto stari živali (Gamble 1997).

Red: Trobčarji (Proboscidea) / Lihoprsti kopitarji (Perissodactyles)
Družina: Sloni (Elephantidae) / Nosorogi (Rhinocerotidae)

Mammuthus primigenius (Blumenbach, 1799) seu *Dicerorhinus* sp. seu *Coleodonta antiquitatis* (Blumenbach, 1799)

Gradivo: sklop plasti 10–13: phalanx III.

Tretja prstnica iz sklopa plasti 10 do 13 (inv. št. D. b. 2433) pripada velikemu rastlinojedu (*sl. 11.16*). V kolikor gre za najdbo nosoroga, bi prišle načeloma v poštev kar tri vrste: gozdni nosorog oz. *Dicerorhinus kirchbergensis* (=*D. mercki*) (Jäger, Kaup, 1839–41), stepski nosorog oz. *D. hemitoechus* (Falconer, 1868) ter dlakavi nosorog oz. *Coelodonta antiquitatis* (Blumenbach, 1799). J. Radovčić iz Hrvaškega prirodoslovnega muze-

Tab. 11.13: Mere drugega in tretjega spodnjega meljaka alpskega kozoroga (*Capra ibex*) iz Divjih bab I. Navedena je tudi opisna statistika za fosilne primerke iste vrste z različnih evropskih najdišč (Malez 1963; Lequatre 1994; Münzel *et al.* 1994). Vse mere so v mm.
Tab. 11.13: Measurements of second and third lower molars of alpine ibex (*Capra ibex*) from Divje babe I. Descriptive data for fossil specimens of the same species from various European sites are also given (Malez 1963; Lequatre 1994; Münzel *et al.* 1994). All measurements are in mm.

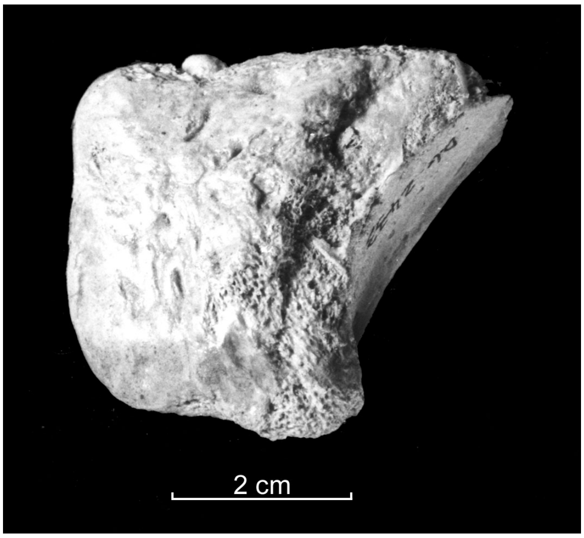
Tooth	**Dimension**	**Divje babe I**	**Europe** ***C. ibex* (fossil)**
		C. ibex	**Me (N)** **min–max**
M_2	Greatest length	16.0	17.0 (9) 16.0–19.4
	Greatest breadth	10.7	9.7 (11) 8.4–10.7
M_3	Greatest length	27.0	29.0 (5) 28.8–32.7
	Greatest breadth	10.0	10.2 (5) 10.0–10.8

ja v Zagrebu je prstnico iz Divjih bab I primerjal s fosilnim materialom iz Krapine ter najdbo pogojno pripisal vrsti *Stephanorhinus kirchbergensis* (≈ *D. kirchbergensis*; *cf.* Guérin 1996; Radovčić, ustno). Gozdni nosorog je tudi edini predstavnik svoje družine, ki je v mlajšem pleistocenu zagotovo naseljeval prostor današnje Slovenije (Rakovec 1958; 1959; 1973; S. Brodar 1970; M. Brodar 1996). Ista vrsta je zastopana tudi v mlajšepleistocenski favni Hrvaške (Malez 1979), Madžarske (Jánossy 1986) in SV Italije (Bon *et al.* 1991), kjer pa sta zastopana tudi stepski in dlakavi nosorog. Fosilne najdbe slednjega so znane še iz JV Avstrije (Fladerer 2000).

Ob gozdnem nosorogu pride pri determinaciji tretje prstnice velikega rastlinojeda iz sklopa plasti 10 do 13 v poštev tudi mamut. Zaradi nekoliko manj ploščate sklepne površine sicer obravnavana prstnica nekoliko odstopa od tipičnih primerkov vrste *Mammuthus primigenius* (Blumenbach, 1799), gledano v celoti pa se zdi primerek iz Divjih bab I morfološko kljub vsemu bliže mamutu kot gozdnemu nosorogu. Fosilne najdbe mamuta so na Slovenskem znane z vsaj 15 najdišč (Rakovec 1954; 1973; Pohar 1990; Lenardić, Pohar 1995).

VERTIKALNA PORAZDELITEV NAJDB

Med izkopavanji v Divjih babah I je bilo največje število ostankov velikih sesalcev (brez jamskega medveda) pobranih iz sklopa plasti 2 do 5 (NISP = 502) ter iz plasti 8 (NISP = 146). Zgodnjeglacialni sklop plasti 12 do 23 je bistveno manj bogat; od tam namreč izvira le 110 najdb (*tab. 11.14*). Interpretacija vertikalne porazdelitve ostankov ni enostavna, saj se v njej ne kažejo le dejanske spremembe v strukturi nekdanjih združb. Med potencialno pomembne dejavnike sodijo še različna intenzivnost razpadanja najdb, spremenljiva vloga posameznih dejavnikov akumulacije, različna debelina plasti ter delež raziskanega tlorisa. Upoštevati je seveda treba tudi morebitne spremembe v metodah in tehnikah izkopavanja, zaradi česar v nadaljevanju nekoliko več pozornosti namenjam ostankom z izkopnega polja v osrednjem in notranjem delu jame (glej poglavje 1 v tem zborniku, *sl. 1.3*). S koncem raziskovanja vhodnega dela jame so namreč arheologi konvencionalen način koordinatnega dokumentiranja najdb zamenjali z enostavnejšim in bolj praktičnim, temelječim na osnovnih področnih enotah dimenzije 1 x 1 x 0,12 m. Sočasno s tem so uvedli tudi mokro sejanje in pregledovanje vseh odkopanih sedimentov.



Sl. 11.16: Tretja prstnica mamuta (*Mammuthus primigenius*) oz. nosoroga (Rhinocerotidae) iz sklopa plasti 10–13 (inv. št. D. b. 2433). Fotografija: T. Lauko.
Fig. 11.16: Third phalanx of mammoth (*Mammuthus primigenius*) or rhinoceros (Rhinocerotidae) from the complex of layers 10–13 (inv. no. D. b. 2433). Photograph T. Lauko.

Navedene modifikacije v metodiki izkopavanja so prispevale k zmanjšanju deleža najdb, ki so bile med pobiranjem spregledane in posledično zavržene. Poleg tega je boljša ocena prostornine pregledanega sedimenta omogočila izračun geometrijske gostote določljivih kosti na posamezno plast (tj. število najdb na volumensko enoto sedimenta; *sl. 11.17*).[7] Po največji koncentraciji najdb izstopa sklop plasti 2 do 5, drugo mesto pa zaseda plast 10 (in ne več 8 kot pred standardizacijo na enak volumen sedimenta; *tab. 11.14*). Podobno vertikalno porazdelitev izkazujejo tudi ostanki rjavega medveda in volka. Zanimivo je, da iz plasti 2 do 5 ter 10 do 14 izvira tudi glavnina vseh najdenih kamenih artefaktov (Turk *et al.* 2002b). To namreč kaže, da so med nastajanjem obeh sklopov plasti jamo izmenično obiskovali tako ljudje kot velike zveri.

Nekoliko drugačna je vertikalna porazdelitev najdb gamsa in drugih srednje velikih do velikih rastlinojedov (srna, kozorog, jelen). Največ ostankov na prostorninsko enoto sedimenta je bilo sicer tudi v tem primeru pobranih iz sklopa plasti 2 do 5, kar bi lahko kazalo na višjo frekvenco človekovih in volčjih obiskov jame. Težje razložljiv pa je majhen delež kosti in zob rastlinojedov v plasti 10. Preseneča tudi koncentracija gamsjih kosti v plasti 6 do 7, kjer je bilo najdenih razmeroma malo kamenih artefaktov in ostankov velikih zveri. Paleoklimatske ocene resda kažejo na poslabšanje razmer med odlaganjem vsaj dela plasti 2 do 5 ter tudi plasti 6 (Turk *et al.*, 2001a), kar je morda prispevalo k dejanskemu povečanju števila gamsov in kozorogov v takratnih združbah širše okolice Divjih bab I (*sl. 11.17; tab. 11.14*). Na takšen razvoj dogodkov bi bilo navsezadnje mogoče sklepati tudi iz številnih najdb alpskega svizca v navede-

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[7] Ker je bil v osrednjem in notranjem delu jame sediment izkopan samo do plasti 14, so na *sl. 11.17* prikazani le podatki za obdobje OIS 3.

Tab. 11.14: Pogostnost najdb v Divjih babah I zastopanih taksonov velikih sesalcev po posameznih plasteh. V tabeli so prikazani le podatki za najdbe z razmeroma natančno opredeljeno stratigrafsko lego. Senčena polja označujejo primere, kjer gre večje število ostankov zelo verjetno pripisati le eni živali.
Tab. 11.14: Frequency of finds of taxa of large mammals represented at Divje babe I, by individual layers. Only data for finds with a relatively exactly defined stratigraphic location are included in the table. The shadowed areas mark cases in which there are a large number of remains, very probably from a single animal.

Taxon:	**Stages and Layers**																									**Σ**
	OIS 3												**OIS 5**													
	2-5	**6**	**6-7**	**7**	**7-8**	**8**	**8-10**	**9**	**10**	**10-11**	**11**	**11-12**	**12**	**12-13**	**13**	**13-14**	**14**	**14-16**	**16**	**17**	**17a**	**17-19**	**18**	**20**	**21**	
Lepus sp.	4	1				2									1											8
M. marmota	186		1	3	2	28	1		2																	223
U. arctos	68	4		3		35	3	1	17	1	4	1	1	5	10	3	6	1	1		3	1				168
C. lupus	64	8	2	6	1	23	2	1	26		1	1	1		3		1			1	1				1	143
V. vulpes	2																		3							5
A. lagopus			1			13																				14
M. putorius	46					3					1															50
M. martes	40	3	10	6	1	21	4		14	1	3	1	1	1	4		2		6	2						120
L. lutra	1																									1
L. lynx	1	1																								2
P. pardus	7																									7
P. spelaea	4		2	2		3															3				1	15
S. scrofa	3																									3
C. elaphus	4				1				2						2		1			1				1		12
C. capreol.	3	1				5					1						1									11
R. rupicap.	61	2	6	1		13			10		1				2		1				6		2	3	1	109
C. ibex	8	1																								9
Σ	502	21	22	21	5	146	10	2	71	2	11	3	3	6	22	3	12	1	10	4	13	1	2	4	3	900

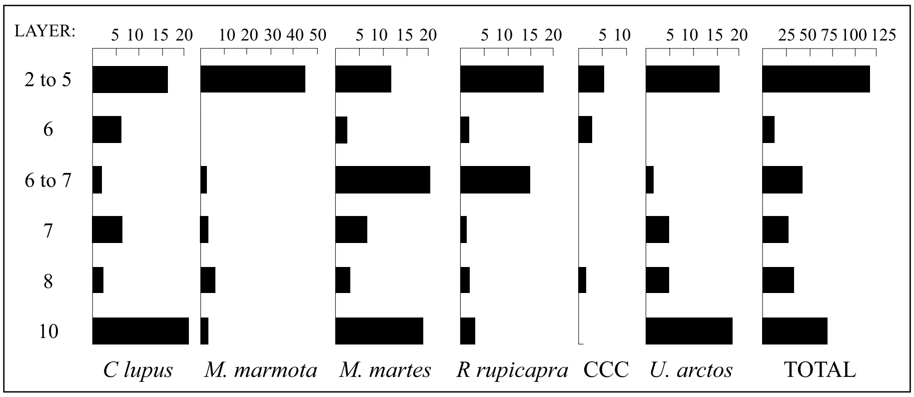
nem sklopu plasti. Po drugi strani pa je v istem stratigrafskem kontekstu relativno visoka tudi koncentracija najdb kune zlatice (*Martes* cf. *martes*), ki zaradi navezanosti na gozd preferira milejšo klimo. Ostanki kune so bili razmeroma številni tudi v plasteh 6 do 7 in 10, vendar pa je treba biti pri interpretaciji tega podatka previden. Porazdelitev najdb v prostoru namreč kaže, da jih je večina verjetno pripadala le dvema osebkoma (po enemu na plast). Prostorska porazdelitev ostankov iz plasti 2 do 5 je manj zgovorna, saj so navedene plasti zaradi krioturbacije nagubane.

Še neposrednejši vpogled v favno velikih sesalcev širše okolice Divjih bab I v različnih fazah würma omogočajo podatki v *tabeli 11.15*, ki kažejo število ostankov posameznega taksona po sedimentacijskih nivojih. Takšen prikaz podatkov je bil sicer mogoč le za del izkopnega polja (glej poglavje 1 v tem zborniku), zato je tudi skupno število najdb v tabeli manjše (NISP = 300). Po drugi strani pa lahko zaradi objektivnejše stratigrafije, večjega števila najdb in boljše časovne ločljivosti z večjo zanesljivostjo primerjamo podatke o ostankih velikih sesalcev vzdolž stratigrafskega stolpca s palinološkim in sedimentološkim zapisom ter z vertikalno porazdelitvijo večjega števila, časovno bolje ločljivih ostankov sesalske mikrofavne (glej poglavja 5, 8 in 10 v tem zborniku).

Ostanki zveri tvorijo v profilu dva izrazita vrhunca (*tab. 11.15*), ki se ujemata z mrzlo in vlažno klimo v času nastanka plasti 4–5a in spodnjega dela plasti 8. (glej poglavje 6 v tem zborniku, *sl. 6.7a*). Rezultat lahko razložim z večjim zanimanjem zveri za jame-brloge v času zaostrenih klimatskih razmer.

OCENA NEKDANJEGA OKOLJA

Tradicionalni arheozoološki/paleontološki pristop k preučevanju nekdanjega okolja temelji na projekciji ekoloških toleranc recentnih populacij posameznih vrst na populacije iz preteklih obdobij. Ker pa so se sesalci sposobni prilagoditi na različna okolja, so lahko v preteklosti naseljevali tudi drugačne habitate od tistih, v katerih živijo danes (npr. Musil 1985; Bützler 1986; Miracle in Sturdy 1991; Van Kolfschoten 1995; Phoca-Cosmetatou 2002). Vpliv temperature, vlažnosti in drugih fizikalnih pogojev na distribucijo posameznih vrst je namreč praviloma le posreden (odvisno od navedenih dejavnikov se spreminjajo konkurenčne sposobnosti živali). Dejstvo je, da fizikalni pogoji areal posamezne vrste neposredno omejujejo le na njeni absolutni meji distribucije, zato enačenje ekološkega[8] in fiziološkega optimuma ni ustrezno (Van Kolfschoten 1995). Seveda pa



Sl. 11.17: Vertikalna porazdelitev ostankov nekaterih bolje zastopanih taksonov velikih sesalcev iz Divjih bab I. Podatki se nanašajo izključno na osrednji in notranji del jame (glej poglavje 1 v tem zborniku, *sl. 1.3*) in so standardizirani na enak volumen sedimenta (tj. 10 m^3). Plasti, katerih skupna prostornina pregledanih usedlin iz osrednjega in notranjega dela izkopnega polja ni presegala 5 m^3, v analizi niso upoštevane. Volumen na sliki prikazanih plasti je: sklop pl. 2–5 (34,8 m^3), pl. 6 (11,0 m^3), pl. 6-7 (5,3 m^3), pl. 7 (9,0 m^3), pl. 8 (59,3 m^3) ter pl. 10 (6,5 m^3). Koeficient korelacije med debelino posameznih plasti in v njih ugotovljeno gostoto vseh ostankov je majhen in ni statistično značilen (Spearmanov R = –0,08; p > 0,05). Obrazložitev simbolov: CCC – *C. ibex* + *C. elaphus* + *C. capreolus*.
Fig. 11.17: Vertical distribution of the remains of some better represented taxa of large mammals from Divje babe I. Data refer exclusively to the central and inner part of the cave (see chapter 1 in this volume, *Fig. 1.3*) and they are standardised to the same volume of sediments (i.e. 10 m^3). Layers of which the total volume of examined sediments from the central and inner part of the excavation field did not exceed 5 m^3 were not taken into account in the analysis. The volume of the layers shown in the figure is: complex of layers 2–5 (34.8 m^3), Layer 6 (11.0 m^3), Layer 6-7 (5.3 m^3), Layer 7 (9.0 m^3), Layer 8 (59.3 m^3) and Layer 10 (6.5 m^3). The coefficient of correlation between the thickness of individual layers and the established density of all remains in them is small and is not statistically significant (Spearman's R = –0.08; p > 0.05). Explanation of symbols: CCC – *C. ibex* + *C. elaphus* + *C. capreolus*.

to ne pomeni, da podatki o prisotnosti ostankov posameznih indikatorskih vrst velikih sesalcev za paleoekološke študije niso zanimivi. Lahko so namreč zelo uporabni kot neodvisna kontrola paleookoljskih in paleoklimatskih rekonstrukcij, ki temeljijo na drugih paleoekoloških indikatorjih (npr. sedimentološki ali palinološki zapis, ostanki malih sesalcev ipd.).

Doslej najpopolnejša in z globalnimi paleoklimatskimi zapisi ($\delta^{18}O$ in pelod) primerljiva paleoklimatska krivulja za najdišče Divje babe I temelji na rezultatih sedimentološke analize (Turk *et al.* 2001a; 2002b; glej tudi poglavje 5 v tem zborniku). Iz njih je mogoče razbrati, da je bilo podnebje v OIS 3 domnevno manj stanovitno, v povprečju pa vsekakor bistveno hladnejše in vlažnejše kot v OIS 5a–5d. Takšne sklepe potrjujejo rezultati palinoloških in antrakotomskih raziskav (Šercelj, Culiberg 1991; Culiberg, Šercelj 1997; poglavje 8 v tem zborniku) ter študija ostankov malih sesalcev (glej poglavje 10 v tem zborniku). S predstavljeno paleoklimatsko krivuljo so skladni tudi ostanki velikih sesalcev, čeprav je večina taksonov ubikvističnih (*sl. 11.18*).[9] Izmed 12 vrst redu Carnivora bi izpostavil predvsem polarno lisico, ki danes večinoma naseljuje tundro. Njeni ostanki so bili najdeni v plasti 8, ki naj bi pretežno (8a, 8c in delno 8b) nastala prav v obdobju hladne klime.[10] Iz plasti 8 izvirajo tudi najdbe domnevno planinskega zajca, danes vezanega na območje tundre, tajge in alpinskih travnikov (Sulkava 1999). Domnevni ostanki vrste *L. timidus* so bili skupaj s številnimi najdbami alpskega svizca odkriti še v sklopu plasti 2 do 5. V istih plasteh je bil s posameznimi najdbami zastopan tudi divji prašič, katerega optimalni življenjski prostor predstavljajo listnati in mešani gozdovi. Med nastajanjem sklopa plasti 2 do 5 so torej obdobje razmeroma hladne klime najverjetneje prekinjale tudi nekoliko toplejše faze, ki so omogočale obstoj mešanih gozdnih sestojev. Gozd je bil bolj ali manj stalno prisoten tudi v uvodnem delu OIS 3. To nakazujejo najdbe kune zlatice v plasteh 10 do 12/13, saj omenjena zver med različnimi tipi habitatov preferira prav gozdove (Bright 1999).

Tretja prstnica velikega rastlinojeda iz sklopa plasti 10 do 13 je morfološko bliže mamutu kot gozdnemu nosorogu. Takšna determinacija je verjetnejša tudi z vidika paleoklime, saj naj bi bil uvodni del OIS 3 razmeroma hladen (*sl. 11.18*). V nasprotju z mamutom je bil nam-

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[8] Pod pojmom ekološki optimum razumem tiste pogoje, pri katerih kaže dana vrsta v naravi največjo abundanco.

[9] Upošteval sem le gradivo iz OIS 3, saj je vzorec živalskih ostankov iz OIS 5a–5d preskromen.

[10] Ostanki polarne lisice so bili najdeni na globini –321 cm in –345 cm (tj. sedimentacijska nivoja 26 in 28); sedimentološke analize kažejo, da sta omenjena sedimentacijska nivoja dejansko nastala v obdobju hladne klime (glej podpoglavje 5.2 v tem zborniku).

Tab. 11.15: Pogostnost najdb v Divjih babah I zastopanih taksonov velikih sesalcev po posameznih stratigrafskih nivojih. Podatki se nanašajo le na najdbe z izkopnih polj A in B (glej Turk 2003; poglavje 1 v tem zborniku).

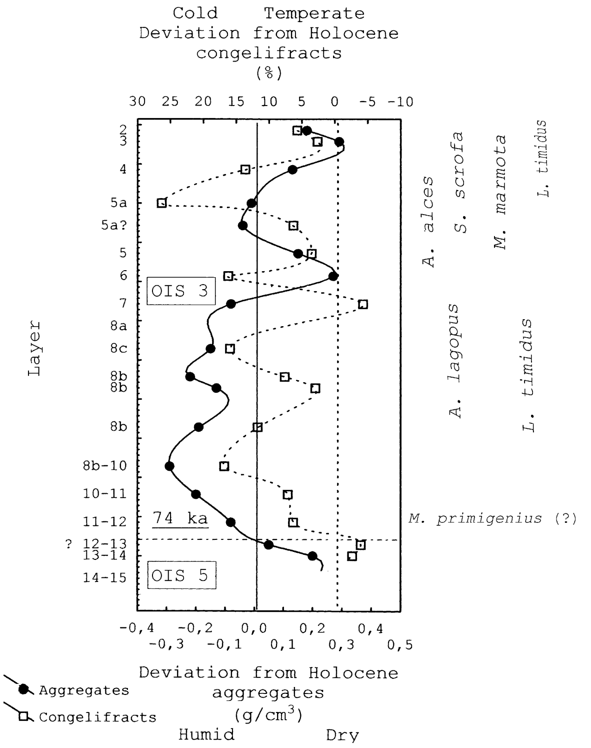
Tab. 11.15: Frequency of finds of taxa of large mammals represented at Divje babe I, by individual stratigraphic level. Data refer only to finds from excavation fields A and B (see Turk 2003; chapter 1 in this volume).

Depth (cm)	**Facies**	***M. marmota***	***L.* cf. *timidus***	***Ursus arctos***	***P. spelaea***	***P. pardus***	***Lynx lynx***	***Felis silvestris***	***Canis lupus***	***Alopex lagopus***	***Alopeex/Vulpes***	***Martes martes***	***M. putorius***	***L. lutra***	***Cervus elaphus***	***C. capreolus***	***R. rupicaprs***	***Capra ibex***	**T O T A L**
-20	A	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	**5**
-32	A	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	**8**
-44	A	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	**8**
-56	A	7	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	**10**
-68	A	1	0	3	0	0	0	0	2	0	0	0	0	0	0	0	0	0	**6**
-81	A	12	0	5	0	0	0	0	3	0	0	0	1	0	0	0	1	0	**22**
-94	A	9	0	6	0	2	0	0	5	0	0	2	0	0	0	0	1	0	**25**
-106	A	0	0	2	0	2	0	0	3	0	0	1	0	0	0	0	1	0	**9**
-117	A	0	0	1	0	0	0	0	1	0	0	3	3	0	1	0	0	0	**9**
-129	A	1	0	1	0	0	0	0	2	0	0	2	17	0	0	0	0	0	**23**
-141	A	0	0	2	0	0	0	0	3	0	0	0	10	1	0	0	0	0	**16**
-153	A	1	0	0	0	0	0	0	2	0	0	1	1	0	0	0	0	0	**5**
-165	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
-177	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	**2**
-189	A	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
-201*	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**
-213	A	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	1	0	**4**
-225	A	0	0	2	0	0	0	0	4	0	0	3	0	0	0	0	0	0	**9**
-237	B	0	0	5	1	0	0	0	1	0	0	3	0	0	0	0	0	0	**10**
-249	B	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**5**
-261	B	0	0	3	0	0	0	0	2	0	0	0	0	0	0	0	1	0	**6**
-273	B	5	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**
-285	B	0	0	3	0	0	0	0	2	0	0	2	0	0	0	0	0	0	**7**
-297	B	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**
-309	B	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	**3**
-321	B	1	1	1	0	0	0	0	0	3	0	2	0	0	0	0	0	0	**8**
-333*	B	0	0	4	1	0	0	0	2	0	0	3	1	0	0	0	2	0	**13**
-345	B	2	0	0	0	0	0	2	0	1	0	2	1	0	0	2	0	0	**10**
-357	B	1	0	2	0	0	0	0	1	0	0	2	0	0	0	1	0	0	**7**
-369	B	1	0	0	0	0	0	0	3	0	0	4	0	0	0	1	0	0	**9**
-381	B	1	0	5	0	0	0	0	10	0	0	10	0	0	1	0	1	0	**28**
-393	B	0	0	2	0	0	0	0	3	0	0	3	0	0	0	0	1	0	**9**
-405*	B	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	**3**
-417	B	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**1**
-429	B	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
-441	C-1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	**2**
-453	C-1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	**2**
Σ		**57**	**1**	**55**	**3**	**4**	**1**	**2**	**52**	**4**	**1**	**51**	**35**	**1**	**2**	**5**	**25**	**1**	**300**

*Level with hearth.

reč gozdni nosorog vezan na toplejše in verjetno tudi vlažnejše okolje (Musil 1985). Najdba losa v sklopu plasti 4 do 6 kaže na prisotnost vlažnih habitatov (Pucek 1981).

Ker je projiciranje ekoloških preferenc recentnih populacij na tiste iz preteklih obdobij pogosto problematično (Van Kolfschoten 1995), sem se paleoekološke raziskave lotil še nekoliko drugače. Ekološko nišo posameznih vrst sem poskusil izpeljati iz treh lastnosti sesalskih populacij, ki jih je mogoče rekonstruirati tudi pri fosilnih taksonih: velikosti živali, vrste njihove prehrane (tj. karnivor, omnivor, insektivor idr.) in pa prostora, kjer se praviloma zadržujejo (tj. arborealne vrste, skansorialne vrste, fosorialne vrste idr.). Na osnovi navedenih podatkov naj bi bilo namreč mogoče verodostojno oceniti razpon ekoloških niš proučevane fosilne sesalske skupnosti, s tem pa tudi orisati njeno strukturo (Andrews



Sl. 11.18: Umestitev indikatorskih vrst velikih sesalcev iz Divjih bab I v posamezne klimatsko definirane faze würma. Paleoklimatska krivulja je bila sestavljena na osnovi sedimentološkega zapisa (Turk *et al.* 2002; Turk 2004).

Fig. 11.18: Placing of indicator species of large mammals from Divje babe I in individual climatically defined phases of the Würm. The paleoclimatic curve was composed on the basis of sedimentological records (Turk *et al.* 2002; Turk 2004).

1995). Podatki, ki se nanašajo na favno velikih in malih sesalcev iz Divjih bab I, so podani na *sliki 11.19*.

Lastne podatke sem primerjal s tistimi, ki jih za strukturo sesalskih skupnosti iz nižinskih gozdov (N = 8), montanskih gozdov (N = 3), gozdnato-gormovnih pokrajin (N = 8) ter ravninskih nizkih travnikov (N = 1) tropske Afrike podajajo Andrews in sodelavci (1979). Primerjava tropskih ekosistemov s tistimi v zmernem pasu sicer ni najustreznejša. Bistveno bolj od vertikalne strukturiranosti ekosistema namreč v njegovi biodiverziteti odsevata količina primarnim konzumentom dostopne hrane[11] in pa stabilnost v njeni razpoložljivosti (Kryštufek 2001). Po drugi strani pa danes vrsto ključnih velikih sesalcev, ki so (oz. to velja za njim sorodne fosilne vrste) v ledenih dobah naseljevali tudi evropska tla, najdemo le še ponekod v tropih (npr. lev, leopard, hijena, slon, nosorog, veliki votlorogi; Kurtén 1968; Musil 1992). Prav izključitev pestre združbe velikih rastlinojedov iz ekosistemov zmernih klimatov v zadnjih fazah würma in v holocenu pa je marsikje zagotovo privedla do popolnega zaraščanja dotlej odprtih habitatov, ne da bi na to vplivale morebitne klimatske ali edafske spremembe (prim. Kryštufek 2001). Največji predstavniki izginule megafavne (npr. mamut v Evropi) so namreč v pleistocenu verjetno omejevali razrast sklenjenega gozda, podobno kot rastlinojeda megafavna v Afriki to počne še danes. Kaj pa velike zveri? Njihova prisotnost o nekdanji klimi sicer ne pove veliko, zato pa posredno kaže na ustrezno nosilno zmogljivost okolja, torej na bogato združbo velikih rastlinojedov.

Izsledki analize so povzeti na *sliki 11.19* in se v celoti skladajo z neodvisno pridobljenimi paleookoljskimi ocenami (glej poglavja 5, 8 in 10 v tem zborniku). Odstopanje med vzorcema zgodnjeglacialne in interpleniglacialne starosti je največje v lokomotornih adaptacijah na prostor, v katerem se živali praviloma gibljejo (t.i. cona zadrževanja). V gradivu iz OIS 3 je namreč delež vrst velikih terestričnih sesalcev očitno večji od deleža vrst malih terestričnih sesalcev, ki jih sicer lahko najdemo tudi na spodnjih vejah grmičevja in padlih drevesih. Med recentnimi habitati afriškega tropskega pasu kažejo podobno sliko sesalske združbe gozdnato-grmovnatih in travniških habitatov. Ker pa v okviru travniških habitatov arborealne vrste manjkajo, se zdi v smislu ekološke diverzitete interpleniglacialna favna Divjih bab I vendarle še najbolj podobna združbam gozdnato-grmovnatih pokrajin. V nasprotju z vzorcem iz OIS 3 je v gradivu iz OIS 5a delež zastopanosti velikih terestričnih sesalcev primerljiv z deležem malih terestričnih sesalcev. V tem smislu je zgodnjeglacialna favna iz Divjih bab I še najbliže združbam tropskih gozdov, čeprav pri slednjih delež vrst malih terestričnih sesalcev praviloma presega delež vrst velikih.

Razlike med fosilnimi in recentnimi sesalskimi združbami sem tudi statistično testiral (*tab. 11.16*). Pri vsaki od štirih kategorij (tj. velikost, taksonomija, prehranjevalna skupina, cona zadrževanja) sem ugotavljal obseg korelacije med obravnavanimi favnami v deležu zastopanosti posameznih razredov (npr. pri kategoriji "prehranjevalna skupina" delež insektivorov, karnivorov, fruktivorov...).[12] V rezultatih se žal močno kaže skromna časovna ločljivost vzorca; ker se je gradivo akumuliralo v več deset tisoč let dolgem obdobju, imamo namreč pri analizi favnističnega gradiva opravka s palimpsestom. Visoki statistično značilni koeficienti korelacije med vzorcem iz OIS 3 ter recentnimi sesalskimi združbami nižinskih in/ali montanskih gozdov tropske Afrike v kar treh kategorijah so kljub temu zgovorni (*tab. 11.16*). Očitno namreč temperatura in vlažnost v interpleniglacialu nikoli nista bili tako nizki, da bi onemogočali obstoj (vsaj) gozdnato-grmovnate krajine. Obe-

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[11] Sicer velika primarna produkcija listopadnega gozda tako npr. znatnemu delu primarnih konzumentov ni dostopna, saj je večina organske snovi v lesu.

[12] Uporabil sem neparametrični Spermanov R-test. Pri tem sem razrede znotraj posamezne kategorije ekološke raznolikosti rangiral tako, da sem razred z največ vrstami označil z rangom ena, tistega z drugim največjim številom vrst z rangom 2 itd.

Tab. 11.16: Korelacijski koeficienti (Spearmanov R) med izbranimi kategorijami ekološke raznolikosti obeh fosilnih vzorcev iz Divjih bab I na eni strani in recentnih sesalskih združb treh tipov habitatov (gozd, gozdnato-grmovnata pokrajina in travnik) tropske Afrike na drugi. Senčena polja označujejo statistično značilne korelacijske koeficiente (p<0,05).
Tab. 11.16: Correlation coefficients (Spearman's R) among selected categories of ecological heterogeneity of both fossil specimens from Divje babe I, on the one hand, and recent mammal associations of three types of habitat (forrest, woodland-bushland and short grass plains) of tropical Africa on the other. Statistically significant correlation coefficients (p<0.05) are shaded.

Ecological category	**Sample**	**Forest**	**Woodland - bushland**	**Short grass plains**
Taxonomy	OIS 3	0.87	0.97	0.97
	OIS 5	0.97	0.87	0.87
Size	OIS 3	0.89	0.89	0.89
	OIS 5	0.97	0.82	0.82
Locomotor zonal adapt.	OIS 3	0.73	0.73	0.59
	OIS 5	0.66	0.71	0.62
Feeding adaptation	OIS 3	0.03	0.96	0.93
	OIS 5	-0.05	0.50	0.72

nem pa velja opozoriti tudi na veliko podobnost med interpleniglacialno favno in recentnimi travniškimi združbami, saj so bili visoki koeficienti korelacije med njimi ugotovljeni pri kar treh od skupno štirih kategorijah (tj. "taksonomija", "velikost" in "prehranjevalna skupina"). To namreč nakazuje, da so bili na območju Divjih bab I v OIS 3 ves čas prisotni tudi bolj ali manj odprti habitati.

V nasprotju s stanjem v OIS 3 naj bi bilo okolje v OIS 5a–5d bolj gozdnato. To izhaja iz razmeroma visoke korelacije med zgodnjeglacialno favno iz Divjih bab I in združbami recentnih tropskih gozdov v kategorijah "velikost" in "cona zadrževanja" (*tab. 11.16*). Skladni s tem so podatki iz *tabele 11.17*, ki povzemajo primerjavo obeh fosilnih vzorcev iz Divjih bab I z dvema subfosilnima favnama iz Viktorjevega spodmola pri Divači (JV Slovenija). Po deležu zastopanosti posameznih razredov znotraj kategorije "cona zadrževanja"[13] je namreč zgodnjeglacialni vzorec iz Divjih bab I bliže gradivu iz mezolitskih plasti Viktorjevega spodmola kot pa tistemu iz

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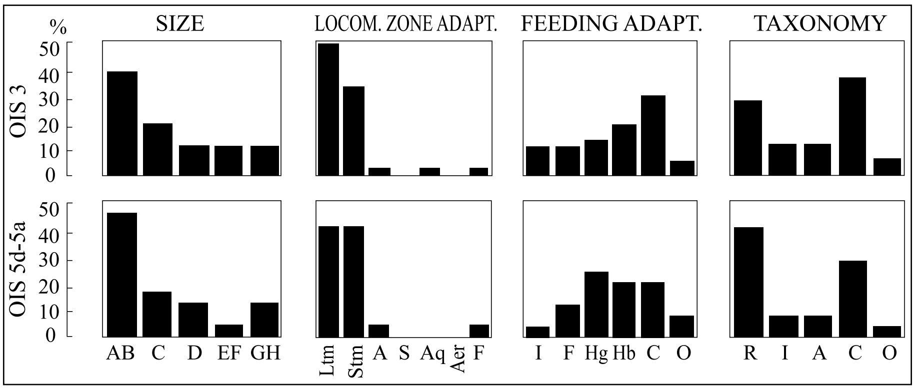
[13] Kategorijo "cona zadrževanja" sem izbral zato, ker so ravno tu razlike med fosilnim vzorcem iz OIS 5a–5d in tistim iz OIS 3 največje (*sl. 11.19*).

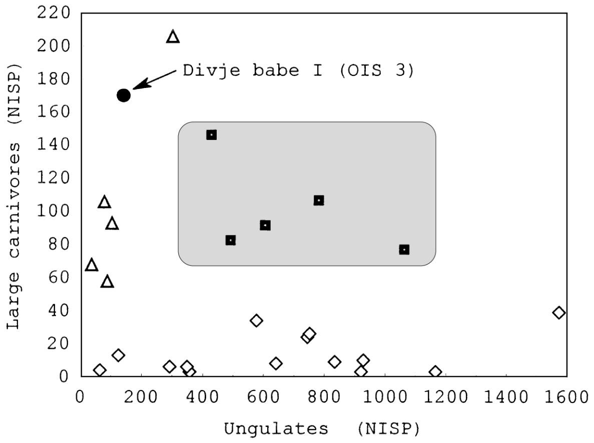


Sl. 11.19: Histogrami ekološke raznolikosti za zgodnjeglacialno (≈ OIS 5a–5d) in interpleniglacialno (≈ OIS 3) favno iz Divjih bab I. Ordinata predstavlja delež vrst, uvrščenih v posamezen razred (abcisa). Število vrst znotraj vsakega od obeh vzorcev: OIS 3 (N = 33), OIS 5d–5a (N = 22). Legenda: velikost: AB – do 1 kg, C – 1 do 10 kg, D – 10 do 45 kg, EF – 45 do 180 kg, GH – nad 180 kg; cona zadrževanja: Ltm – veliki terestrični sesalci, Stm – mali terestrični sesalci, A – arborealen, S – skansorialen, Aq – akvatičen, Aer – aerialen, F – fosorialen; prehranjevalna skupina: I – insektivor, F – frugivor, Hg – herbivor, ki se pretežno pase, Hb – herbivor, ki pretežno smuka, C – karnivor, O – ostalo; taksonomska skupina: R – Rodentia, I – Insectivora, A – Artiodactyla, C – Carnivora, O – ostalo.
Fig. 11.19: Histograms of ecological diversity for Early Glacial (≈ OIS 5a–5d) and Interpleniglacial (≈ OIS 3) fauna from Divje babe I. The ordinate represents the share of species ranked in individual classes (abscissa). The number of species within each of the two samples: OIS 3 (N = 33), OIS 5d–5a (N = 22). Legend: size: AB – to 1 kg, C – 1 to 10 kg, D – 10 to 45 kg, EF – 45 to 180 kg, GH – above 180 kg; Locomotor zonal adaptation: Ltm – large terrestrial mammals, Stm – small terrestrial mammals, A – arboreal, S – scansorial, Aq – aquatic, Aer – aerial, F – fosorial; feeding adaptation: I – insectivore, F – frugivore, Hg -grazer, Hb – browser, C – carnivore, O – other; taxonomic groups: R – Rodentia, I – Insectivora, A – Artiodactyla, C – Carnivora, O – other.

Tab. 11.17: Korelacijski koeficienti (Spearmanov R) med zastopanostjo posameznih razredov znotraj ekološke kategorije "cona zadrževanja" pri obeh fosilnih vzorcih iz Divjih bab I na eni strani in obeh subfosilnih vzorcih iz Viktorjevega spodmola na drugi. Senčena polja označujejo statistično značilne korelacijske koeficiente ($p < 0,05$). Za obrazložitev glej besedilo.
Tab. 11.17: Correlation coefficients (Spearman's R) between representation of individual classes within ecological categories of the "locomotor zonal adaptation" with both fossil specimens from Divje babe I, on the one hand and both subfossil specimens from Viktorjev spodmol on the other. Statistically significant correlation coefficients ($p < 0.05$) are shaded. See text for explanation.

D. babe I	Viktorjev spodmol (Mesolithic)	Viktorjev spodmol (Bronze age)
OIS 3	0.790	0.789
OIS 5	0.962	0.858

bronastodobnega sedimenta istega najdišča. V nasprotju s tem razlik v obsegu korelacije med interpleniglacialnim vzorcem iz Divjih bab I in vsakim od obeh subfosilnih vzorcev iz Viktorjevega spodmola ni. Pri tem je potrebno navesti, da naj bi bila v mezolitiku širša okolica Viktorjevega spodmola pretežno gozdnata, medtem ko so na prehodu iz bronaste dobe v železno domnevno prevladovali odprti habitati (Toškan, Kryštufek 2004; Toškan, Dirjec 2004a).



Sl. 11.20: Grafični prikaz razmerja med številom določljivih primerkov (NISP) kopitarjev in velikih zveri (brez medveda) iz interpleniglacialnih plasti Divjih bab I. Za primerjavo so podani podatki z več italijanskih (Sala 1990b; Bartolomei *et al.* 1994; Stiner 1994; Fiore *et al.* 2004), enega francoskega (Moncel *et al.* 2004), enega španskega (Estévez 1987) in dveh slovenskih (Pohar 1985; 1992) paleolitskih najdišč. Skupina "velike zveri" zajema jamskega leva, leoparda, lisasto hijeno in volka. Legenda: △ - poglavitni dejavnik akumulacije domnevno velike zveri; ◇ - poglavitni dejavnik akumulacije domnevno paleolitski človek, □ - pomembni dejavniki akumulacije tako paleolitski človek kot tudi velike zveri (šarafirano polje).
Fig. 11.20: Graphic presentation of the ratio between the number of identifiable specimens (NISP) of ungulates and large carnivores (without bear) from the Interpleniglacial layers of Divje babe I. For comparison, data are given for a number of Italian (Sala 1990b; Bartolomei *et al.* 1994; Stiner 1994; Fiore *et al.* 2004), one French (Moncel *et al.* 2004), one Spanish (Estévez 1987) and two Slovene (Pohar 1985; 1992) Palaeolithic sites. The group of "large carnivores" includes cave lion, leopard, hyena and wolf. Legend: △- assemblages presumably collected by large carnivores; ◇ - assemblages presumably collected by Palaeolithic man, □ – assemblages presumably collected by both Palaeolithic man and large carnivores (shaded area).

DEJAVNIKI AKUMULACIJE

K akumulaciji ostankov makrofavne v paleolitskih jamskih najdiščih pogosto niso prispevali le ljudje, ampak tudi živali same. Znano je, da se v jame včasih zatečejo bolne ali ranjene živali, ki nato tam poginejo (prim. Fosse in Philippe 2005). Upoštevati je treba tudi naravno smrtnost med hiberniranjem oz. tik po njem; v primeru Divjih bab I je bil domnevno prav to poglavitni razlog za akumulacijo velikega števila ostankov jamskega medveda (Debeljak 2002b). Zveri naj bi h kopičenju kosti v jamah prispevale tudi s plenjenjem (Straus 1982; Miracle 1991; Stiner 1994; Blasco 1997). Tako se v Divjih babah I ostanki zajca stratigrafsko skoraj popolnoma ujemajo z najdbami lisice, ki je danes njegov najpomembnejši plenilec (*tab. 11.14;* Kryštufek 1991). Domnevno pomembna je bila tudi vloga volka in morda velikih mačk, saj je vrednost količnika med številom kosti zveri in kopitarjev razmeroma visoka (*sl. 11.20*). V gradivu interpleniglacialne starosti[14] iz Divjih bab I namreč prevladujejo prav ostanki medveda (hibernirajoči omnivor) in volka (v socialni skupnosti živeča zver), z nekoliko skromnejšim številom najdb pa so zastopani še lisica, divja mačka, vidra, kuna zlatica in dihur. Kot kažejo raziskave številnih mlajšepleistocenskih najdišč je bil namreč delež (velikih) zveri med kuhinjskimi odpadki paleolitskega človeka praviloma bistveno manjši (Klein in Cruz-Uribe 1984; Miracle 1991; Stiner 1994; a glej tudi Blumenschine 1995; Yravedra 2002).

Vlogo v jami naravno poginulih živali pri nastajanju tafocenoze je v primeru Divjih bab I težko oceniti (izjemo predstavlja medved). Dejstvo pa je, da je večina kosti poškodovanih. Pri tem je pomembno, da fragmentiranost ni omejena le na manj kompaktne skeletne elemente (npr. lobanja, sternum, os penis). Medtem ko bi bilo namreč takšne poškodbe mogoče razložiti že z naravnim razpadanjem na in v sedimentu, je namreč številne (tudi prečne) lome dolgih kosti bolj utemeljeno povezovati z aktivnostjo človeka in/ali zveri. Pri tem pa se postavljata dve ključni vprašanji, namreč: (1) kolikšen delež kosti, ki jih je v Divjih babah I zavrgel paleolitski človek, predstavlja ostanek njegovega lastnega plena (v pri-

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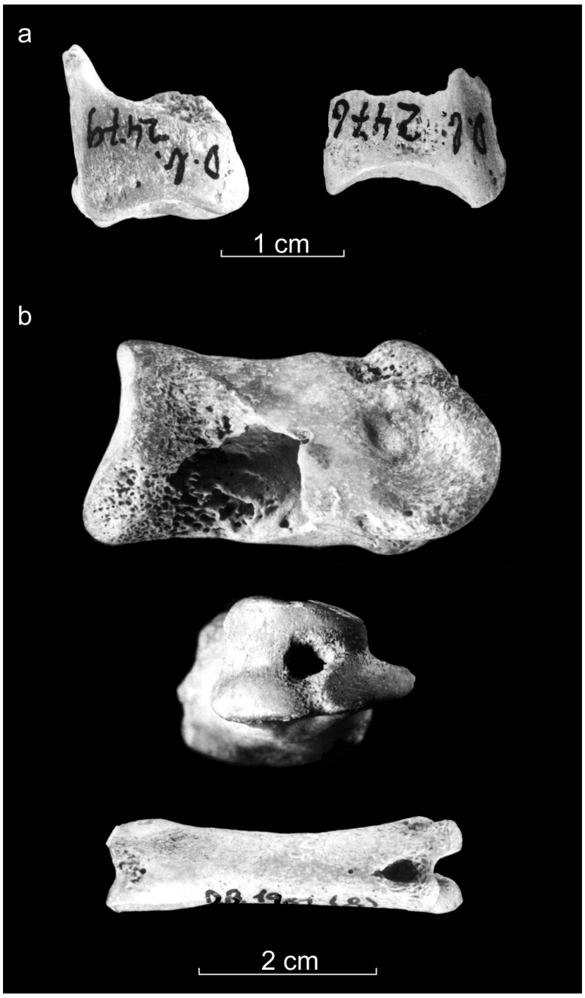
[14] Vzorec zgodnjeglacialne starosti je za podobno primerjavo preskromen.



Sl. 11.21a, b: Fosilni ostanki prstnic iz Divjih bab I, ki so jih domnevno fragmentirali: a – paleolitski ljudje oz. b – volkovi. Primerki z za človeka značilnim vzorcem fragmentiranosti so običajno razklani; površina kosti na mestu loma je gladka. V nasprotju s tem volkovi prstnic običajno ne strejo, ampak jih obgrizejo. Na tako obdelanih primerkih lahko sicer najdemo manjše luknje, v celoti razklani ostanki pa se pojavljajo le izjemoma (Stiner 1994).
Fig. 11.21a, b: Fossil remains of phalanxes from Divje babe I, which are presumed to have been fragmented by: a – Palaeolithic man or b – wolves. Specimens with fragmentation typical of humans are normally split; the break edges are clean and unmarred. In contrast, wolves do not normally crush phalanxes but gnaw them. Although small holes can be found on such specimens, completely split remains only appear exceptionally (Stiner 1994).

merjavi z deležem mrhovine) ter (2) v kolikšni meri so k akumulaciji ostankov prispevale velike zveri (brez medveda). O najustreznejši metodi za iskanje odgovora na ti vprašanji so mnenja v stroki močno deljena (Klein, Cruz-Uribe 1984; Marean, Spencer 1991; Marean, Kim 1998; Stiner 1991; 1994; 1998a; 2002; Blumenschine 1995; Domínguez-Rodrigo 1996; 1999; Milo 1998; Yravedra 2002; Pickering *et al.* 2003; Phoca-Cosmetatou 2004; 2005). Zaradi navedenega se bom v nadaljevanju dotaknil obeh najpogosteje uporabljenih pristopov. Njuna skupna točka je izhajanje iz podatkov o številu in mestu pojavljanja vseh tistih sledi na površini kosti, ki jih je mogoče neposredno navezati na aktivnost človeka (zasekanine, urezi, sledi udarcev) oz. zveri (odtisi zob). Upošteval sem tudi vzorec fragmentiranosti posameznih kosti, saj je paleolitski človek te razbijal drugače, kot to počno zveri (prim. Haynes 1980; 1983; Stiner 1994; Blasco 1997; *sl. 11.21*).

Med določljivimi ostanki kopitarjev so sledi zverske (pretežno volčje; prim. Haynes 1980; 1983) oz. človekove aktivnosti opazne predvsem na kosteh spodnjega dela obeh parov okončin (*sl. 11.22* in *sl. 11.23*). Kar zadeva zveri, predstavlja v tem pogledu edino izjemo domnevno obgrizena glava stegnenice (*caput femoris*) gamsa iz plasti 17a. Za človeka značilen vzorec fragmentiranosti kažejo poleg kosti spodnjega dela okončin še primerek lopatice in spodnje čeljustnice ter po en proksimalen fragment koželjnice, komolčnice in stegnenice. Iz rezultatov etnoloških študij izhaja, da vzorec procesiranja uplenjenih živali pri ledenodobnih ljudeh z različnih območij in iz različnih obdobij zelo verjetno ni bil povsem enak (Binford 1978; Monahan 1998; Domínguez-Rodrigo 1999). Spremenljiva je tudi sama prehrambna vrednost posameznih delov plena, ki je med drugim odvisna od vrste, starosti in spola uplenjenih živali ter sezone uplenitve/pogina (Outram 2000). Iz navedenega nedvomno izhaja, da je treba biti pri *post hoc* kvalitativnem rangiranju posameznih anatomskih regij živali zelo previden. Ker pa so sledi človekove aktivnosti vidne tudi na kosteh iz bolj mesnatih delov kopitarjev, vendarle sodim, da so imeli paleolitski ljudje z območja Divjih bab I vsaj občasno dostop do celotnega trupla uplenjenih oz. zaradi kakega drugega vzroka poginulih živali.

Na prisotnost (prevlado?) kosti uplenjenih živali med ostanki kopitarjev[15] iz Divjih bab I kaže tudi številčno razmerje med vsoto MNE posameznih skeletnih elementov glave in rogovja na eni strani ter kosti okončin brez prstnic, zapestnic in večine nartnic na drugi (v nadaljevanju: (H+H)/L; Stiner 1994). Ostanki plena obligatnih mrhovinarjev (npr. progasta in rjava hijena) naj bi namreč kazali bistveno višje vrednosti navedenega indeksa, kot to velja za aktivne plenilce (npr. volk), saj je praviloma le slednjim omogočen dostop do vseh delov uplenjene živali. Da so številni fragmenti lobanje, čeljustnic in rogov med ostanki hrane mrhovinarjev[16] dejansko posledica njihove omejene izbire, je Skinner s sodelavci (1980) dokazal z nastavljanjem celih trupel oslov v bližino brlogov progastih hijen. V skladu s pričakovanji so se namreč deleži ostankov posameznih ana-

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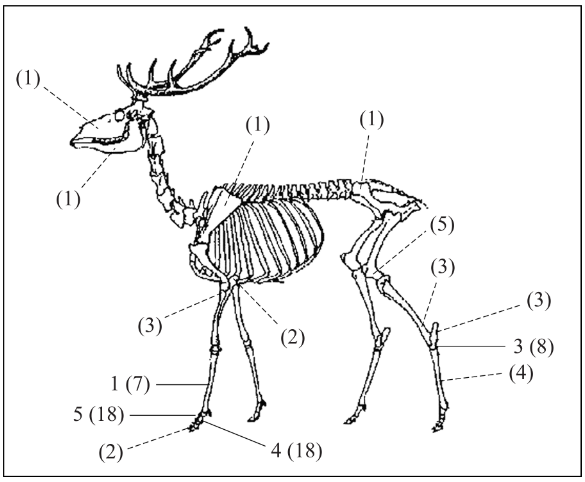
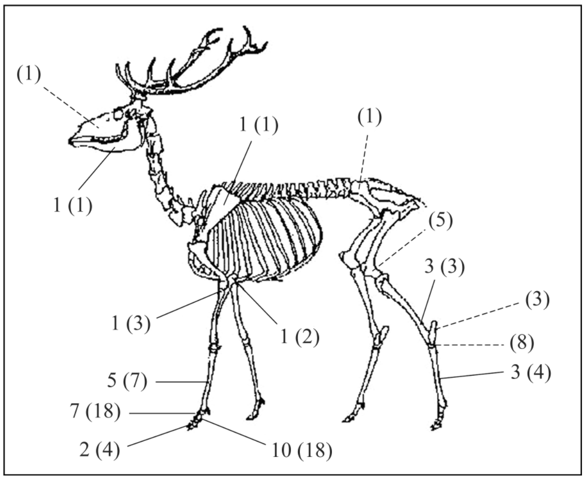
[15] Upošteval sem le kosti kopitarjev srednjega velikostnega razreda. Med ostanki plena velikih zveri in človeka izkazujejo namreč prav ti največjo variabilnost v zastopanosti posameznih anatomskih regij (Stiner 1994).

[16] To še posebej velja za manj agresivne mrhovinarje (Richardson, Bearder 1996).



Sl. 11.22: Število in mesto pojavljanja sledi na fosilnih kosteh kopitarjev iz Divjih bab I, ki jih je mogoče neposredno navezati na aktivnost zveri (tj. odtisi zob, specifičen vzorec fragmentiranosti). V oklepaju je navedeno skupno število primerkov posameznega skeletnega elementa v obravnavanem vzorcu. Pri determinaciji nisem razlikoval med prstnicami prednjih in zadnjih okončin.
Fig. 11.22: Number and place of appearance of traces on fossil bones of ungulates from Divje babe I which can be directly connected to the activities of carnivores (i.e., gnawing marks, specific pattern of fragmentation). In brackets is stated the total number of specimens of an individual skeletal element in the sample in question. In the determination I did not distinguish between phalanxes of front and rear extremities.



Sl. 11.23: Število in mesto pojavljanja sledi na fosilnih kosteh kopitarjev iz Divjih bab I, ki jih je mogoče neposredno navezati na aktivnost paleolitskega človeka (tj. urezi, zasekanine, sledi udarcev, specifičen vzorec fragmentiranosti). V oklepaju je navedeno skupno število primerkov posameznega skeletnega elementa v obravnavanem vzorcu. Pri determinaciji nisem razlikoval med prstnicami prednjih in zadnjih okončin.
Fig. 11.23: Number and place of appearance of traces on fossil bones of ungulates from Divje babe I which can be directly connected to the activities of Palaeolithic man (i.e., cut marks, chop marks, cone fractures, specific pattern of fragmentation). In brackets is stated the total number of specimens of an individual skeletal element in the sample in question. In the determination I did not distinguish between phalanxes of front and rear extremities.

tomskih regij med ostanki plena hijen bistveno spremenili in se zelo približali deležem ostankov plena volkov.

Vrednost indeksa (H+H)/L za vzorec fosilnih ostankov kopitarjev srednjega velikostnega razreda iz Divjih bab I je podana na *sliki 11.24*. Podatek ne odstopa le od vrednosti za obligatne mrhovinarje, ampak tudi od tistih za lisasto hijeno, ki je od mrhovine odvisna le delno.[17] Število razpoložljivih ostankov jelena in kozoroga (tj. kopitarjev srednjega velikostnega razreda) je sicer v vzorcu iz Divjih bab I skromno. Vendar pa rezultati eksperimentalnih študij kažejo, da indeks (H+H)/L ni občutljiv na pičlo število najdb (Stiner 1994). Poleg tega po nizki vrednosti tega indeksa izstopa tudi vzorec fosilnih ostankov kopitarjev vseh velikostnih razredov, ki je po številu najdb sicer bistveno bogatejši (NISP = 155).

Ne glede na domnevno robustnost indeksa (H+H)/L pa številni avtorji njegovo uporabo v celoti zavračajo (npr. Blumenschine 1995; Marean, Kim 1998; Milo 1998; Domínguez-Rodrigo 1999; Yravedra 2002; Pickering *et al.* 2003). Njegova šibka točka naj bi bila predvsem nezadovoljivo upoštevanje prehrambnih preferenc velikih zveri. Tem naj bi bili namreč z maščobo prepojeni drobci spongiozne kosti ob epifizah bistveno bolj zanimivi od pustih kompaktnih fragmentov diafiz (a glej tudi Stiner 1994; 2002). Čeprav je pri tafonomskih študijah treba upoštevati tudi frekvenco pojavljanja manj kompaktnih (delov) kosti (Rogers 2000), naj bi bilo namreč vlogo človeka in/ali zveri pri akumulaciji kostnih ostankov mogoče primerno osvetliti šele z analizo (fragmentov) diafiz. V to smer kažejo številne aktualistične študije (Blumenschine 1988; 1995; Lupo 1995; Capaldo 1998), pritrdila pa so jim tudi eksperimentalna opazovanja (Marean 1991; Marean, Bertino 1994).[18] Število in mesto pojavljanja urezov, zasekanin, sledi udarcev in odtisov zob na dolgih kosteh je namreč zelo odvisno od tega, ali je imel do plena prvi dostop človek (kar ga načeloma postavlja v vlogo lovca) ali zver (kar človeka potisne kvečjemu v vlogo mrhovinarja). Z vidika obeh (tj. zveri in človeka) je mogoče prehrambno vrednost kosti razdeliti na tri komponente: mehko tkivo okrog kosti

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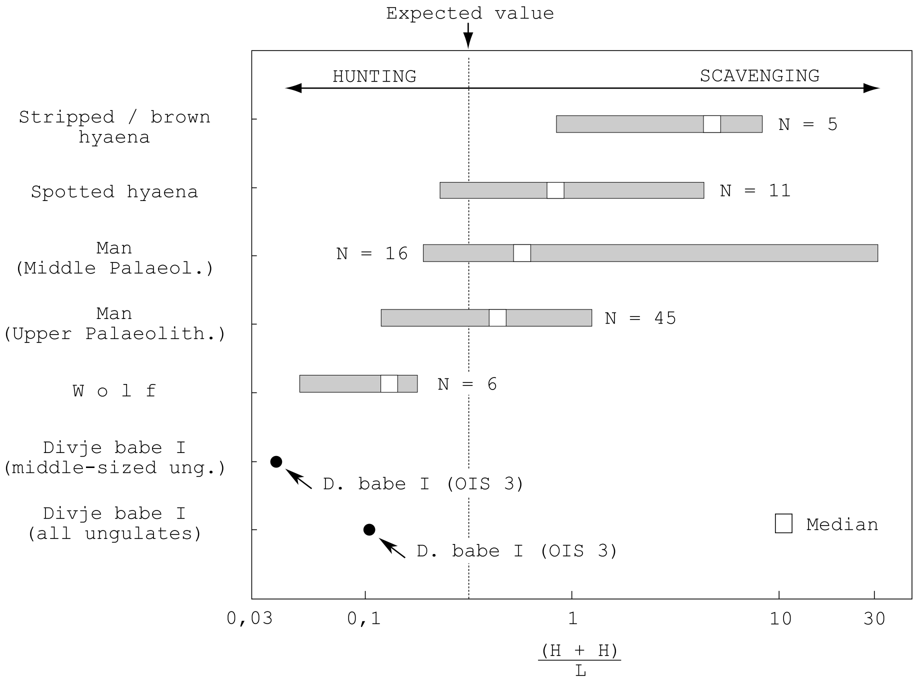
[17] Koeficient korelacije (Spearmanov R) med MNE in strukturno gostoto posameznih kosti ni statistično značilen. Iz navedenega izhaja, da razlike v obstojnosti najdb domnevno niso bistveno vplivale na ugotovljen delež zastopanosti posameznih skeletnih elementov. Podatki o strukturni gostoti kosti se nanašajo na jelena (Lyman 1999).

[18] Večina citiranih aktualističnih in eksperimentalnih študij sicer temelji na opazovanju hijen, vendar pa je predstavljeni vzorec procesiranja plena zelo podoben tudi pri kanidih (prim. Morey, Klippel 1991).



Sl. 11.24: Razpon vrednosti indeksa (H+H)/L za vzorec fosilnih kopitarjev iz Divjih bab I. Kot primerjava so navedeni podatki za tri različne vrste recentnih zveri ter za paleolitskega človeka z več italijanskih najdišč (Stiner 1994). Pričakovana vrednost (= expected value) se nanaša na vrednost indeksa (H+H)/L, kot bi jo pričakovali pri popolni zastopanosti vseh skeletnih elementov plena. Za obrazložitev glej besedilo.

Fig. 11.24: Range of values of index (H+H)/L for sample of fossil ungulates from Divje babe I. As comparison, three different species of recent carnivores and for Palaeolithic man from a number of Italian sites are cited (Stiner 1994). Expected value refers to the value of index (H+H)/L, as would be expected with a complete representation of all skeletal elements of prey. See text for explanation.

(meso, maščoba, kite), mozeg v mozgovnem kanalu (predvsem dolge kosti) in pa maščoba v spongiozni kosti, ki se pri cervidnih/bovidnih dolgih kosteh nahaja predvsem ob obeh epifizah. Ko ljudje in zveri z dolgih kosti uplenjenih oz. naravne smrti poginulih živali trgajo mehko tkivo, puščajo največ sledi (urezi, odtisi zob) na diafizah, saj je tam največ mesa in maščob. Dostop do kostnega mozga si omogočijo z grizenjem oz. strtjem kosti, pri čemer sledi obeh aktivnosti najdemo predvsem na diafizah (hijene; Marean, Kim 1998) oz. epifizah (volkovi; Haynes 1980; 1983). Poudariti velja, da je zanimanje zveri za fragmente diafiz po odstranitvi kostnega mozga praktično nično. Drugače je z epifizami (oz. s spongiozno kostjo tik ob njih), ki imajo zaradi relativno visoke vsebnosti maščobe še vedno precejšnjo prehrambno vrednost. Zveri jih običajno pogoltnejo, v želodcu ekstrahirajo kar največji delež maščobe, preostanek pa izbljuvajo (hijene) oz. izločijo z odvajanjem (kanidi). V nasprotju s tem so srednjepaleolitski ljudje maščobo iz spongiozne kosti domnevno pridobivali s prekuhavanjem (npr. Hanson 1998; a glej tudi Marean, Kim 1998).

Frekvenca in mesto pojavljanja urezov, zasekanin, sledi udarcev in odtisov zob na fosilnih kosteh iz Divjih bab I potrjujeta tezo, da je imel pogosto prav paleolitski človek prvi dostop do poginulih (uplenjenih?) jelenov, gamsov, kozorogov in srn. To kažejo posamezne sledi urezov na diafizah dolgih kosti (*sl. 11.25*), predvsem pa večje število odtisov zverskih zob na epifizah (oz. tik ob njih) kot na diafizah.[19] V nasprotju s tem se glavnina sledi, kakršne Blumenschine s sodelavci (1996), Marean, Kim (1998) ter Milo (1998) povezujejo z aktivnostmi človeka, pojavlja na diafizah. Večina uplenjenih oz. v jami naravno poginulih živali je bila torej domnevno najprej na razpolago človeku. Ta je od kosti odtrgal mehka tkiva (na to kaže prisotnost urezov in odsotnost odtisov zob na diafizah) oz. si je s strtjem kosti omogočil dostop do mozga. Ostanki (tj. fragmenti diafiz, epifize) so z energetskega vidika bistveno manj zanimivi, zato jih človek verjetno ni redno prekuhaval, sežigal ipd. To v primeru Divjih bab I nakazuje že odsotnost ostankov običajnih lovnih vrst v ognjiščih in neposredno ob njih (Paunović *et al.* 2002; glej tudi *tab. 11.15*). Če (ko) je človek kosti zavrgel (oz. ko je zapustil jamo), so se do njih dokopale velike zveri, v Divjih babah I predvsem volkovi. Zanimivi so jim bili z maščobo prepojeni fragmenti spongiozne kosti, o čemer pričajo sledi obgrizovanja na epifizah oz. tik ob njih (*sl. 11.26*). Pri

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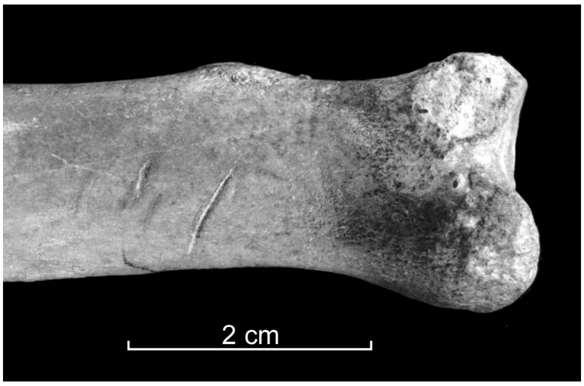
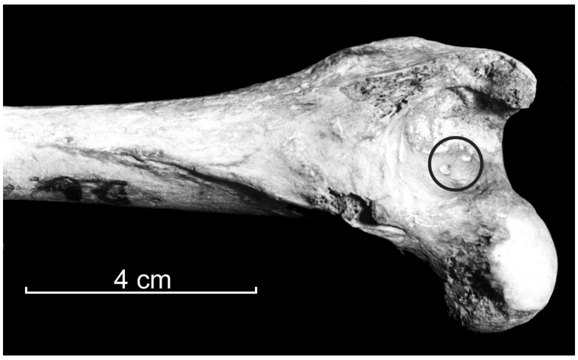
[19] Upošteval sem le gradivo, ki je bilo izkopano po letu 1990; pred tem se namreč sediment še ni rutinsko spiral preko sit, zaradi česar so bili številni manjši fragmenti diafiz med izkopavanji spregledani in zato zavrženi.



Sl. 11.25: Sledi urezov na diafizi volčje koželjnice iz plasti 17 (inv. št. D. b. 174). Fotografija: T. Lauko.
Fig. 11.25: Cut marks on the diaphyis of a wolf's radius from Layer 17 (inv. no. D. b. 174). Photograph T. Lauko.

tem skorajšnja odsotnost podobnih sledi na fragmentiranih diafizah nakazuje, da so večino dolgih kosti verjetno že pred prihodom zveri strli ljudje.

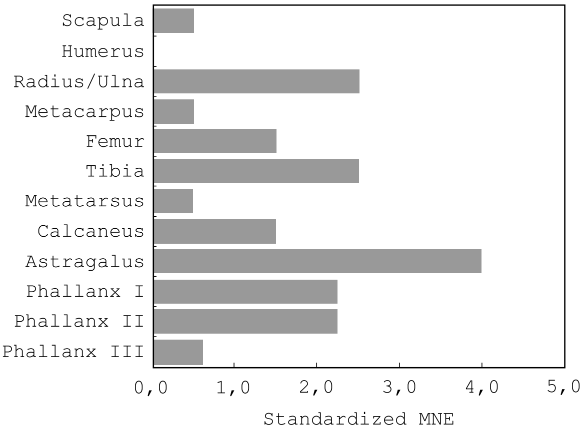
Podoben vrstni red dostopa do (ostankov) uplenjenih/poginulih živali je bil ugotovljen tudi pri analizi številnih drugih paleolitskih najdišč v Evropi (npr. Estévez 1987; Auguste 1995; Blasco 1997; Yravedra 2002), zato sam po sebi ni presenetljiv. Odprto pa ostaja vprašanje, kako močan je bil v Divjih babah I pritisk zveri na odpadke paleolitskega človeka? Po eksperimentalnem razbijanju kosti afriških kopitarjev prvega in drugega velikostnega razreda (*sensu* Bunn 1982), pri čemer so uporabljali izključno kameno orodje, so sledi udarcev zasledili na približno tretjini vseh fragmentov dolgih kosti (Blumenscine 1995). V nadaljevanju so ugotavljali tudi delež ostankov z odtisi zob, potem ko so cele (poskus 1) oz. že zdrobljene dolge kosti brez mozga (poskus 2) nastavili različnim prosto živečim afriškim zverem (večinoma je šlo za lisaste hijene). V prvem poskusu je bil delež obgrizenih kosti pričakovano visok (v povprečju 70,8 %), saj so si hijene z drobljenjem kosti omogočile dostop do mozga. V nasprotju s tem so bili v okviru poskusa 2 odtisi zob opaženi na samo petini vseh ostankov (večinoma na fragmentih spongiozne kosti). Delež obgrizenih kosti kopitarjev iz Divjih bab I je še nižji; to gre do neke mere gotovo pripisati različni intenzivnosti, s katero so hijene in volkovi drobili kosti. Po drugi strani pa lahko glede na pičlo število najdb z odtisi zob sklepamo tudi na razmeroma skromno vlogo volkov (in velikih mačk) kot mrhovinarjev pri ostankih plena paleolitskega človeka oz. v jami naravno poginulih živalih. Nenazadnje bi bilo v nasprotnem primeru med ostanki apendikularnega skeleta kopitarjev pričakovati precej manjši delež skočnic, petnic in drugih kompaktnih kosti od ugotovljenega (*sl. 11.27*); ostanke naštetih skeletnih elementov namreč pogosto v celoti razkrojijo že prebavni sokovi psov (Payne. Munson 1985). Skladna s tem je ugotovitev, da epifize koželjnic (N = 3) in stegnenic (N = 3) kopitarjev v vzorcu iz Divjih bab I niso obgrizene, kar bi bilo ob večjem pritisku volkov na ostanke človekovega plena oz. v jami naravno poginulih živali sicer pričakovano (prim. Haynes 1980).



Sl. 11.26: Sledi obgrizovanja na proksimalnem koncu volčje stegnenice iz sklopa plasti 4-6 (inv. št. D. b. 129). Fotografija: T. Lauko.
Fig. 11.26: Gnawing marks on the proximal end of a wolf's femur from the complex of layers 4-6 (inv. no. D. b. 129). Photograph T. Lauko.

SKLEP

Ker so mali sesalci boljši kazalec nekdanjega okolja od velikih (Andrews 1990), sem v pričujočem prispevku največ pozornosti namenil dejavnikom akumula-



Sl. 11.27: Standardizirane vrednosti najmanjšega števila elementov (*Minimum Number of Elements*; MNE) za posamezne elemente apendikularnega skeleta v vzorcu kopitarjev iz Divjih bab I. Vrednosti MNE so standardizirane po številu pojavljanja posameznega skeletnega elementa v skeletu (Stiner 1994).
Fig. 11.27: Standardized values of the Minimum number of elements (MNE) for individual elements of appendicular skeleton in the sample of ungulates from Divje babe I. MNE values are standardised by the number of appearances of an individual skeletal element in the skeleton (Stiner 1994).

cije sesalskih kosti v Divjih babah I. Za nastanek tafocenoze naj bi bili ob naravno poginulih živalih odgovorni tudi paleolitski človek in zveri. Tako kažejo število in mesto pojavljanja urezov, zasekanin, odtisov zob in sledi udarcev s kamnitim orodjem na dolgih kosteh kopitarjev. Zdi se, da so bila trupla jelenov, gamsov, kozorogov in srn običajno najprej dostopna človeku, njemu nezanimive odpadke (predvsem gre tu za z maščobo prepojene fragmente spongiozne kosti ob epifizah) pa naj bi naknadno uživale še zveri. Malo verjetno je, da bi bili ljudje pri iskanju mrhovine uspešnejši od zveri, zato naj bi glavnina kosti kopitarjev v Divjih babah I predstavljala ostanek človekovega plena. Med dejavnike akumulacije velja kljub temu prištevati tudi velike zveri. V tem smislu je zanimiv podatek, da med najdenimi kočniki volkov, leopardov in jamskih levov močno prevladujejo primerki mladih in subadultnih živali[20] (*sensu* Stiner 1994). Iz tega namreč izhaja, da so imeli v jami občasno svoje brloge tudi volkovi in velike mačke. Glede na njihovo etologijo (Ewer 1973; Domínguez-Rodrigo 1994; Stiner 1994; Blasco 1997) pa to v končni fazi pomeni, da predstavlja vsaj del najdb v jami zelo verjetno ostanek njihovega lastnega plena.

Nobenega dvoma ni, da so ljudje in zveri jamo obiskovali izmenično. Žal razlikovanje med posameznimi obiski ni mogoče, saj je časovna ločljivost vzorca preskromna in se meri v stoletjih. Vertikalna porazdelitev kosti z vidnimi sledmi človekove aktivnosti kaže, da jih večina izvira iz sklopa plasti 2 do 5. Isti sklop plasti izstopa tudi po velikem številu kamenih artefaktov (Turk, Kavur 1997). Vendar pa navedenih podatkov še ni mogoče interpretirati kot kazalec povečane frekvence človekovega obiskovanja jame na račun pogostnosti obiskov velikih zveri. Število najdenih orodij, jeder, odbitkov, razbitin in lusk je namreč največje ravno tam, kjer je največja tudi geometrijska gostota kosti volkov (tj. v plasti 4; Turk, Dirjec 1997b; Turk, Kavur 1997)[21]. Poleg tega je bilo v plasti 4 pobranih kar 122 celih kosti na kubični meter sedimenta (v okviru sklopa plast 2–5 jih je bilo več najdenih le še v plasti 3), kar ob daljšem človekovem bivanju v jami ne bi pričakovali. Da so se ljudje lahko dokopali do mozga, so namreč dolge kosti okončin praviloma intenzivno razbijali. Po drugi strani pa je tudi res, da jame človeku niso vedno služile le kot bivališče ali lovska postojanka, ampak so imele lahko tudi drugačno vlogo (npr. obredni prostor). Morda je bilo tako tudi v Divjih babah I. V tem smislu velja omeniti najdbo domnevne piščali in preluknjane lobanje jamskega medveda (glej podpoglavje 12.4 v tem zborniku) ter najdbe oglja tise, brina in jelše (glej poglavje 8 v tem zborniku), ki jih v drugih paleolitskih najdiščih južno od alpske poledenitve ni (Šercelj, Culiberg 1985).[22] Nenavadna je tudi odsotnost ostankov običajnih lovnih živali v ognjiščih in ob njih (Paunović *et al.* 2002; *tab. 11.15*). Še več: kosti, ki so bile razmetane okoli ognjišč, pripadajo skoraj izključno jamskemu medvedu in so brez vidnih poškodb, ki nastanejo pri razkosavanju plena s kamnitim orodjem. Če Divje babe I paleolitskemu človeku dejansko niso služile (le) za zavetišče ali lovsko postojanko, lahko seveda pričakujem, da je bil pri obdelavi živali v jami specifičen (obreden?) tudi vzorec njihovega razkosavanja in razbijanja kosti. V tem primeru živalski ostanki najverjetneje sploh ne bi predstavljali kuhinjskih odpadkov paleolitskega človeka, to pa bi seveda imelo pomembne implikacije za celovito oceno njegove vloge pri nastajanju preučevane tafocenoze.

ZAHVALA

Zahvaljujem se dr. Ivanu Turku, ki mi je omogočil študij fosilnih ostankov iz Divjih bab I. Članek je v pretežnem delu povzetek lastne doktorske disertacije, zato bi se želel na tem mestu zahvaliti mentorici prof. dr. Vidi Pohar ter članoma komisije prof. dr. Jerneju Pavšiču in prof. dr. Borisu Bulogu. Podiplomsko usposabljanje je financiralo Ministrstvo za šolstvo, znanost in šport. Za spodbudne razprave, ki so spremljale celoten potek raziskave, sem hvaležen dr. Ivanu Turku in Janezu Dirjecu. Zahvaljujem se tudi dr. J. Radovčiću in dr. P. Wojtalu za pomoč pri determinaciji tretje prstnice mamuta/nosoroga ter Mihi Kroflu za nasvete pri determinaciji velikih mačk. Za omogočen dostop do primerjalne osteološke zbirke sem hvaležen kolegom z Zavoda za geologijo in paleontologijo kvartarja iz Zagreba, za fotografije Tomažu Lauku, za tehnično pomoč pri oblikovanju slikovnega gradiva pa Dragu Valohu.

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[20] Od skupno 16 kočnikov omenjenih treh vrst jih je mladim ali subadultnim primerkom pripadalo kar 12 (Toškan 2004).

[21] Plasti 10–13, v katerih je druga največja gostota volka, so bile v podrobno obravnavanem osrednjem delu jame skoraj brez paleolitskih najdb, pač pa jih je bilo absolutno največ pri jamskem vhodu.

[22] Edino izjemo predstavlja primerek oglja brina (*Juniperus* sp.) iz Parske golobine pri Pivki (Šercelj, Culiberg 1985).

11. REMAINS OF LARGE MAMMALS FROM DIVJE BABE I STRATIGRAPHY, TAXONOMY AND BIOMETRY

BORUT TOŠKAN

Abstract

In the Upper Pleistocene (OIS 3 and OIS 5) layers of the Palaeolithic cave site Divje babe I, in addition to finds of cave bear, a further 995 remains of large mammals from at least 20 different species were found: *Lepus timidus* seu *europaeus*, *Marmota marmota*, *Ursus arctos*, *Canis lupus*, *Vulpes vulpes*, *Alopex lagopus*, *Mustela putorius*, *Martes martes*, *Lutra lutra*, *Felis silvestris*, *Lynx lynx*, *Panthera pardus*, *Panthera spelaea*, *Sus scrofa*, *Cervus elaphus*, *Alces alces*, *Capreolus capreolus*, *Rupicapra rupicapra*, *Capra ibex* and *Mammuthus primigenius* seu *Dicerorhinus* seu *Coleodonta*. The number and place of appearance of cutmarks, carnivore tooth marks and hammerstone percussion marks on the long bones of ungulates show that both Palaeolithic man and carnivores contributed to the accumulation of the taphocenosis in the cave. It appears that man typically had first access to carcasses of large herbivores (red deer, chamois, ibex, roe deer), while carnivore access was largely restricted to scavenging of hominid-butchered fare, specifically grease from hammerstone-generated (near-) epiphyseal fragments. It is very unlikely that people would be more successful than wolf, bear, cave lion, leopard and lynx in seeking carrion, so the bulk of the bones of ungulates in Divje babe I presumably represent the remains of human prey.

Many remains of large mammals were collected during the extensive period of excavation of the Divje babe I site (western Slovenia, 450 m asl). As expected (Miracle 1991) the large majority of them belong to cave bear (*Ursus spelaeus*) and these have already been the subject of a number of preliminary studies (e.g., Turk *et al.* 1988–1989; 1990; 1992; Turk, Dirjec 1989; 1991; Debeljak 1996; 2002a). Little attention, however, has been devoted to date to the finds of other large mammals (see, e.g., Turk, Dirjec 1997b). I thus provide below a taxonomic review of the mammal macrofauna, followed by findings concerning the characteristics of the palaeoenvironment and the role of man vs. carnivores in the accumulation of the studied taphocenosis.

METHODS

The material in question was collected in two successive phases of excavations, in which different field-work techniques and methods were used. In the first period (i.e., between 1980 and 1986) the eastern part of the cave was investigated in a conventional manner, during which the sediments were not rinsed through a sieve. Individual finds were documented vertically by layers, which were followed between approximately meter distant neighbouring profiles. From the start of the second phase of excavations (period between 1989 and 1999), when the central and inner parts of the cave were excavated, the methodology essentially changed. From then on, the basic sample was a 1 x 1 m square with a depth of 12 cm. From 1990 onwards, all excavated sediments were rinsed and examined on sieves with 10 mm, 3 mm and 0.5 mm mesh. More detailed data on the site and field-work methodology is given by Turk (Chapter 1 in this volume). The oldest excavated layers (i.e., layers 21–26) are presumed to have been deposited in the Riss-Würm Interglacial (OIS 5e), layers 12–20 in the Early Glacial (OIS 5a-5d), the majority of the remainder (layers 2–11) in the Interpleniglacial or Middle Würm (OIS 3); Layer 1 is of Holocene origin (OIS 1). The age of the oldest studied sediments is believed to be more than 115,000 years, and those from Layer 2 approximately 40,000 years (Turk *et al.* 2001a; Chapter 1 in this volume).

I was assisted in identification by fossil and recent material from Slovenia (collection of the Institute of Archaeology ZRC SAZU and the Department of Palaeontology NTF, University of Ljubljana) and Croatia (collection of the Institute of Quaternary Palaeontology and Geology, Zagreb). In terms of systematic classification, I used the system given by Guérin, Patou-Mathis (1996). Age structures were assessed by tooth-wear analyses. Measurements were taken according to Torres (1988; for bear skull) and Von Driesch (1976; other skeletal elements); metric data are given in *Annex 11.1*. In looking for cutmarks, chopmarks, percussion marks and tooth marks, a stereomicroscope (15x magnification) with a strong light source was used (see Blumenschine *et al.* 1996).

The analysis of abundance uses the number of identified specimens (NISP), since the overall number of finds was relatively modest. Teeth embedded in jawbones were treated as isolated (e.g., a mandible with preserved M_1 would be treated as NISP = 2). By doing so, I tried to minimize the disturbing influence of differential taphonomic loss and fragmentation in various periods of the Würm. The analysis of anatomical part representation uses the minimum number of skeletal element counts (MNE), based on bone material, not teeth. In this study, bone MNE is derived from the most common portion of each skeletal element and represents the sum of right and left sides for elements that naturally occur in pairs (Stiner 1994).

Non-parametric tests were used in statistical processing (e.g., Spearman rank R, χ^2-test, Mann-Whitney U test; StatSoft, Inc. 2001), since the distribution of the analysed metric data generally deviates from normal. Statistical processing was done with the programme package STATISTICA for Windows, version 6.0 (StatSoft, 2001).

All the bone finds from Divje babe I are stored in the National Museum of Slovenia in Ljubljana.

TAXONOMY

In addition to finds of cave bear, it was possible to identify a further 995 remains of large mammals, which were ascribed to 20 species from 10 families (*Fig 11.1*). The majority of species (i.e. 15) still inhabit Slovenia today, although some only because of reintroduction after previous local extinction (e.g., *Capra ibex*, *Lynx lynx*, *Marmota marmota*). Of the total of five species no longer present in Slovenia today, two became extinct at the end of the Pleistocene (*Mammuthus primigenius* (?) and *Panthera spelea*). The remaining three (*Alces alces*, *Alopex lagopus* and *Panthera pardus*) withdrew elsewhere.

Order: hares, rabbits and pikas (Lagomorpha)
Family: hares and rabbits (Leporidae)

Lepus timidus/europaeus

Material: group of layers 2–5: ulna, vertebra lumbalis, ossa coxae (2x);[1] Layer 6: dens; Layer 8: phalanges (2x); Layer 13: humerus; Layer 2–11/12: astragalus; layers 12–22: metapodium.

Distinguishing between European hare (*Lepus europaeus* Pallas, 1778) and mountain hare (*Lepus timidus* Linnaeus, 1758) is difficult. Right upper incisors are thought to allow reliable specific identification (Rakovec 1961; Malez 1963; Kryštufek 1991), but there are none in the Divje babe I sample. It should also be possible to differentiate between the two species on the basis of the degree of development of the posterior-lingual enamel ridge of the second upper premolars (Chaline 1966), but the only available P^2 from Divje babe I is damaged in this part. Metric data are not of great help either, since both available long bones are fragmented. The greatest breadth of the distal epiphysis of the humerus from Layer 13 (inv. No. D. b. 1303) is 12 mm. This value lies within the range seen in recent European hare from the former Soviet Union (range: 7.5-15 mm; N is not stated; Gromova 1950) but, at the same time, it does not differ from fossil specimens of mountain hare from southern Moravia (range: 11–13 mm; N = 22; Rakovec 1959).

Finds of the genus *Lepus* from Divje babe I originate from layers 2–13, which are thought to have been deposited in OIS 3. The climate at that time was cold and, as such, more suitable for mountain hare. Today, the area of distribution of this species is mostly covered by tundra and taiga[2] (Lequatre 1994), while European hare prefers arable land, meadows and pastures (Kryštufek 1991). Furthermore, while *L. timidus* seems to have been generally widespread in Slovenia during the Upper Pleistocene (Rakovec 1959; 1961; 1962-63; 1973; Osole 1976), fossil remains of *L. europaeus* are only known from Potočka zijalka (Brodar, S. in M. 1983).

Order: Rodents (Rodentia)
Družina: Squirrels (Sciuridae)

Marmota marmota (Linnaeus, 1758)

Material: Alpine marmot is represented in the sample from Divje babe I with 234 remains. The complete list of finds by layers and skeletal elements is given in *Annex 11.2A*.

Two allopatric species of marmot inhabited Europe in the Würm: alpine marmot and steppe marmot (*M. bobac* Müller, 1776). On the basis of the number of roots of the fourth lower premolars and the colour of incisors, the specimens from Divje babe I were ascribed to *M. marmota* (Rakovec 1935; Chaline 1966). All the available P_4, namely, have three roots (and not two, as in the case of *M. bobac*), and the incisors are also intensive orange (in the case of steppe marmot they are appreciably lighter). The same species (i.e. *M. marmota*) have also been ascribed to finds of marmot from other Palaeolithic sites of Slovenia, Northeast Italy, Southeast Austria, Western Hungary, Croatia and Bosnia and Herzegovina (Rakovec 1973; Jánossy 1986; Malez 1986a; Bon *et al.* 1991; Fladerer 2000; Toškan 2004).

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[1] The lumbar vertebra and both fragments of pelvis (one left, one right) come from the same quadrat and cut so they are probably the remains of the same animal.

[2] In the Alps *L. timidus* inhabits mountain pastures, dwarf pine scrub and high moorland (Kryštufek 1991).

Recent alpine marmots inhabit open mountain grasslands. They dig tunnels in which they sleep, overwinter and hide from predators. They can only therefore settle where the soil is at least three metres deep or there is at least as much alluvium (Kryštufek 1991). As is evident from *Table 11.14*, finds of marmot in Divje babe I are most numerous in layers 2-5.[3] It is known that recent marmots sometimes seek shelter in rocky cracks and underground cavities (Turk *et al.* 1996); this is not least demonstrated by the fossil tunnels in some Upper Pleistocene cave sites (e.g., Pohar 1989; Pohar, Brodar 2000). It is also known that a relatively large number of animals die during the five to six month hibernation (Kryštufek 1991). However, since the majority of marmot remains from Divje babe I originate from the upper one metre of sediment (i.e., layers 2–5), they probably represent human and/or small carnivore food waste. Winter hibernation tunnels of recent alpine marmot, namely, go at least 2 to 3 metres deep (Vidic 1994), which is deeper than Layer 5 in Divje babe I.[4]

Order: Carnivores (Carnivora)

Carnivores are represented in the sample from Divje babe I by 12 species from four families. Fourteen remains (mainly phalanges, incisors, carpal and tarsal bones) could only be identified on the level of order. The remaining finds are presented in more detail below.

Family: Bears (Ursidae)

Ursus spelaeus Rosenmüller, 1794

The remains of cave bear in Divje babe I represent by far the largest share of finds of large mammals (>99 % NISP), so they are dealt with separately in the volume (see Chapters 12, 15–18 in this volume).

Ursus arctos Linnaeus, 1758

Material: Brown bear is represented in the sample from Divje babe I with 192 remains. The complete list of finds by layers and skeletal parts is given in *Annex 11.2B*.

Fossil finds of brown bear normally occur together with finds of cave bear, although usually in smaller numbers. The disproportion in numbers of the two species is probably a result of the lesser dependence of brown bear on hibernation in caves (Couturier 1954; Argant 1996a). The genus *Ursus* displays great morphological variability (Kryštufek 1991), which often makes specific identification problematic. Roughly one third of a total of 192 bear bones and teeth from Divje babe I could only therefore be ascribed to *U. arctos* provisionally. The majority are isolated premolars, which appear only exceptionally with *U. spelaeus* (Ewer 1973; Torres 1988). Identification of the remaining check-teeth is less problematic, since differences between the two species are greater in the case of molars (*Table 11.1*).

The find of a skull from Layer 6 is interesting (inv. No. D.b. 1606a), since it is almost undamaged (see Chapter 15 in this volume, *Fig. 15.4b*). In terms of size, it somewhat exceeds Upper Pleistocene specimens from the Iberian Peninsula (*Annex 11.1C*; see Torres 1988). The lower jaw from Layer 14 (inv. No. D.b.532) deserves special attention. It is a damaged specimen, of which only the *corpus mandibulae* with its alveolar part is preserved. The teeth are missing but, on the basis of the alveoli, the canines and third lower molar already had formed roots. Morphologically, the mandible is between brown and cave bear (*Fig. 11.2*). It is linked to the latter by the convex lower edge and labial wall of the *corpus mandibulae* and by the absence of alveoli of the first premolar. On the other hand, the slender distal part of the *corpus mandibulae*, which is connected to the relatively gracile canines, links the specimen in question to brown bear (Torres 1988; Capasso Barbato *et al.* 1990). The length of the cheek-teeth row (P_4–M_3; measured along the alveoli) is 97.3 mm, which lies within the range of *U. spelaeus* from Mokroška jama in the Savinja Alps (Rakovec 1967).

The oldest remains of brown bear known so far in Slovenia are from Jama pod Herkovimi pečmi on Kozjak (Würm I; Pohar 1981), the species being also represented in the fauna of numerous other Upper Pleistocene sites in the region (Toškan 2004). Taking into account available ESR dates (Turk *et al.* 2001a; Chapter 6 in this volume) the specimens from the deepest layers of Divje babe I could be classified alongside those from Jama pod Herkovimi pečmi as the oldest remains of brown bear known to date in Slovenia.

Family: Dogs (Canidae)

Canis lupus Linnaeus, 1758

Material: Wolf is represented in the sample from Divje babe I by 167 specimens. The complete list of finds by layers and skeletal parts is given in *Annex 11.2C*.

Wolf is represented in the fauna of the majority of Slovene Palaeolithic sites (Toškan 2004), although generally only with a modest number of remains. This is not so in the case of Divje babe I, since in terms of the number of finds, it is behind only bear and marmot.

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[3] Layer 2 deposited before the deep freezing of the soil in the parts behind the cave entrance (*cf.* Turk 1997), i.e. when digging tunnels in the cave would still be possible.

[4] In view of the ethology of recent alpine marmot and the geological composition of the group of layers 2–5 there seems little possibility of winter tunnels being shallower in the cave than those in the open (F. Frey-Roos, oral communication).

Identification was not problematic, with the exception of a few smaller and fairly fragmented remains, mainly phalanges (even these, however, show typical canide morphology). In this sense it is worth mentioning the canines from layers 5-6 (inv. No. D. b. 95; *Fig. 11.3*) and 17a (inv. no. D. b. 476). Although the teeth do not differ morphologically from those of wolf, in terms of size[5] both lie within the range of fossil dhole (*Cuon alpinus* [Thenius 1954]). The latter species is represented in Mousterian layers of Apnarjeva jama by Celje (Malez, Turk 1991) and in a number of Upper Pleistocene sites in Austria, Hungary and Croatia (Malez 1965; 1986a; Mottl 1975; Jánossy 1986).

The size of wolves in Western Europe increased relatively uniformly from the end of the last glacial (= Riss) right up to the onset of the Holocene (Crégut-Bonnoure 1996a). Whether a similar trend can be expected for the area south of the Alpine glaciation is impossible to say only on the basis of the finds from Divje babe I. From the small amount of available metric data, it can be only concluded that the remains in question here lie within the range of fossil *C. lupus* from Central Europe (*Fig. 11.4*). Fossil wolves from Divje babe I, however, exceed recent specimens from the area of the former Soviet Union (Gromova 1950; 1960).

Vulpes vulpes (Linnaeus, 1758)

Material:complex of layers 2–5: dentes (C_1 in M_1); Layer 16: dens (P_2), ulna; unknown layer: mandibula.

Red fox is represented in the sample from Divje babe I with a modest number of remains, which is actually characteristic for the majority of contemporary sites in the region (Toškan 2004). Because distinguishing between red and arctic fox (*Alopex lagopus*) is difficult only on the basis of isolated teeth (Rakovec 1959; Poplin 1976; Altuna 2004), I relied mainly on metric data in the identification (*Table 11.2*). Specific identification of some finds nevertheless remains tentative, since *V. vulpes* shows great variability in the size of individual skeletal elements (Kryštufek 1991; Crégut-Bonnoure 1996a). Because of the incomplete state of preservation, the identification of both teeth from the layers 2–5 is also to some extent questionable. The first lower molar (inv. No. D. b. 1462) was ascribed to *V. vulpes,* despite the fact that in relation to its length, it lies within (at the upper limit of) the range for fossil and recent arctic fox from Europe (Poplin 1976). Namely, because of the fragmentation of the mesial part, the greatest length of the tooth could not be measured (the obtained measurement represents only its slightly underestimated approximation). Similar applies to the canine from the same complex of layers (inv. No. D. b. 458), which already has a slightly worn tip of the crown.

Identification of the ulna and mandible is less problematic. In the case of *V. vulpes,* the *foramen mentale* lies on the mandible below the first lower premolar (which also applies to the specimen from Divje babe I), while with *A. lagopus* it is located slightly posteriorly, i.e., below the second premolar (Poplin 1976). What about the ulna from Layer 16 (inv. No. D. b. 457)? Because of smaller prominences for tendon/muscule attachments (see Malez 1963) and the saddle like depression between the *olecranon* and the posterior part of the *processus olecrani* (see Beneš 1975) it was ascribed to red fox (*Fig. 11.5a*). Such a determination is confirmed by the size of the bone (*Table 11.3*).

Alopex lagopus (Linnaeus, 1758)

Material: Layer 6-7: dens (C_1); Layer 8: mandibula, dentes (I_3, P_2, P_4), vertebrae (3x), ulna, metacarpus, phalanx II (2x), ossa coxae, calcaneus.

Arctic fox is represented in the sample by 14 finds. With the exception of the calcaneus, all remains from Layer 8 were found close together, so there are probably good grounds for ascribing them to the same individual. The identification of the mandible (inv. No. D.b. 2039) is based on the position of the *foramen mentale* (*Fig. 11.6*), the relatively small curved basal edge of the *corpus mandibulae* and the size itself of the specimen (Poplin 1976; Argant 1991). The identification of the ulna (inv. No. D. b. 2040; *Fig. 11.5b*) is similarly not in question, since it does not even achieve the dimensions of recent arctic fox (*Table 11.3*). The size of the premolars is also modest (length P_2: 8.0 mm), so they were ascribed to a relatively small specimen (female?) of *A. lagopus*.

Identification of the canines from Layer 6-7 and the calcaneus from Layer 8 is based exclusively on their size. The calcaneus from Layer 8, namely, lies within the range of recent and fossil *A. lagopus* (maximum length: 27 mm, maximum width: 11.0 mm), and the canine does not even achieve the values of recent arctic foxes in the height of the crown on the buccal side (= 11.5 mm) (see Gromova 1960; Castaños 1987; Altuna 2004).

Arctic fox appears sporadically within the context of European Upper Pleistocene sites. Its remains only become rather more numerous in sediments deposited in OIS 2 (Kurtén 1968). In contrast to the ubiquitous red fox, *A. lagopus* is closely bound to an environment with a cold climate and today inhabits areas of tundra with arctic islands (Pulliainen 1999). In the coldest periods of the Würm, its area of distribution also included the Iberian Peninsula (Altuna 2004), southern France (Bonifay 1971), Italy (Bartolomei *et al.* 1992), Croatia

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[5] Dimensions: labial-lingual breadth: 10.2 and 12.5 mm; anterior-posterior breadth: 6.5 and 7.8 mm.

(Malez 1963), Hungary (Jánossy 1986) and even Bulgaria (Wiszniowska 1982). Finds from Layer 8 of Divje babe I are dated to the period between 60,000 and 50,000 BP (Turk *et al.* 2001a; Chapters 6 and 7 in this volume), so that to date they represent the geologically oldest evidence of the presence of *A. lagopus* in Slovenia. Together with those from Betalov spodmol by Postojna (Würm II+III; Rakovec 1959), they are also the only ones that do not originate from OIS 2 (Toškan 2004).

Vulpes vulpes seu *Alopex lagopus*

Material: Layer 5: phalanx II; Layer 8: dens (I^3); Layer 12/13: phalanx I; Layer 16: dens (I^3).

Four finds of fox from Divje babe I did not allow for their determination to the level of species, although they do not deviate morphologically from corresponding elements of common fox (comparable material for arctic fox was not available to me). The phalanges are too fragmented to be measured.

Family: Mustelids (Mustelidae)

Mustela putorius Linnaeus, 1758

Material: Western polecat is represented in the sample from Divje babe I with 50 remains. The full list of finds by layers and skeletal elements is given in *Annex 11.2D.*

With the exception of the canine and the metapodial, all remains from layers 2–5 probably belonged to the same individual, since they were found close together. I relied in identification mainly on the three mandibles, since distinguishing between western and steppe polecat (*Mustela eversmanni* [Lesson, 1827]) on the basis of post-cranial skeletal elements is problematic (Crégut-Bonnoure 1996b). Western polecat is best distinguished from its steppe relative by the height of the mandible between the last premolar and the first molar (Koby 1951). While the stated dimension with western polecat is always smaller than 8 mm, with recent steppe polecats it ranges between 8.4 and 9.3 mm (*Table 11.4*). It should not be overlooked that recent polecats are very variable in size. Even dwarf and giant specimens can be found, which are presumed to be a result of more or less favourable conditions in the period of fast physical growth (Buchalczyk, Ruprecht 1977). Precisely because of the aforementioned, I ascribed the lower mandible from Layer 8 (inv. No. D. b. 2510) to *M. putorius,* even though its height exceeds 8 mm. Not least, the specimens in question do not deviate in any other dimension from fossil and recent western polecat (*Table 11.4*), and there are clear similarities on the morphological level. So the *fossa masseterica*, which with steppe polecat should reach anteriorly all the way to an imaginary point below the centre of the first molar (Pohar 1981), already ends in the specimen in question below the second molar (*Fig. 11.7c*). Moreover, with steppe polecat there is a bulge on the basal edge of the *corpus mandibulae* below the fourth premolar and the first molar (Crégut-Bonnoure 1996b). Such a bulge is not visible in the case of the mandible from Layer 8 or it is at least not more accentuated than with typical specimens of western polecat.

The only find of *M. eversmanni* in Slovenia is known from the end of the Riss-Würm Interglacial (Jama pod Herkovimi pečmi; Pohar 1981), but it is also represented in the fauna of a number of contemporary sites in the western part of the Pannonian basin (Malez 1963; 1979; Jánossy 1986). Today, steppe polecat inhabits semi-desert and forest/grassland steppe in areas with cold winters and warm to hot summers (Wolsan 1999). However, the disputed polecat mandible from Divje babe I (inv. No. D. b. 2510) originates from Layer 8, which deposited in a period of a relatively humid climate (Šercelj, Culiberg 1991; Turk, Bastiani 2000; Turk *et al.* 2002b; Chapter 10 in this volume). The then environment thus seems to have been more in accord with the needs of western polecat, which today mainly inhabits lowlands and river valleys, withdrawing from (artificially) drained land (Kryštufek 1991).

Martes cf. *martes* (Linnaeus, 1758)

Material: Pine marten is represented in the sample from Divje babe I by 139 remains. The full list of finds by layers and skeletal elements is given in *Annex 11.2E.*

Taxonomically relevant morphological differences between pine marten and beech marten (*M. foina* [Erxleben, 1777]) are limited to a few details on the skull, mandible and teeth. Because of this, and the great variability occurring in the size of the two species, specific identification of fossil remains of the genus *Martes* is in general fairly difficult (Bonifay 1971; Castaños 1987). So of all the 139 bones and teeth of martens from Divje babe I, only 27 could be identified with certainty in terms of species (i.e., 5 first upper and 7 first lower molars, 14 mandibles and a fragment of skull). All were ascribed to pine marten. The most reliable taxonomic sign with mandibles is the distance between the *foramen mentale*; with beech marten this does not generally exceed 3 mm, but with pine marten always exceeds 4 mm (Kryštufek 1991; *Table 11.5*). Furthermore, the lingual edge of the first lower molar with *M. foina* has a clear notch in the middle, while with *M. martes* M_1 is only slightly concave at this point (Kryštufek 1991; *Fig. 11.8*). The two species can also be distinguished by the shape of the first upper molar. In beech marten, this has a poorly developed inner lobus, so that the length of the tooth in the sagital plane is a great deal shorter than its width; in pine marten the length of the tooth in the sagital plane is almost the same as the width (Pucek 1981). The only fragment of skull was ascribed to *M. martes* because of the location of the *foramen jugale*: the difference between them in pine marten is less than the length of the *bulla tympanica*, while in beech marten it is greater (Pucek 1981).

Together with the first upper/lower molars, mandibles and the skull fragment, all the other fossil remains of the genus *Martes* from Divje babe I probably also belong to pine marten. As Crégut-Bonnoure (1996b) states, pine marten was probably the only representatives of martens in Europe during the Upper Pleistocene, since beech marten only appeared in the Holocene (but see also Malez 1963; Castaños 1987; Bon *et al.* 1991). Argant (1991) advocates the same opinion for Western Europe and Wolsan (1993) for Central. Beech marten is only known in the fauna of Palaeolithic sites in Slovenia from Potočka zijalka in the Savinja Alps, but the stratigraphic context of the find is problematic (Döppes 2004). Pine marten is known from a number of Upper Pleistocene sites in Slovenia (Toškan 2004).

Lutra lutra (Linnaeus, 1758)

Material: complex of layers 2-5: dens (C_1).

The otter from Divje babe I (inv. No. D. b. 1354) is the first known find of this species from any of the Slovene Upper Pleistocene sites. The species is known from Early Holocene layers of Breg by Ljubljana (Pohar 1984), Pod Črmukljo by Šembije (Pohar 1986) and Viktorjev spodmol by Famlje (Toškan, Dirjec 2004a) and from Upper Pleistocene sites of neighbouring Croatia (Malez 1986b), Hungary (Jánossy 1986) and NE Italy (Bon *et al.* 1991).

The identification of the C_1 from the layers 2-5 is mainly based on its morphology, since in terms of size canines of otter do not essentially differ from the canines of badger (*Meles meles* [Linnaeus, 1758]), whose remains are well known from several Upper Pleistocene sites in the region (Rakovec 1973). The specimen was thus identified as otter because the lower canine in badger has a strongly expressed edge on the mesio-lingual side: this stretches from the base of the crown almost to its tip. In contrast, the C_1 of otter has only a smallish ridge in this part, which is limited to the basal part of the tooth crown (*Fig. 11.9*). In addition, the canine in question is also clearly smaller than the C_1 of fossil badgers (*Table 11.6*).

One further canine was found in scattered sediment from Divje babe I, which could provisionally be ascribed to *L. lutra*. Unfortunately, the crown is damaged in the mesial part, its tip being worn. In view of the morphology of the preserved part, it could also be ascribed to badger but in terms of size it is closer to otter (*Table 11.6*).

Family: Cats (Felidae)

Felis silvestris Schreber, 1777

Material: Layer 8: mandibula, dens (P^4).

Both finds of wildcat from Divje babe I probably belong to the same animal, since they come from the same sample (i.e. quadrat/cut). Only the *processus coronoideus* with the *caput mandibulae* is preserved of the mandible and the P^4 lack the base of all three roots. The preserved parts of the roots, as well as the crown, are hollow. In domestic cat, a permanent fourth upper premolar erupts at the age of four to five months (Silver 1972). Because the specimen from Divje babe I already shows slight traces of wear, it probably belongs to a juvenile (although more than a year old) animal.

Lynx lynx (Linnaeus, 1758)

Material: complex of layers 2-5: dens (M_1); Layer 6: dens (P_4); Layer 2-11/12: dens (M_1).

The genus *Lynx* is represented in Divje babe I by 3 isolated teeth. The paraconid on P_4 (inv. No. D. b. 2072) is present and well developed. The same applies to the hypoconid and basal cingulum on the posterior part of the crown. Ascription of the specimen to the genus *Lynx*, therefore, does not seem questionable, despite the additional parastilid posterior to the hypoconid (*Fig. 11.10a).*

Specific identification of the finds under discussion is more problematic than the generic. In addition to the Eurasian or northern lynx, namely, Iberian lynx (*Lynx pardinus* [Temminck, 1827]) is also known from the Upper Pleistocene in Europe, and the differences in morphology and size of skeletal elements between the two species are minimal. The greatest length of the fourth lower molar from Divje babe I is of only limited taxonomic value eventhough it lies within the range seen in recent specimens of Eurasian lynx from northern Europe, thus exceeding the size of P_4 in fossil Iberian lynx from Spain (*Table 11.7*). Metric data of teeth, in fact, are not considered a reliable taxonomic sign (Argant 1996b). *Lynx lynx* is represented in the fossil fauna of three sites in Slovenia (Pavšič, Turk 1989; Dirjec, Turk 1992; Pohar, Brodar 2000), while there is no evidence of the presence of the Iberian lynx.[6] The latter is also missing in the Upper Pleistocene fauna of NE Italy, SE Austria and Hungary (Jánossy 1986; Rustioni *et al.* 1995; Fladerer 2000), and appears in Croatia only from Veternica cave in Medvednica (Malez 1963). Because of this, the fourth lower premo-

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[6] Rakovec (1961) ascribed three canines from Parska golobina in Pivška kotlina to *L. pardinus*, but later revision indicated such an identification as being erroneous (Krofel *et al.* 2005).

lar from Layer 6 of Divje babe I was provisionally ascribed to Eurasian lynx.

I also ascribed to the same species the first lower molar from the Interpleniglacial group of layers 2–11/12 (inv. No. D. b. 70). In Iberian lynx, namely, M_1 does not have developed metaconids and basal *cingulum* in the posterior part (Bonifay 1966; 1971; Castaños 1987), while both are present in the specimen from Divje babe I (*Fig. 11.10b*). The first lower molar from the group of layers 2–11/12 also stands out by the extended talonid, which the Iberian lynx does not have (Argant 1996b). Precisely because of the above-average extension of the metaconid-talonid, the M_1 from Divje babe I lies within the range seen in recent Eurasian lynxes from northern Europe only in the dimensions that do not relate to the extreme distal edge of the tooth (i.e., the greatest breadth of the crown and length of the paraconid; *Table 11.7*).

Identification of the first lower molar from layers 2–5 (D. b. I, kv. 41c/2) is more problematic, since only part of the tooth crown is preserved. On the basis of the size of the preserved fragment and the angle between the posterior ridge of the paraconid and mesial ridge of the protoconid, this specimen was also ascribed to the genus *Lynx*.

Panthera pardus (Linnaeus, 1758)

Material: complex of layers 2–5: dens (M_1), vertebra, os carpale, phalanx II (3x), phalanx III; unknown layer: phalanx III.

Leopard is represented in the fossil fauna of Divje babe I with eight finds, which are all of Interpleniglacial (= OIS 3) age. The tail vertebra, the wrist bone and one each second and third phallanx probably belong to a single individual, since they were found close together. Morphologically they correspond in entirety with the relevant skeletal elements of recent and fossil leopards, so that their identification was not problematic (*Fig. 11.11*). The same applies to the remaining phalanges from the same complex of layers, which also correspond in terms of size with fossil specimens of *P. pardus* (*Fig. 11.12*).

The first lower molar from layers 2–5 (inv. No. D. b. 646) is damaged; only the paraconid and part of the mesial root have been preserved. Nevertheless, in terms of the greatest length of the paraconid, the specimen under discussion lies within the range seen in recent leopard from Africa and Asia and, at the same time, deviates from the data for recent lynx from Northern Europe and Russia (*Table 11.8*).

Panthera spelaea Goldfuss, 1810

Material: complex of layers 2–5: dentes (dP_3, dP_4, P^4); Layer 6-7: phalanx II (?); Layer 7: phalanx III, vertebra; Layer 8: dentes (dP_3, M_1), vertebra; Layer 17a: dens (P_4), vertebra, phalanx III; Layer 21: vertebra; complex of layers 12/13–22: metatarsus III, astragalus, phalanx II, phalanx III; unknown layer: fibula.

Cave lion is represented with 18 remains, of which 6 were teeth. In the morphological sense, the finds are typically feline, but with the specific identification I relied on metric data (*Table 11.9* and *Table 11.10*). In terms of size, cave lion significantly exceeds members of other large cats which inhabited the Central Europe during the Upper Pleistocene. Only the identification of the second phallanx from Layer 6-7 (inv. No. D. b. 1783; *Fig. 11.13a*) is slightly problematic. The specimen is extremely short and robust, thus differing from cave lion from several European sites (*Table 11.10*) both in its greatest length (= 33.0 mm) and in the breadth of the distal epiphysis (= 26.0 mm).

Metric analyses of *P. spelaea* teeth from several European sites highlighted considerable differences between individual allopatric populations. Turner (1984) explained the heterogeneity (mainly) by sexual dimorphism, but Schütt, Hemmer (1978) ascribed it to isolation because of re-glaciation during the Würm. Cave lions from the eastern Alpine area are thought by them to have represented a separate branch in the development of the species. They are said to have differed from those of neighbouring populations mainly in terms of greater weight and relatively wider premolars and molars. However, in these terms, both undamaged molars from Divje babe I are closer to specimens from sites in NW Croatia, which Gužvica (1998) links with the western European line of cave lion. This is evident with the first lower molar (inv. No. D. b. 1864; *Fig. 11.13b*) from the thickened edge of the base of the crown, the accentuate *cingulum* on the lingual side and the ratio between the greatest breadth and length of the tooth (this amounts to barely 0.505). Similar applies to the fourth upper premolar (inv. No. D. b. 728), in which the ratio between the length of the tooth to the deuterocone and its greatest length is only 0.919 (see Gužvica 1998).

The construction of a reliable age structure for cave lions from Divje babe I is prevented by the modest number of finds (see Lyman 1987), but it is nevertheless worth drawing attention to the same number of permanent and deciduous teeth. Identification of the latter is based on their morphological characteristics. The deciduous P_3 (inv. No. D. b. 631; *Fig. 11.13c*), with a pair of relatively strong, clearly obliquely growing roots, differs significantly from the permanent P_3 of the same species (Smuts *et al.* 1978). Obliquely growing roots, of which the mesial is essentially stronger than the distal, are also characteristic of the deciduous fourth lower molar (inv. No. D. b. 1355; *Fig. 11.13d*); although this already has a completely molariform shape of the crown. Morphologically, the aforementioned tooth could also correspond to the deciduous P_4 of leopard. However, the greatest length of the tooth from Divje babe I is approximately 18.5 mm, while according to Schmid (1940), the range of values of the same dimension with permanent P_4 of recent leopards is barely 13.5–20.4 mm (average value: 16.9; N = 157). Measurements of permanent P_4 of *P. spelaea* and *P. leo* are given in *Table 10.9*; the length of deciduous P_4 in *P. spelaea* from Germany amounts to 18.75 mm (Heller 1983). The deciduous third upper molar (inv. No. D. b. 2073; *Fig. 11.13e*) does not differ morphologically from the same tooth of a cave lion (Smuts *et al.* 1978). It has three roots, two of which are strongly developed. The crown is distinguished from the crown of a permanent tooth mainly in the location of the deuterocone. In the case of the deciduous third upper premolar, the deuterocone does not lie lingually-distally from the parastil, as is characteristic of permanent P_3. Instead, the axis of the tooth is withdrawn mesially and not just longitudinally (i.e., mesially-distally; see Rabeder 1992). All three deciduous teeth cited above belong to 17 month animals (cf. Smuts *et al.* 1978).

Order: Even-toed ungulates (Artiodactyla)

Ungulates are represented in the sample from Divje babe I with six species from two families. While the majority of finds could be identified at least to the level of genus, in 13 cases this was not possible. Of the latter, 12 were ascribed to bovids (Bovidae), and a fragment of a metapodial to cervids (Cervidae).

Family: Hogs and pigs (Suidae)

Sus scrofa Linnaeus, 1758

Material: complex of layers 2–5: maxilla (including P^4 and M^1), dens ($I_{inf.}$), phalanx I.

Wild boar is represented in the fauna of Divje babe I with three finds, which all come from the complex of layers 2–5. The structure and wear stage of the teeth shows that the maxilla probably belonged to an 18 year old individual (see Schmid 1972; Rolett, Chiu 1994). The phalanx was ascribed to an animal at least one to two years old (Schmid 1972). Wild boar is a relatively thermophilous species, so the finds from Divje babe I could actually not be sinsedimentational. However, the species is also represented in the fauna of some contemporary sites in NE Italy (Bon *et al.* 1991), Slovenia (Rakovec 1973), Hungary (Jánossy 1986), Croatia (Malez 1986) and perhaps in SE Austria (Fladerer 2000).

Family: Deer (Cervidae)

Cervus elaphus Linnaeus, 1785

Material: complex of layers 2–5: metacarpus*, metatarsus, metapodium*, phalanx II; Layer 7/8: phalanx II; Layer 10: os carpale, os tarsale; Layer 13: dens ($I_{inf.}$), metacarpus; Layer 14: os carpale; Layer 17: metacarpus; Layer 20: os carpale; complex of layers 2–11/12: os carpale*; complex of layers 12/13–22: os carpale; unknown layer: metacarpus, phalanx III. Particularly fragmented specimens, whose specific identification is not reliable are marked with an asterisk (*).

Red deer is represented in the sample from Divje babe I with 17 remains. Identification of three of them is provisional; they do not deviate morphologically in any way from typical deer specimens but all are particularly fragmented. The number of remains of Early Glacial age (= OIS 5a-5d) is comparable with the number of Interpleniglacial (= OIS 3) finds, which is shown by no other taxon of large mammal in the material from Divje babe I.

(?) *Alces alces* (Linnaeus, 1758)

Material: complex of layers 4–6: phalanx II.

The cervid proximal epiphysis of the second phalanx from the group of layers 4–6 (inv. No. D. b. 100) probably belonged to moose. The specimen does not deviate in the greatest medio-lateral breadth of the proximal epiphysis from values for post-glacial moose of eastern France and Switzerland and thus exceeds in size fossil specimens of *C. elaphus* from various European sites (*Table 11.11*). Nevertheless, the area of today's Slovenia is thought to have been inhabited in the Würm also by a larger form (sub-species?) of red deer, which Pohar (1994) links with *Cervus elaphus maral*. Since phalanges of the latter subspecies do not achieve the size of post-glacial moose (Mottl 1951; Malez 1963; Chaix and Desse 1981), I provisionally ascribed the phalanx from the complex of layers 4–6 to *A. alces*. The morphological characteristics of the find accord with such an identification, since the broadening on the antero-medial edge of the proximal articular surface characteristic of moose is also seen (despite the fragmentation) on the second phalanx in question from Divje babe I (*Fig. 11.14*).

Finds of moose are already known in Slovenia from the end of the Mindel-Riss Interglacial (Brodar 1970), and from a number of Upper Pleistocene sites (Toškan 2004). In contrast, finds of *C. elaphus maral* are only known from three Late Würm sites (Rakovec 1962–63; Pohar 1985; 1992).

Note: In Layer 8, in addition to other animal remains, a fragment of cervid sesamoid bone was also found. It does not deviate morphologically from the same bone of red deer (*Cervus elaphus*), but since it is clearly larger, it is perhaps a moose (*Alces alces*) find, too.

Capreolus capreolus (Linnaeus, 1758)

Material: complex of layers 2–5: ulna, os tarsale, phalanx I; Layer 6: phalanx II; Layer 8: phalanx I (2x), phalanx II, phalanx III, os carpale; Layer 11: phalanx I; Layer 14: phalanx I; unknown layer: phalanx I.

Altogether, 14 remains were ascribed to roe deer, of which only one originates from OIS 5. The available metric data correspond with sub-fossil specimens of *C. capreolus* from central Slovenia (*Table 11.12*).

Rupicapra rupicapra (Linnaeus, 1758)

Material: Chamois is represented in the sample from Divje babe I with 112 specimens. The full list of finds by layers and skeletal elements is given in *Annex 11.2F.*

Chamois is by far the best represented herbivore in Divje babe I. The identification was based on the guidelines published by Prat (1966), Crégut-Bonnoure, Guérin (1996c), Pucher, Engl (1997) and Gamble (1997). Available metric data show that fossil chamois do not differ essentially from subfossil specimens from the same region (*Annex 11.1i*). Remains from the deepest layers of Divje babe I are thought to originate from the period of transition of the Riss-Würm interglacial to the Würm glacial (Turk *et al.* 2001a), so they are among the oldest known finds of *R. rupicapra* in Slovenia.

Capra ibex Linnaeus, 1758

Material: complex of layers 2–5: dentes (C_1, M_3), femur, tibia (2x), phalanx II (2x), phalanx III; Layer 6: dens (M_2).

Ibex is represented in the sample with nine remains. Morphologically, most of them correspond to the description given by Prat (1966) for *C. ibex*. Only the third lower molar from the complex of layers 2–5 (inv. No. D. b. 850) deviates slightly in that its distal (i.e., third) cusp does not show the thickening at the base of the crown typical of *C. ibex* (*Fig. 11.15*). Metrically, the aforementioned specimen lies within the range seen in fossil ibex from a number of European sites (*Table 11.13*).

Animals of all age classes are represented in the sample. The M_3 from the complex of layers 2–5 and M_2 from Layer 6 are both worn enough to be safely ascribed to mature animals (Gamble 1997; Payne 1973; Deniz, Payne 1982). Both ibex long bones in the sample, on the other hand, have unfused epiphyses. The tibia from the complex of layers 2–5 belonged to a subadult individual (age at death < 5 years) and the femur from scattered sediment to a no more than six-month-old animal (Gamble 1997).

Order: Elephants (Proboscidea)/Odd-toed ungulates (Perissodactyles)
Family: Elephants (Elephantidae)/Rhinoceroses (Rhinocerotidae)

Mammuthus primigenius (Blumenbach, 1799) seu *Dicerorhinus* sp. seu *Coleodonta antiquitatis* (Blumenbach, 1799)

Material: complex of layers 10–13: phalanx III.

The phalanx from the complex of layers 10–13 (inv. No. D. b. 2433) belongs to a large herbivore (*Fig. 11.16*). Insofar as the find is that of a rhino, in principle three species enter into consideration: Mercke's rhinoceros *Dicerorhinus kirchbergensis* (=*D. mercki*) (Jäger, Kaup, 1839-41), steppe rhinoceros *D. hemitoechus* (Falconer, 1868) and woolly rhinoceros *Coelodonta antiquitatis* (Blumenbach, 1799). J. Radovčić from the Croatian Natural History Museum in Zagreb compared the phalanx from Divje babe I with fossil material from Krapina, and provisionally ascribed the find to the species *Stephanorhinus kirchbergensis* (≈ *D. kirchbergensis*; see Guérin 1996; Radovčić, oral). Mercke's rhinoceros is also the only representative of its family which certainly inhabited the area of today's Slovenia in the Upper Pleistocene (Rakovec 1958; 1959; 1973; S. Brodar 1970; M. Brodar 1996). The same species is also represented in the Upper Pleistocene fauna of Croatia (Malez 1979), Hungary (Jánossy 1986) and NE Italy (Bon *et al.*, 1991), but steppe and woolly rhinoceros are also represented there. Fossil finds of the latter are also known from SE Austria (Fladerer 2000).

Together with Mercke's rhinoceros, mammoth must also be considered in the identification of the third phalanx of a large herbivore from the complex of layers 10–13. Because of the slightly less platelike articular surface, the phalanx in question slightly deviates from typical specimens of *Mammuthus primigenius* (Blumenbach, 1799) but seen overall, the specimen from Divje babe I seems closer to mammoth than Mercke's rhinoceros. Fossil finds of mammoth are known from at least 15 sites in Slovenia (Rakovec 1954; 1973; Pohar 1990; Lenardić, Pohar 1995).

VERTICAL DISTRIBUTION OF FINDS

During excavations at Divje babe I, the largest number of remains of large mammals (without cave bear) was collected from the complex of layers 2–5 (NISP = 502) and Layer 8 (NISP = 146). The Early Glacial (= OIS 5) layers 12–23 are significantly less rich; only 110 finds come from there (*Table 11.14*). Interpretation of the vertical distribution of remains is not straightforward, since it does not show only the actual changes in the structure of former communities. Potentially important disturbing factors include differential taphonomic loss, the variable role of man and carnivores as factors of accumulation of the taphocenosis, different thicknesses of layers and the proportion of investigated floor area. It is also of course necessary to take into account the change in the method and technique of excavation, because of which rather more attention will be devoted below to remains from the excavated field in the central and inner part of the cave (see Chapter 1 in this volume, *Fig. 1.3*). With the completion of investigation of the entrance part of the cave, namely, the archaeologists replaced the conventional method of coordinate documentation of finds with a simpler and more practical method based on basic field units of a dimension 1 x 1 x 0.12 m. They also simultaneously introduced wet sieving of all sediments.

The aforementioned modification to the methodology of excavation contributed to a reduction in the number of finds which were overlooked during collection and, consequently, discarded. In addition, the better estimate of the volume of examined sediment enabled a calculation of the geometric density of finds by layers (*Fig. 11.17*).[7] The complex of layers 2–5 stands out in terms of the highest concentration of finds, with Layer 10 (and no longer Layer 8 as in *Table 11.14*) occupying second place. The remains of brown bear and wolf show a similar vertical distribution. It is interesting that that the bulk of all stone artefacts also originate from layers 2-5 and 10–14 (Turk *et al.* 2002b). This suggests that both humans and large carnivores alternately visited the cave during the deposition of the two groups of layers.

The vertical distribution of finds of chamois and other medium to large herbivores (red deer, ibex, roe deer) is slightly different, although in this case, too, the most remains per volumetric unit of sediment was collected from layers 2–5. This might be indicative of a higher frequency of human and wolf visits to the cave. More difficult to explain is the small share of bones and teeth of herbivores in Layer 10. The concentration of chamois bones in layers 6–7 is also surprising, since relatively few stone artefacts and remains of large carnivores originate from these layers. Paleoclimatic estimates do in fact indicate worsening conditions during deposition of at least part of layers 2–5 as well as Layer 6 (Turk *et al.* 2001a), which perhaps contributed to an actual increase in the numbers of chamois and ibex in the then communities of the wider area of Divje babe I (*Figure 11.17; Table 11.14*). Such a development of climatic events could also be inferred from the numerous finds of alpine marmot in the cited group of layers. It is thus surprising that the concentration of finds of pine marten (*Martes* cf. *martes*) in the same stratigraphic context is also relatively high, although the cited species prefers a milder climate because of its reliance on forest. The remains of marten are also relatively numerous in layers 6–7 and 10 but care must be taken in the interpretation of this evidence. The scattering of finds, namely, shows that the majority probably belonged to only two individuals (one per layer). The vertical distribution of remains from layers 2–5 is less eloquent since, because of cryoturbation, the cited layers are folded.

Data in *Table 11.15*, which show the number of remains of individual taxa by sedimentary level, enable a further more direct insight into the fauna of large mammals of the wider environment of Divje babe I in various phases of the Würm. Such a presentation of data, however, was only possible for part of the excavation field (see Chapter 1 in this volume) so the total number of finds in the table is smaller (NISP = 300). On the other hand, such a presentation of data allows for direct comparison of available macrofaunistic data with palynological and sedimentological records and with the vertical distribution of remains of mammal microfauna, since it is based on a more objective stratigraphy and better temporal resolution (see Chapters 5, 8 and 10 in this volume).

The vertical distribution of carnivore remains form two pronounced peaks (*Table 11.15*) which correspond to the cold and damp climate at the time of deposition of layers 4–5a and the lower part of Layer 8 (see Chapter 6 in this volume, *Fig. 6.7a*). The result can be explained by the greater interest of carnivores in a cave-lair during more severe climatic conditions.

PALEOENVIRONMENT

The traditional archaeological/paleontological approach to paleoenvironmental studies is based on the projection of the ecological tolerance of recent populations of various species to conspecific populations from past periods. Nevertheless, since mammals are capable of adapting to various environments, they may have inhabited different habitats in the past to those in which they live today (e.g. Musil 1985; Bützler 1986; Miracle, Sturdy 1991; Van Kolfschoten 1995; Phoca-Cosmetatou 2002). The impact of temperature, humidity and other physical conditions on the distribution of individual species is generally only indirect (the competitive ability of animals changes depending on the aforementioned conditions). In fact, the area of distribution of a species is directly limited by the physical conditions of the environment only at its absolute limits of distribution, so equating ecological[8] and physiological optima is inappropriate (Van Kolfschoten 1995). This does not of

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[7] Since sediment was only excavated to layer 14 in the central and inner part of the cave, only data for the OIS 3 are shown in *Fig. 11.17*.

[8] In the concept of ecological optimum I understand the

course mean that data on the presence of individual indicator species of large mammal are not of interest for paleontological studies. They can be very useful as an independent control of paleoenvironmental and paleoclimatic reconstructions that are based on other paleoecological indicators (e.g., sedimentological or palynological records, remains of small mammals etc.).

To date, the most complete paleoclimatic curve for Divje babe I comparable with global paleoclimatic records ($\delta^{18}O$ and pollen) is based on the results of sedimentological analysis (Turk *et al.* 2001a; 2002; see also Chapter 5 in this volume). It is possible to infer from them that the climate in OIS 3 was probably less stable and, on average, certainly essentially colder and damper than in OIS 5a-5d. The results of palynological and anthracotomical research (Šercelj, Culiberg 1991; Culiberg, Šercelj 1997; Chapter 8 in this volume) and the study of micromammal remains (see Chapter 10 in this volume) support such a conclusion. The remains of large mammals accord with the presented paleoclimatic curve, too, although the majority of taxa are ubiquitous (*Fig. 11.18*).[9] One of the few exceptions in this sense is arctic fox, which nowadays inhabits mainly tundra. Its remains were found in Layer 8, which, not surprisingly, is thought to have been predominately (8a, 8c and partially 8b) deposited in a period of a cold climate.[10] Remains of *Lepus* cf. *timidus*, bound today to areas of tundra, taiga and alpine grasslands (Sulkava 1999), also come from Layer 8.

Layers 2–5 contained, in addition to other finds, remains of both *Lepus* cf. *timidus* and *Marmota marmota*, known generally to avoid (dense) forest. However, a tooth, a phalanx and a fragmented maxilla of wild boar were also found in the same stratigraphic context, whose optimum habitat is moderate deciduous and mixed forest. It thus seems that during the deposition of layers 2–5, periods of relatively cold climate were probably also broken by slightly warmer phases, which enabled the existence of stands of mixed forest. Forest must have been more or less continuously present also in the introductory part of OIS 3, since finds of pine marten were found in layers 10–12/13. The latter carnivore, namely, prefers forest among various types of habitat (Bright 1999).

The third phalanx of the large herbivore from the complex of layers 10–13 is morphologically closer to mammoth than Mercke's rhinoceros. Such an identification is also more likely from the point of view of paleoclimate, since the introductory part of OIS 3 was presumably relatively cold (*Fig. 11.18*). In contrast to mammoth, namely, Mercke's rhinoceros seems to have been bound to a warmer and probably damper environment (Musil 1985). The find of moose in the complex of layers 4–6 indicates the presence of a damp habitat (Pucek 1981).

Because projecting the ecological preferences of recent populations on those from past periods is often problematic, I set about paleoecological research slightly differently. I tried to deduce the pattern of community structure for fossil mammal fauna from Divje babe I according to their species diversity by taxonomic group, size, feeding adaptation (i.e., carnivore, omnivore, insectivore etc.) and locomotor zonal adaptation (i.e., arboreal species, scansorial species, fossorial species etc.). On the basis of these data, namely, it should be possible reliably to assess the ecological diversity pattern of fossil mammal communities, thus providing a means of obtaining information on the habitat of those communities (Andrews 1995). Data relating to large and small mammal fauna from Divje babe I are given in *Figure 11.19*.

I compared Divje babe I data with data for modern mammal communities from distinct tropical African habitats: lowland forests (N = 8), montane forests (N = 3), woodland-bushland (N = 8) and short grass plain (N = 1) (Andrews *et al.* 1979). It should be mentioned that the comparison of tropical ecosystems with those in the temperate zone is not ideal. Essentially more than in the vertical structure of an ecosystem, in fact, biodiversity is reflected in the quantity of food available to primary consumers[11] and the (seasonal) stability of its availability (Kryštufek 2001). On the other hand, most large mammals (or related fossil species) that inhabited European territory in the Upper Pleistocene are only still found in the tropics (e.g., lion, leopard, hyena, elephant, rhinoceros, large bovids; Kurtén 1968; Musil 1992). The exclusion of most large herbivores from ecosystems of moderate climates in the final phases of the Würm and in the Holocene often led to the complete overgrowing of until then open habitats, without this having been influenced by possible climatic or edaphic changes (see Kryštufek 2001). The largest representatives of megafauna (e.g., mammoth in Europe) probably limited the over-dominance of forest, as they still do in Africa today. What about large carnivores? Their presence does not tell a lot about the former climate, but it does indirectly indicate the adequate bearing capacity of the environment, thus a rich community of large herbivores.

The results of analysis are summarised in *Figure 11.19* and are entirely in line with independently obtained paleoenvironmental estimates (see Chapters 5, 8 and 10 in this volume). Deviation between the samples from OIS 5a-5d and OIS 3 is greatest in the "locomotor zonal

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conditions with which the given species shows the greatest abundance in nature.

[9] I only took into account material from OIS 3, since the sample of animal remains from OIS 5a-5d was too modest.

[10] This was shown by specific sedimentological analyses (see sub-chapter 5.2 in this volume). Remains of arctic fox were found at a depth of –321 cm and –345 cm.

[11] E.g. even though the primary production of deciduous forest is high, a great deal of the organic material is in the wood (i.e. not available to primary consumers), thus limiting the habitat biodiversity.

adaptation" category. In the material from OIS 3, in fact, the share of large ground mammal species is clearly greater than the share of small ground mammal species, which can also be found on the lower branches of shrubs and fallen trees. In tropical Africa, mammal communities of woodland-bushland and short grass plains show a similar picture. However, since arboreal species are missing from grassland habitats, the Interpleniglacial (= OIS 3) fauna of Divje babe I most resembles the community of woodland-bushland landscapes. In contrast to the sample from OIS 3, the share of large ground mammal species in the material from OIS 5a-5d is proportionate with the share of small ground mammal species. In these terms the Early Glacial (= OIS 5a-5d) fauna of Divje babe I is closest to the community of African tropical forests, although in the case of the latter, small ground mammal species generally exceed the share of species of large ones.

The statistical significance of the diversity distribution between various mammal communities was also tested (*Table 11.16*). Correlations were calculated between fossil and modern faunas for their distribution of classes within each category. The diversity distributions of fossil faunas were first ranked within each of the four taxonomic and ecological categories, and the correlations between them and the same distribution of classes for the means of the four modern community types were calculated.[12] The correlation coefficients were taken to indicate a high level of similarity in class distributions between the faunas being compared. Unfortunately, the low temporal resolution is strongly reflected in the results: because the material accumulated over a period of several tens of thousands of years, we are actually dealing with a palimpsest. The highly statistically significant coefficient of correlation between the sample from OIS 3 and recent mammal communities of lowland and/or montane forests of tropical Africa in three categories is nevertheless eloquent (*Table 11.16*) Temperature and humidity in the OIS 3 clearly were never so low as to prevent the existence of (at least) a woodland-bushland landscape. Moreover, it is worth pointing out the great similarity between Interpleniglacial (= OIS 3) fauna and recent grassland communities from tropical Africa, since high coefficients of correlation were found between them in three of a total of four categories (i.e., taxonomy, size and feeding adaptation). This indicates that more or less open habitats were also present in the area of Divje babe I throughout OIS 3.

In contrast with the situation in OIS 3, the environment in OIS 5a-5d was more forested. This is indicated by the relatively high correlation between the then fauna of Divje babe I and communities of recent tropical African forests in the categories of "size" and "locomotor zonal adaptation" (*Table 11.16*). The data from *Table 11.17* summarise the comparison of the two fossil samples from Divje babe I with two sub-fossil faunas from Viktorjev spodmol by Divača (SE Slovenia). The distribution of classes within the "locomotor zonal adaptation" category[13] observed for the Early Glacial (= OIS 5a-5d) fauna from Divje babe I is more similar to the Mesolithic mammal community from Viktorjev spodmol than the Bronze Age community from the same site. In contrast, differences in the extent of correlation between the Interpleniglacial (= OIS 3) sample from Divje babe I and either of the sub-fossil samples from Viktojev spodmol are only minimal. What need to be added is that the habitat indicated for Viktorjev spodmol in the Mesolithic was presumably mixed forest, while open habitats are thought to have predominated at the Bronze Age – Iron Age boundary (Toškan, Kryštufek 2004; Toškan, Dirjec 2004a).

AGENCIES OF BONE COLLECTION

Not just man but also animals themselves often contributed to the accumulation of macrofaunal remains in Palaeolithic cave sites. It is known that sick and wounded animals sometimes retreated to caves, in which they then died (see Fosse and Philippe 2005). Natural mortality during hibernation or immediately after it must also be taken into account. In the case of Divje babe I, this was actually probably the main reason for the accumulation of a large number of cave bear remains (Debeljak 2002b). Carnivores would also have contributed to the accumulation of bones with prey (Straus 1982; Miracle 1991; Stiner 1994; Blasco 1997). It might well not be coincidental that the stratigraphic position of (mountain) hare remains in Divje babe I almost exactly corresponds to the stratigraphic position of fox finds, which is today its most important predator (*Table 11.14;* Kryštufek 1991). The role of wolf and perhaps large cats was also presumably important, since the value of the quotient between the number of bones of carnivores and ungulates is relatively high (*Fig. 11.20*). Furthermore, in the carnivore material of Interpleniglacial age[14] from Divje babe I, the remains of bear (hibernating omnivore) and wolf (social community living carnivore) predominate, with only modest finds of fox, wildcat, otter, pine marten and polecat. As studies of numerous Upper Pleistocene sites show, the share of (large) carnivores in "kitchen waste" of Palaeolithic humans was

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[12] The non-parametric Sperman's R-test was used. The classes within individual categories of ecological diversity were ranked by giving the class with the highest proportion of species rank 1, that with the second highest proportion of species rank 2, etc.

[13] The "locomotor zonal adaptation" category was chosen because the differences between the fossil samples from OIS 5a-5d and OIS 3 are here the greatest (*Fig. 11.19*).

[14] The Early Glacial (= OIS 5a-5d) sample is too small for similar analysis.

generally essentially less (Klein and Cruz-Uribe 1984; Miracle 1991; Stiner 1994; but see also Blumenschine 1995; Yravedra 2002).

The role of animals dying naturally in the cave as one of the agencies of bone collection is difficult to evaluate in the case of Divje babe I (bear is the exception). It is nevertheless a fact that the majority of bones are damaged and that the fragmentation is not limited to less compact skeletal elements (e.g., skull, sternum, os penis), only. It is thus to be expected such a damage to be linked to natural disintegration on and in the sediment, alone. Furthermore, the numerous (also transverse) breaks of long bones are more thoroughly linked with human and/or carnivore activity, indicating that man and/or carnivores did played an essential role in bone collection. Two key questions can thus be raised: (1) what proportion of the bones discarded by Palaeolithic man in Divje babe I were the remains of his own prey (in comparison with the share of carrion) and (2) to what extent did large carnivores (without bear) contribute to the accumulation of remains in the cave? Opinion is strongly divided about the most suitable method of seeking an answer to such questions (Klein, Cruz-Uribe 1984; Marean, Spencer 1991; Marean, Kim 1998; Stiner 1991; 1994; 1998a; 2002; Blumenschine 1995; Domínguez-Rodrigo 1996; 1999; Milo 1998; Yravedra 2002; Pickering *et al.* 2003; Phoca-Cosmetatou 2004; 2005). Because of this, I will focus below on both of the two most frequently used approaches. Both lay great stress on bone surface modifications, which can be directly linked to the activity of man (cutmarks, percussion marks) or carnivores (gnawing marks). The pattern of fragmentation of individual bones will also be taken into account, since human-caused fractures often differ from those made by carnivores (see Haynes 1980; 1983; Stiner 1994; Blasco 1997; *Fig. 11.21*).

Among the identified ungulate remains, traces of human or carnivore (particularly wolf; see Haynes 1980; 1983) activity are mainly observable on the bones of the lower part of the extremities (*Fig. 11.22* and *Fig. 11.23*). As concerns carnivores, the only exception is the presumably chewed *caput femoris* of a chamois from Layer 17a. What about humans? In addition to bones of the lower part of the extremities, a scapula, a mandible and one each proximal fragment of a radius, ulna and femur show typical human-caused fractures. The results of ethnological studies indicate that the pattern of processing animal prey among Pleistocene people from different regions and from different periods must not have been entirely the same (Binford 1978; Monahan 1998; Domínguez-Rodrigo 1999). The food utility of individual carcass parts is also variable, depending on the species, age, sex and the season of the kill/death of the animal (Outram 2000). It undoubtedly follows from the aforementioned that great care must be taken in the *post hoc* qualitative ranking of individual anatomical regions of an animal. Since traces of human activity are also visible on the bones of meatier parts of ungulates, I nevertheless believe that Palaeolithic man from the area of Divje babe I had at least occasional access to the complete carcass of animals they had killed, or which had died for some other reason.

The sum of horn/antler and head MNE counts for individual ungulate[15] species relative to the MNE for all major limb bones above the foot ([H+H]/L; Stiner 1994), also seems to indicate hunting/prey. The remains of prey of explicit scavengers (e.g., spotted and brown hyena) should show essentially higher values of the cited index than applies for active predators (e.g., wolf), since access to all parts of a hunted animal is generally only enabled to the latter. By placing whole carcases of donkeys in the vicinity of dens of spotted hyena, Skinner *et al.* (1980) showed that the numerous fragments of skulls, mandibles and horns among the food remains of scavengers[16] is actually a result of their limited choice. After placing donkey carcases in the vicinity of dens, namely, the anatomical representation of hyena den faunas essentially changed and very much approached that of wolf den faunas.

The value of the (H+H)/L ratio for medium-sized ungulates from Divje babe I is given in *Figure 11.24*. The data does not deviate only from the values for explicit scavengers, but also for spotted hyena, which is only partially dependent on carrion.[17] The number of available red deer and ibex (i.e., medium-sized ungulates) is modest in the sample from Divje babe I, but the results of experimental studies show that the (H+H)/L ratio is not sensitive to small sample size (Stiner 1994). Besides, in terms of the low value of this index, the much larger sample of all ungulate remains (NISP = 155) also stands out.

Irrespective of the presumed robustness of the (H+H)/L index, many authors reject its use entirely (e.g., Blumenschine 1995; Marean, Kim 1998; Milo 1998; Domínguez-Rodrigo 1999; Yravedra 2002; Pickering *et al.* 2003). Its weak point is considered to be that it does not adequately take into account the food preferences of large carnivores. Namely, the grease-laden near-epiphyseal fragments of cancellous bone are supposed to have been essentially more interesting to them than the almost greaseless compact mid-shaft fragments (but see also Stiner 1994; 2002). Although cancellous (parts of)

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[15] Only the bones of medium-sized ungulates were taken into account, since they show the greatest variability in anatomical representation (Stiner 1994).

[16] This applies in particular to less agressive scavengers (Richardson, Bearder 1996).

[17] The coefficient of correlation (Spearman's R) between MNE and the structural density of individual bones is not statistically significant. It follows from this that differential preservation did not essentially influence the established anatomical representation of Divje babe I medium-ungulate faunas. Data on the structural density relate to red deer (Lyman 1999).

bones must also be taken into account in taphonomic studies (Rogers 2000), the role of man and/or carnivores as bone collectors can thus only be adequately explained by analysis of (fragments of) diaphyses. Numerous actualistic studies point in this direction (Blumenschine 1988; 1995; Lupo 1995; Capaldo 1998), and the thesis has also been confirmed by experimental observation (Marean 1991; Marean, Bertino 1994).[18] The number and placement of cutmarks, percussion marks and tooth marks on long bones depends very much on whether man had first access to prey (which in principle places him in the role of hunter) or whether carnivores did (which puts man primarily in the role of scavenger). From the point of view of both man and carnivore, the food value of bones can be divided into three components: soft tissue around the bone (meat, fat, sinew), bone marrow (mainly in long bones) and greasy cancellous bone, which is mainly limited to near-epiphyseal parts in cervid/bovid long bones. When people or carnivores tear the soft tissue from long bones of an animal, they leave the most traces (cutmarks, tooth marks) on the diaphyses, where there is the most meat and fat. Access to the bone marrow is enabled by chewing or crushing bones, whereby traces of both activities are found mainly on the diaphyses (hyena; Marean, Kim 1998) or epiphyses (wolves; Haynes 1980; 1983). It is worth stressing that carnivores have practically no interest in midshaft fragments after the removal of the bone marrow. It is otherwise with epiphyses (or the cancellous near-epiphyseal fragments) which, because of the relatively high grease content, still have significant food value. Carnivores normally devour them, extract the highest possible proportion of fat in the stomach and disgorge the remains (hyena) or excrete it in excrement (canides). In contrast, Middle Palaeolithic man presumably obtained the grease from the cancellous bone fragments by boiling them (e.g., Hanson 1998; but see also Marean, Kim 1998).

The number and placement of cutmarks, percussion marks and tooth marks on fossil bones from Divje babe I corroborate the thesis of Palaeolithic man often having been the first to have access to the carcases of red deer, chamois, ibex and roe deer. This is demonstrated by individual cutmarks on the diaphyses of long bones (*Fig. 11.25*) and above all by the much larger number of tooth marks on the epiphyses (or near-epiphyseal fragments) than on diaphyses.[19] In contrast, the main traces that Blumenschine *et al.* (1996), Marean, Kim (1998) and Milo (1998) connect with human activity appear on diaphyses. The majority of animals (killed or scavenged) were thus presumably first available to humans. They tore the soft tissue from the bone (this is indicated by the presence of cutmarks and absence of tooth marks on the diaphyses) or accessed the marrow by crushing the bones. The remains (i.e., fragments of diaphyses, epiphyses) were essentially less interesting from an energetic point of view, so humans probably did not regularly cook/burn them etc. In the case of Divje babe I this is also indicated by the absence of the remains of usually hunted animals in hearths or directly beside them (Paunović *et al.* 2002; see also *Table 11.15*). If (when) man discarded the bones (or when he abandoned the cave), large carnivores gained access to them, in Divje babe I mainly wolves. They were interested in the grease-saturated fragments of cancellous bone, to which testify tooth marks on the epiphyses or near-epiphyseal fragments (*Fig. 11.26*). The almost complete absence of similar traces in fragmented diaphyses indicates that the majority of long bones had already been crushed by people before the arrival of carnivores.

A similar order of access to (carcases) of hunted/scavenged animals has also been found in the analysis of numerous other Palaeolithic sites in Europe (e.g., Estévez 1987; Auguste 1995; Blasco 1997; Yravedra 2002), so it is not in itself surprising. The question remains open of how strong was the pressure of carnivores on the waste of Palaeolithic man in the case of Divje babe I. On the basis of experimental crushing of the bones of African ungulates of the first and second size class (*sensu* Bunn 1982), in which exclusively stone tools were used, percussion marks were found on approximately a third of all fragments of long bones (Blumenscine 1995). Thereafter, the share of remains with tooth marks when whole (experiment 1) or fragmented long bones without marrow (experiment 2) were exposed to various wild African carnivores (mostly spotted hyena) was established. In the first experiment, the share of gnawed bones was high, as expected (average 70.8%), since crushing the bones gave the hyenas access to the marrow. In contrast, within the context of experiment 2, tooth marks were only visible on a fifth of all remains (the majority on fragments of cancellous bone). The share of gnawed bones of ungulates from Divje babe I is still lower! This can be ascribed to some extent to the various intensities with which hyenas and wolves crush bones (no hyena remains were found in Divje babe I). Nevertheless, in view of the small number of tooth-marked fragments, a relatively modest role of wolf (and large cats) as scavengers on the hominid-butchered fare or carrion can be inferred. Not least, a significantly lower number of carpal/tarsal bones could otherwise be expected than that established (*Fig. 11.27*), since small compact bones (i.e.,

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[18] The majority of the cited actualistic and experimental studies are based on observation of the hyena, but the presented pattern of processing prey is also very similar with canides (see Morey, Klippel 1991).

[19] Only the material which was excavated after 1990 was taken into account. Prior to this the sediment had not been routinely sieved, because of which numerous small fragments of diaphyses were overlooked during excavation and therefore discarded.

astragalus, calcaneus, os centrotarsale) are often dissolved even by the alimentary juices of dogs (Payne, Munson 1985). It is in line with this finding that the epiphyses of the radius (N = 3) and femur (N = 3) of ungulates in the sample from Divje babe I are not gnawed, which one would expect with greater pressure of wolves on the remains of human prey and animals dying naturally in the cave (see Haynes 1980).

CONCLUSION

Because small mammals are a better indicator of the palaeoenvironment than are large ones (Andrews 1990), a great deal of attention in this contribution was devoted to the role of various agencies of bone collection. Naturally dying animals are presumed to have been responsible for the formation of the taphocenosis, as well as Palaeolithic man and carnivores. The latter is indicated by the number and location of cutmarks, percussion marks and tooth marks on the long bones of ungulates. It seems that the carcases of red deer, chamois, ibex and roe deer were normally first available to humans, their energetically still interesting food waste (mainly grease saturated near-epiphyseal fragments of cancellous bone) being subsequently exploited by carnivores. There is little likelihood that people were more successful in seeking carrion than carnivores, so most of the bones of ungulates in Divje babe I probably represent the remains of human prey. Nevertheless, large carnivores should also be counted among bone collectors. It is interesting in this sense that teeth of young and subadult animals (*sensu* Stiner 1994) greatly predominate among the molars of wolf, leopard and cave lion.[20] It thus seems that wolves and large cats occasionally used the cave as a lair. In view of their etiology (Ewer 1973; Domínguez-Rodrigo 1994; Stiner 1994; Blasco 1997) this means that at least some of the finds in the cave are probably the remains of carnivores' own prey.

There is no doubt that people and carnivores visited the cave alternately. Unfortunately, it is not possible to differentiate among individual visits, since the temporal resolution of the sample is too low. The majority of bones with visible traces of human activity come from layers 2–5. The same complex of layers also stands out in terms of the large number of stone artefacts (Turk, Kavur 1997). However, the cited data cannot be interpreted as an indicator of increased frequency of human visits to the cave at the expense of the frequency of visits of large carnivores. The number of stone tools, cores, fragments and flakes, namely, is highest precisely where there is also the highest geometric density of wolf remains (i.e., in Layer 4; Turk, Dirjec 1997b; Turk, Kavur 1997).[21] In addition, some 122 nonfragmented bones per cubic metre of sediment were collected in Layer 4 (within the context of layers 2–5 more of them were found only in Layer 3), which would not be expected with extended human residence in the cave. In order for people to get to the marrow, namely, they generally had to smash long bones intensively. On the other hand, it is also true that caves did not always serve humans as residences or hunting outposts but could also have had other purposes (e.g., a place of ritual). Perhaps this was also so in Divje babe I. It is worth mentioning in this context the find of a presumed flute and the pierced skull of a cave bear (see sub-chapter 12.4 in this volume), as well as the finds of charcoal of yew, juniper and alder (see Chapter 8 in this volume), which to the best of our knowledge were not found in other Palaeolithic sites south of the Alpine glaciation (Šercelj, Culiberg 1985).[22] The absence of remains of the main hunted animals on or beside hearths is also unusual (Paunović *et al.* 2002; *Table 11.15*). Furthermore, bones that were scattered around hearths belong almost exclusively to cave bear and do not show the damage that occurs in the dismemberment of prey with stone tools. If Divje babe I did not actually serve Palaeolithic man (only) as a shelter or hunting outpost, the pattern of dismembering and crushing bones could also be expected to be specific (ritual?). In this case, the animal remains would not represent the cooking waste of Palaeolithic man, and this would of course have important implications for the overall evaluation of his role in the formation of the studied taphocenosis.

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[20] Of a total of 16 molars of the cited three species found in Divje babe, 12 belong to young or sub-adult specimens (Toškan 2004).

[21] In layers 10–13, characterized by the second highest density of wolf remains, there were almost no Palaeolithic finds in the central part of the cave, which was processed in detail (i.e., water-sieving of the sediment), but absolutely the most at the cave entrance.

[22] The only exception is a specimen of juniper charcoal (*Juniperus* sp.) from Parska golobina by Pivka (Šercelj, Culiberg 1985).

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PRILOGE / ANNEXES

Lepus cf. *timidus*	Measure
Humerus	D.b. 1303
Bd	12.0
BT	10.0
Ulna	D.b. 1050
BPC	8.5
Ossa coxae	D.b. 785
LA	11.5
Astragalus	D.b. 1502
GL	16.0

◁◁
Pril. 11.1A: Mere ostankov planinskega zajca (*Lepus* cf. *timidus*). Vse najdbe so iz OIS 3. Vse mere so v mm.
Annex. 11.1A: Measurements of the remains of mountain hare (*Lepus* cf. *timidus*). All finds are from OIS 3. All measurements are in mm.

Pril. 11.1B: Mere ostankov alpskega svizca (*Marmota marmota*). Vse najdbe so iz OIS 3. Vse mere so v mm.
Annex. 11.1B: Measurements of the remains of alpine marmot (*Marmota marmota*). All finds are from OIS 3. All measurements are in mm.

M. marmota	Measures									
Cranium	D.b.153	D.b.325	D.b.328	D.b.329	D.b.851					
P^3-M^3	22.0	–	21.0	–	21.5					
M^1-M^1	12.5	–	14.0	–	–					
BOC	–	19.5	–	20.0	–					
Mandibula	D.b. 153a	D.b.307	D.b.310	D.b.400	D.b.639	D.b.640	D.b.1092	D.b.1481	D.b.1482	
P_4-M_3	20.5	20.0	21.0	20.0	21.0	21.0	18.0	21.5	22.0	
Id-M_3	32.0	32.0	36.0	–	–	–	–	35.0	–	
Id- P_4	13.0	12.5	16.0	–	–	–	15.0	14.0	–	
Atlas	D.b.308	D.b.1189								
GB	14.0	–								
GL	21.0	–								
BFcr	14.5	14.5								
BFcd	–	18.0								
LAd	–	3.0								
H	–	13.0								
Scapula	D.b.1486	D.b.1586	D.b.1889							
BG	8.0	–	7.5							
GL	–	–	14.0							
SLC	–	11.0	–							
Humerus	D.b.314	D.b.352	D.b.664	D.b.1232	D.b.1330	D.b.1485	D.b.1739			
Bp	–	–	–	15.5	15.0	17.0	–			
Bd	–	20.5	–	–	–	–	–			
BT	–	12.0	14.5	–	–	–	13.0			
Dp	16.5	–	–	–	–	–	–			
Radius	D.b.1488	D.b.1502	D.b.1504							
Bp	9.0	10.0	10.0							
Ulna	D.b.654									
BPC	7.0									
Ossa coxae	D.b.242	D.b.332								
LAR	10.5	11.5								
Femur	D.b.239	D.b.319	D.b.320	D.b.608	D.b.1490	D.b.1507	D.b.1770			
Bp	–	–	–	19.0	–	–	19.0			
DC	–	9.5	9.5	–	9.0	–	9.0			
BTr	16.0	–	–	16.0	14.5	–	–			
Bd	–	–	–	–	–	16.5	–			
Tibia	D.b.10	D.b.115	D.b.318	D.b.333	D.b.1222	D.b.1231	D.b.1491	D.b.1880	D.b.2098	D.b.2099
Bd	10.0	11.0	11.5	11.0	10.0	10.0	11.0	12.0	11.0	10.5
Dd	–	–	–	–	8.0	–	8.0	9.0	9.0	9.0
Astragalus	D.b.877	D.b.984	D.b.1112	D.b.1188	D.b.1214	D.b.1223	D.b.1581	D.b.1583	D.b.1741	
GL	11.0	10.0	11.0	11.5	11.0	12.0	11.0	11.0	12.0	
Calcaneus	D.b.1143	D.b.1475	D.b.1494	D.b.1873						
GL	–	–	–	17.0						
GB	9.5	11.0	12.0	11.5						

Pril. 11.1C: Mere ostankov rjavega medveda (*Ursus arctos*). Podatki, ki se nanašajo na najdbe iz OIS 5a–5d, so zapisane poševno. Vse mere so v mm.
Annex. 11.1C: Measurements of the remains of brown bear (*Ursus arctos*). Data relating to finds from OIS 5a–5d are in italics. All measurements are in mm.

Ursus arctos	**Measures**					
Cranium	D.b.1606					
m. 1	410.0					
m. 2	361.5					
m. 4	172.0					
m. 6	210.5					
m. 8	165.4					
m. 9	75.5					
m. 10	33.0					
m. 11	221.0					
m. 12	79.0					
m. 13	105.5					
m. 14	87.0					
m. 15	59.0					
m. 16	75.0					
m. 17	132.0					
m. 18	83.0					
m. 19	65.0					
M^2 L	43.0					
M^2 B	22.0					
Mandibula	D.b.532	D.b.1063	D.b.1122	D.b.1370	D.b.1849	
C_{ab}-M_3	121.5	–	–	132.0	–	
P_4-M_3	–	86.0	–	89.0	84.0	
M_1-M_3	–	–	–	–	68.5	
HM_2	42.0	38.0	–	–	59.5	
HP_4/M_1	38.0	35.0	39.0	42.0	53.5	
Radius	kv. 37/27	D.b.2534				
Bp	34.0	35.0				
Bd	56.0	54.5				
GL	259.0	259.8				
SD	–	24.0				
DD	–	14.5				
Metacarpus I	*D.b.392*	D.b.884				
Bp	*21.5*	22.0				
Bd	*19.0*	18.5				
GL	*78.0*	70.5				
SD	*11.0*	11.0				
DD	*9.0*	9.5				
Metacarpus II	*D.b.48*	*D.b.104*	*D.b.105*	*D.b.293*	*D.b.568*	
Bp	*17.0*	*17.0*	*12.0*	*15.5*	*17.0*	
Bd	*20.5*	*21.5*	*19.0*	*22.0*	*22.0*	
GL	*86.5*	*89.0*	*80.5*	*89.5*	*86.0*	
SD	*12.5*	*14.0*	*13.0*	*15.0*	*15.0*	
DD	*10.0*	*10.0*	*10.5*	*11.0*	*10.0*	
Metacarpus III	D.b.47	D.b.102	D.b.302	D.b.437	D.b.1158	D.b.2532
Bp	16.0	16.5	16.0	–	16.0	–
Bd	19.0	19.0	19.5	–	19.0	17.0
GL	86.0	91.0	78.0	–	76.5	86.0
SD	13.0	13.5	12.0	12.0	11.5	12.5
DD	12.0	10.5	11.0	10.0	10.0	11.0
Metacarpus IV	*D.b.103*	D.b.2531				
Bp	*17.5*	18.0				
Bd	*20.0*	20.0				
GL	*85.0*	25.5				
SD	*15.0*	13.0				
DD	*11.5*	9.5				

continued....

Pril. 11.1C / Annex 11.1C (nadaljevanje / cont.)

Ursus arctos	**Measures**					
Metacarpus V	D.b.43	D.b.398	D.b.1220			
Bp	–	23.0	26.5			
Bd	–	22.0	22.0			
GL	91.0	85.0	81.5			
SD	15.5	15.0	14.5			
DD	17.0	10.5	11.5			
Patella	*D.b.46*	D.b.1744				
GL	*53.5*	54.5				
GB	*34.0*	37.0				
Tibia	D.b.2536					
SD	30.0					
DD	33.0					
Calcaneus	kv. 96/5	D.b.30	D.b.38			
GL	–	90.0	74.0			
GB	50.0	49.5	40.0			
Metatarsus I	49/81	D.b.490	D.b.1749	D.b.1750		
Bp	–	23.0	21.5	20.0		
Bd	18.0	20.5	15.0	16.0		
GL	63.0	71.0	52.0	52.0		
SD	9.5	10.0	10.0	9.0		
DD	8.0	10.0	8.0	9.0		
Metatarsus II	D.b.436	D.b.881				
Bp	12.0	15.0				
Bd	19.0	18.0				
GL	80.0	74.0				
SD	12.5	12.0				
DD	9.0	10.0				
Metatarsus III	D.b. 9	D.b.140	D.b.273			
Bp	18.5	–	19.0			
Bd	–	–	20.0			
GL	–	–	87.0			
SD	14.0	10.5	14.0			
DD	10.0	10.0	12.0			
Metatarsus IV	*D.b.517*					
Bp	*19.0*					
Bd	*22.0*					
GL	*94.0*					
SD	*15.0*					
DD	*12.0*					

Pril. 11.1D: Mere ostankov volka (*Canis lupus*). Podatki, ki se nanašajo na najdbe iz OIS 5a-5d, so zapisane poševno. Vse mere so v mm.
Annex. 11.1D: Measurements of the remains of wolf (*Canis lupus*). Data relating to finds from OIS 5a-5d are in italics. All measurements are in mm.

Canis lupus	**Measures**			
Mandibula	D.b. 1980 (8)	D.b.353	D.b.1400	
P_1-P_4	–	55.0	56.0	
P_2-P_4	44.0	46.0	49.0	
M_1-M_3			51.0	
P_1-M_3			104.0	
HM_1			31.0	
HP_2	–	24.5	30.0	

continued...

Pril. 11.1D / Annex 11.1D (nadaljevanje / cont.)

Canis lupus	**Measures**			
Dentes	D.b.1161	D.b.1400	D.b.1464	
P^4 L	–	–	26.0	
P^4 B	–	–	10.0	
P^4 GB	–	–	14.0	
M^2 L	10.0	–	–	
M^2 B	8.0	–	–	
M_1 L	–	33.0	–	
M_1 B	–	11.0	–	
M_2 L	–	12.5	–	
M_2 B	–	7.5	–	
Atlas	D.b.50	D.b.395		
Lad	15.5	18.0		
BFcr	40.0	38.0		
H	28.0	30.5		
GL	–	47.0		
GB	–	97.0		
Scapula	D.b. 2576			
GLP	37.0			
LG	31.0			
BG	21.0			
SLC	32.0			
Humerus	D.b.1846	D.b.2605		
Bd	37.0	–		
BT	28.5	27.0		
SD	15.0	–		
DD	16.5	–		
Radius	*D.b.174*	D.b.2622		
Bp	*21.5*	–		
Bd	–	29.0		
SD	*15.0*	–		
Metacarpus I	D.b.472			
Bp	6.5			
Bd	8.0			
GL	30.0			
SD	–			
DD	–			
Metacarpus II	D.b.2698			
Bp	9.0			
Bd	11.0			
GL	69.0			
SD	8.0			
DD	6.5			
Metacarpus III	D.b.1978 (Šeb.)	D.b.106	D.b.1844	
Bp	9.5	9.5	9.0	
Bd	11.5	11.0	10.0	
GL	81.0	86.5	75.0	
SD	7.0	7.5	8.0	
DD	6.0	7.0	7.0	
Metacarpus IV	kv. 36/13			
Bp	9.0			
Bd	11.0			
GL	86.0			
SD	9.0			
DD	7.5			

continued....

Pril. 11.1D / Annex 11.1D (nadaljevanje / cont.)

Canis lupus	**Measures**			
Metacarpus V	D.b.473			
Bp	14.0			
Bd	12.0			
GL	68.0			
SD	7.0			
DD	6.0			
Femur	D.b.129			
Bp	54.0			
DC	25.0			
SD	17.0			
Astragalus	*D.b.66*			
GL	*35.0*			
Calcaneus	D.b.24	*D.b.51*	D.b.1156	D.b.1296
GL	64.5	*57.0*	55.0	59.0
GB	27.0	*25.5*	22.0	23.0
Metatarsus II	D.b.1980 (3-7)	D.b.1002		
Bp	7.0	7.0		
Bd	11.0	10.5		
GL	77.5	79.0		
SD	7.0	7.0		
DD	7.0	7.0		
Metatarsus III	D.b.60	*D.b.576*	D.b.2577	D.b.2579
Bp	7.0	*9.0*	13.0	–
Bd	12.0	*10.0*	12.0	–
GL	91.5	*84.0*	103.0	–
SD	8.0	*7.0*	10.0	8.0
DD	8.0	*6.0*	7.5	9.0
Metatarsus IV	D.b.304	D.b.463	kv. 32 iz. 16	
Bp	11.0	12.0	11.5	
Bd	11.0	12.0	9.5	
GL	96.0	105.0	88.0	
SD	8.0	9.0	8.5	
DD	7.5	8.5	7.0	
Metatarsus V	D.b.397	D.b.459	D.b.806	
Bp	11.0	13.0	12.0	
Bd	10.0	11.0	11.0	
GL	81.0	91.5	80.0	
SD	7.0	6.0	7.0	
DD	6.5	8.0	6.0	

Panthera spelaea	**Measures**	
Astragalus	*D.b.554*	
GL	*57.0*	
Metatarsus III	*D.b.564*	
Bp	*17.0*	
SD	*24.0*	
Bd	*20.0*	
GL	*143.0*	
Phalanx II	*D.b.588*	D.b.1783
Bp	*18.0*	28.0
SD	*17.0*	–
Bd	*11.5*	26.0
GL	*45.0*	33.0

◁◁

Pril. 11.1E: Mere ostankov jamskega leva (*Panthera spelaea*). Podatki, ki se nanašajo na najdbe iz OIS 5a–5d, so zapisane poševno. Vse mere so v mm.

Annex. 11.1E: Measurements of the remains of cave lion (*Panthera spelaea*). Data relating to finds from OIS 5a–5d are in italics. All measurements are in mm.

Pril. 11.1F Mere ostankov navadnega dihurja (*Mustela putorius*). Vse najdbe so iz OIS 3. Vse mere so v mm.
Annex. 11.1F: Measurements of the remains of European polecat (*Mustela putorius*). All finds are from OIS 3. All measurements are in mm.

Mustela putorius	Measures	
Maxilla	D.b. 1308/2	
P^4 L	8.0	
P^4 B	4.0	
M^1 L	6.0	
M^1 B	3.5	
Axis	D.b. 1280	
LCDe	16.0	
LAPa	16.0	
H	16.0	
BFcr	11.0	
SBV	8.0	
BPacd	11.0	
Scapula	D.b. 1308	D.b. 1593
GLP	9.0	9.0
BG	5.0	5.0
SLC	6.5	–
Radius	D.b. 1294/2	D.b. 1294/3
Bp	5.0	5.0
Bd	7.0	7.0
GL	34.0	33.5
Ulna	D.b. 1294	D.b. 1346
BPC	5.0	5.0
GL	45.0	–
Femur	D.b. 1083	D.b. 1308/5
Bp	–	11.0
DC	–	6.0
SD	–	4.0
Bd	12.0	11.5
GL	–	52.0
Tibia	D.b. 1279	D.b. 1308/4
Bp	11.0	10.5
Bd	8.0	8.5
Dd	6.0	6.0
GL	55.0	55.0
Calcaneus	D.b. 1294/4	
GL	13.0	
GB	8.0	
Astragalus	D.b. 1308/3	
GL	10.0	

Pril. 11.1G: Mere ostankov jelena (*Cervus elaphus*). Vse najdbe so iz OIS 3. Vse mere so v mm.
Annex. 11.1G: Measurements of the remains of red deer (*Cervus elaphus*). All finds are from OIS 3. All measurements are in mm.

Cervus elaphus	Measures	
Metacarpus	D.b.147	
SD	25.5	
DD	19.0	
Bd	41.0	
Metatarsus	D.b.430	
SD	25.5	
DD	22.5	
Bd	42.0	
GL	276.5	
Phalanx II	D.b. 1	D.b.146
Bp	–	19.5
SD	16.0	15.5
Bd	18.0	15.0
GL	44.0	42.0
Phalanx III	D.b.303	
Ld	44.0	
MBS	17.0	

Pril. 11.1H: Mere ostankov kune zlatice (*Martes* cf. *martes*). Podatki, ki se nanašajo na najdbe iz OIS 5a–5d, so zapisane poševno. Vse mere so v mm.
Annex. 11.1H: Measurements of the remains of pine marten (*Martes* cf. *martes*). Data relating to finds from OIS 5a–5d are in italics. All measurements are in mm.

Martes martes	**Measures**								
Cranium	D.b.1081								
BOC	17.0								
BFM	10.0								
HFM	8.0								
HOT	18.5								
HS	19.0								
Mandibula	*D.b.439*	D.b.440	D.b.441	D.b.521	D.b.1308	D.b.1525	D.b.2075	D.b.2465	
Tot. L	–	59.5	–	–	–	–	–	–	
P_1-M_3	*34.0*	33.0	–	–	–	31.5	–	–	
M_1-M_3	*15.0*	15.0	–	–	–		–	–	
P_1-P_4	*20.0*	19.0	–	–	–	20.0	19.0	–	
HP_2	*10.5*	9.0	9.0	9.0	8.0	8.0	10.5	9.0	
HM_1	*12.0*	11.0	–	–	–	–	–	11.0	
Dentes	Kv. 41b/13	*D.b.439*	D.b.1572	D.b.1585	D.b.1781	D.b.2075	D.b.2464	D.b.2497	D.b.2509
M^1 L	9.0	–	9.0	9.0	9.0	–	8.0	–	–
M^1 B	6.0	–	6.5	6.0	6.5	–	6.5	–	–
M_1 L	–	*11.5*	–	–		11.5	–	11.5	11.0
M_1 B	–	*5.0*	–	–		4.5	–	5.0	4.5
Atlas	D.b.757	D.b.1872	D.b.2508						
GL	13.0	–	–						
LAd	–	7.0	7.0						
H	13.0	12.5	13.0						
BFcr	21.5	21.0	20.5						
BFcd	14.0	14.0	–						
Axis	D.b.2494								
LCDe	19.0								
LAPa	15.0								
BFcr	13.0								
H	15.5								
Humerus	D.b.448	D.b.449	D.b.1773	D.b.2455					
Bp	13.0	–	14.0	–					
Dp	14.0	–	–	–					
SD	5.0	5.5	–	–					
Bd	17.0	–	–	16.5					
BT	11.0	–	–	12.0					
Ulna	D.b.443	D.b.1875							
BPC	6.5	9.0							
Radius	D.b.444	D.b.445	D.b.450	D.b.1315	D.b.1774	*D.b.1843*	D.b.2463		
Bp	7.5	7.5	–	6.0	–	*8.0*	6.5		
SD	4.0	3.5	–	–	–	*3.5*	3.5		
Bd	–	10.0	10.0	–	9.0	*9.0*	–		
GL	–	62.0	–	–	–	*62.0*	–		
Femur	*D.b.148*	*D.b.442*	D.b.447	D.b.451	D.b.1764	D.b.2084	D.b.2085	*D.b.2461*	
Bp	–	*17.5*	17.0	–	16.0	–	17.0	*16.0*	
DC	–	*8.0*	8.5	–	8.0	9.5	8.0	*7.0*	
SD	–	*5.5*	5.5	5.5	–	–	5.5	–	
Bd	*14.0*	–	–	–	–	–	15.0	–	
GLC	–	–	83.5	–	–	–	86.0	–	
GL	–	–	82.0	–	–	–	86.0	–	
Tibia	D.b.1763	D.b.2475							
Bp	15.5	15.0							
Calcaneus	D.b.768	D.b.821	D.b.1771						
GB	9.0	10.5	10.5						
GL	18.5	–	20.5						
Astragalus	D.b.1580	D.b.2060							
GL	12.5	14.5							

continued...

Pril. 11.1F / Annex 11.1F: (nadaljevanje / cont.)

Martes martes	Measures								
Metatarsus III	D.b.151								
Bp	*4.0*								
Bd	*4.0*								
SD	*3.0*								
DD	*2.0*								
GL	*35.0*								

Pril. 11.1I: Mere ostankov gamsa (*Rupicapra rupicapra*). Podatki, ki se nanašajo na najdbe iz OIS 5a–5d, so zapisane poševno. Vse mere so v mm.
Annex. 11.1I: Measurements of the remains of chamois (*Rupicapra rupicapra*). Data relating to finds from OIS 5a–5d are in italics. All measurements are in mm.

R. rupicapra	Measures									
Dentes	D.b.710	D.b.1898								
M$_3$ L	21.0	–								
M$_3$ B	8.0	–								
dP$_4$ L	–	15.0								
dP$_4$ B	–	6.5								
Radius	D.b.1093									
Bp	33.0									
BFp	31.0									
SD	19.0									
DD	10.0									
Ulna	D.b.1096									
BPC	18.0									
Femur	*D.b.570*									
DC	*22.0*									
Tibia	D.b.607	D.b.1521								
Bd	26.0	31.0								
Dd	–	19.5								
Calcaneus	D.b.137									
GB	23.0									
Astragalus	*D.b.555*	*D.b.563*	*D.b.587*	*D.b.595*	D.b.634	D.b.1519				
Bd	–	*20.0*	*22.0*	–	19.0	18.0				
GLl	*29.5*	*32.0*	*34.0*	–	29.0	30.0				
GLm	*28.0*	*31.0*	*32.0*	*31.0*	27.0	28.0				
Dl	*16.0*	*17.0*	*18.5*	*18.0*	17.5	17.0				
Dm	–	–	*18.5*	–	16.5	–				
Phalanx I	D.b.163	D.b.1110	*D.b.1446*	D.b.1447	D.b.1514	D.b.1842	D.b.1847	D.b.1894	D.b.2106	D.b.2107
Bp	14.5	14.0	–	14.0	14.5	14.0	–	–	15.5	11.0
Bd	–	–	*13.0*	–	–	12.0	13.0	12.0	–	–
GL	–	–	–	–	–	49.0	–	–	–	–
SD	–	–	–	–	–	9.0	–	–	–	–
DD	–	–	–	–	–	8.0	–	–	–	–
Phalanx II	D.b.1990 (10-13)	*D.b.109*	*D.b.591*	D.b.742	D.b.1205	D.b.1448	D.b.1510	D.b.1729	D.b.1731	
Bp	14.0	*15.0*	–	–	11.0	13.0	13.0	15.0	14.0	
SD	8.0	–	*8.0*	–	8.0	–	–	10.0	–	
Bd	10.0	–	*8.5*	–	7.5	–	–	12.0	–	
GL	30.0	–	*31.5*	35.5	24.0	–	–	51.0	–	

Capra ibex	Measures		
Tibia	D.b. 1091	D.b. 1181	D.b. 1520
Bd	34.0	34.0	31.0
Dd	26.5	–	23.0
Phalanx II	D.b. 1162	D.b. 1317	
Bp	18.0	16.0	

◁◁

Pril. 11.1J: Mere ostankov alpskega kozoroga (*Capra ibex*). Vse najdbe so iz OIS 3. Vse mere so v mm.
Annex. 11.1J: Measurements of the remains of alpine ibex (*Capra ibex*). All finds are from OIS 3. All measurements are in mm.

Pril. 11.2A: Razporeditev kranialnih in postkranialnih najdb alpskega svizca (*Marmota marmota*) iz Divjih bab I po plasteh. V kategoriji "other" (= ostalo) so vključeni naslednji skeletni elementi: clavicula, costae. Legenda: LU – plast neznana, OIS 3 – interpleniglacial (natančnejša časovna umestitev ni mogoča).

Annex 11.2A: Distribution of cranial and post-cranial finds of alpine marmot (*Marmota marmota*) from Divje babe I by layers. The category "other" includes the following skeletal elements: clavicula, costae. Legend: LU – layer unknown, OIS 3 – Interpleniglacial (a more exact temporal classification is not possible).

Layer	**Cranium**	**Maxilla**	**Mandibula**	**Dentes**	**Atlas / Axis**	**Vertebrae**	**Scapula**	**Humerus**	**Radius**	**Ulna**	**Ossa carpalia**	**Metacarpalia**	**Phalanges**	**Ossa coxae**	**Femur**	**Patella**	**Tibia**	**Fibula**	**Ossa tarsalia**	**Metatarsalia**	**Metapodia**	**Other**	**TOTAL**
2-5	6	4	8	56	2		2	14	4	3		2	29	4	6		8	2	14	5	13	4	186
6																							–
6-7													1										1
7													2								1		3
7-8						1								1									2
8			1	4			1					1	7	2	1		4	1	1	1	4		28
8-10													1										1
9																							–
10				1								1											2
OIS5				1																			1
LU			2	3		1								1	1	1			1				10
Σ	6	4	11	65	2	2	3	14	4	3	–	4	40	8	8	1	12	3	16	6	18	4	234

Pril. 11.2B: Razporeditev kranialnih in postkranialnih najdb rjavega medveda (*Ursus arctos*) iz Divjih bab I po plasteh. V kategoriji "other" (= ostalo) so vključeni naslednji skeletni elementi: costae, os penis. Legenda: LU – plast neznana, OIS 3 – interpleniglacial (natančnejša časovna umestitev ni mogoča), OIS 5 – zgodnji glacial (natančnejša časovna umestitev ni mogoča).

Annex 11.2B: Distribution of cranial and post-cranial finds of brown bear (*Ursus arctos*) from Divje babe I by layers. The category "other" includes the following skeletal elements: costae, os penis. Legend: LU – layer unknown, OIS 3 – Interpleniglacial (a more exact temporal classification is not possible), OIS 5 – Early Glacial (a more exact temporal classification is not possible).

Layer	**Cranium**	**Maxilla**	**Mandibula**	**Dentes**	**Atlas / Axis**	**Vertebrae**	**Scapula**	**Humerus**	**Radius**	**Ulna**	**Ossa carpalia**	**Metacarpalia**	**Phalanges**	**Ossa coxae**	**Femur**	**Patella**	**Tibia**	**Fibula**	**Ossa tarsalia**	**Metatarsalia**	**Metapodia**	**Other**	**TOTAL**
1-7											1					1							2
1-13													1										1
2-5			4	37		1					4	4	13						1	3		1	68
3-7				1																			1
6	1			2												1							4
6-7																							–
7				2		1																	3
7-8																							–
8			2	17	1	3			4		2		5			1				1			36
8-10				2																1			3
9																				1			1
9-13												2											2
10				11							1	2	1				2						17
10-11				1																			1
10-13																				2			2
11			1	2									1										4
11-12				1																			1
11-13				1																			1
OIS3			1																	1			2
12																						1	1
12-13				3									1									1	5
13				2								3	4						1				10
13-14				2																1			3
13-16												1	1										2

continued...

Pril. 11.2B / *Annex 11.2B* (nadaljevanje / cont.)

Layer	Cranium	Maxilla	Mandibula	Dentes	Atlas / Axis	Vertebrae	Scapula	Humerus	Radius	Ulna	Ossa carpalia	Metacarpalia	Phalanges	Ossa coxae	Femur	Patella	Tibia	Fibula	Ossa tarsalia	Metatarsalia	Metapodia	Other	TOTAL
14				1								2	3										6
14-16																				1			1
16				1																			1
17																							–
17a													2								1		3
17-19												1											1
OIS5			1	1								1	1										4
LU				2								4							1				7
Σ	1	–	9	89	1	5	–	–	4	–	8	20	33	–	–	3	2	–	3	11	1	3	193

Pril. 11.2C: Razporeditev kranialnih in postkranialnih najdb volka (*Canis lupus*) iz Divjih bab I po plasteh. V kategoriji ”other” (= ostalo) so vključeni naslednji skeletni elementi: costae, os penis. Legenda: LU – plast neznana, OIS 5 – zgodnji glacial (natančnejša časovna umestitev ni mogoča).
Annex 11.2C: Distribution of cranial and post-cranial finds of wolf (*Canis lupus*) from Divje babe I by layers. The category ”other” includes the following skeletal elements: costae, os penis. Legend: LU – layer unknown, OIS 5 – Early Glacial (a more exact temporal classification is not possible).

Layer	Cranium	Maxilla	Mandibula	Dentes	Atlas / Axis	Vertebrae	Scapula	Humerus	Radius	Ulna	Ossa carpalia	Metacarpalia	Phalanges	Ossa coxae	Femur	Patella	Tibia	Fibula	Ossa tarsalia	Metatarsalia	Metapodia	Other	TOTAL
1-7												1											1
2-5		1	2	13	1	2			1		3	2	27		1			2	6	3		1	65
3-7																				1			1
6				2									4		1						1		8
6-7				2																			2
7				1							1		2							1		1	6
7-8												1											1
8			1	6	1	1					1	1	4							4	3	1	23
8-10													2							2			4
9																			1				1
9-13						1					1												2
10				5		2	1				5	4	6						2	1			26
10-11																							–
10-13													1										1
11								1															1
11-12																						1	1
12																			1				1
12-13																							–
13						1							2										3
13-14																							–
14						1																	1
14-16																							–
16																							–
17									1														1
17a																				1			1
17-19																							–
18																							–
20																							–
21																	1						1
OIS5				1																2			3
LU					1	2		1	1	1		2	1				1		1	1		1	13
Σ		1	3	30	3	10	1	2	3	1	11	11	49	–	2	–	2	2	11	16	4	5	167

Pril. 11.2D: Razporeditev kranialnih in postkranialnih najdb navadnega dihurja (*Mustela putorius*) v vzorcu iz Divjih bab I po plasteh. V kategoriji "other" (= ostalo) so vključeni naslednji skeletni elementi: costae, clavicula.
Annex 11.2D: Distribution of cranial and post-cranial finds of European polecat (*Mustela putorius*) in the sample from Divje babe I by layers. The category "other" includes the following skeletal elements: costae, clavicula.

Layer	**Cranium**	**Maxilla**	**Mandibula**	**Dentes**	**Atlas / Axis**	**Vertebrae**	**Scapula**	**Humerus**	**Radius**	**Ulna**	**Ossa carpalia**	**Metacarpalia**	**Phalanges**	**Ossa coxae**	**Femur**	**Patella**	**Tibia**	**Fibula**	**Ossa tarsalia**	**Metatarsalia**	**Metapodia**	**Other**	**TOTAL**
2-5		2	2	1	1	14	2		2	2		2	2	2	2		2	2	2	1	1	4	46
6																							–
6-7																							–
7																							–
7-8																							–
8			1	1																			2
8-10																					1		1
9																							–
10																							–
10-11																							–
11				1																			1
Σ	–	2	3	3	1	14	2	–	2	2	–	2	2	2	2	–	2	2	2	1	2	4	50

Pril. 11.2E: Razporeditev kranialnih in postkranialnih najdb kune zlatice (*Martes* cf. *martes*) iz Divjih bab I po plasteh. V kategoriji "other" (= ostalo) so vključeni naslednji skeletni elementi: costae. Legenda: OIS 5 – zgodnji glacial (natančnejša časovna umestitev ni mogoča).
Annex 11.2E: Distribution of cranial and post-cranial finds of pine marten (*Martes* cf. *martes*) from Divje babe I by layers. The category "other" includes the following skeletal elements: costae. Legend: OIS 5 – Early Glacial (a more exact temporal classification is not possible).

Layer	**Cranium**	**Maxilla**	**Mandibula**	**Dentes**	**Atlas / Axis**	**Vertebrae**	**Scapula**	**Humerus**	**Radius**	**Ulna**	**Ossa carpalia**	**Metacarpalia**	**Phalanges**	**Ossa coxae**	**Femur**	**Patella**	**Tibia**	**Fibula**	**Ossa tarsalia**	**Metatarsalia**	**Metapodia**	**Other**	**TOTAL**
2-5	1		4	12	1			1	1			4	5		3		1		3	3	1		40
5-6													1						1		1		3
6						1		1					1										3
6-7						1			1	2		1	2					1	1	1			10
7					7							1	2						1		1		12
7-8			1																				1
8			2	5		4		1		2			4		1		2			1			22
8-10				1	1				1				1										4
9																							–
10			3	3		2						1	2							1			12
10-11				1																			1
10-13				1																			1
11				2								1											3
11-12				1																			1
12					1																		1
12-13													1										1
13				2					1						1								4
13-14																							–
14																			1	1			2
14-16																							–
16				1					2	1					2								6
16-17								2	1						1							3	7
17			1																	1			2
OIS5			1												1		1						3
Σ	1	–	12	29	10	8	–	5	7	5	–	8	19	–	9	–	4	1	7	8	3	3	139

Pril. 11.2F: Razporeditev kranialnih in postkranialnih najdb gamsa (*Rupicapra rupicapra*) iz Divjih bab I po plasteh. V kategoriji "other" (= ostalo) so vključene sezamoidne kosti. Legenda: OIS 5 – zgodnji glacial (natančnejša časovna umestitev ni mogoča), LU – plast neznana.

Annex 11.2F: Distribution of cranial and post-cranial finds of chamois (*Rupicapra rupicapra*) from Divje babe I by layers. The category "other" includes sesamoid bones. Legend: OIS 5 – Early Glacial (a more exact temporal classification is not possible), LU – layers unknown.

Layer	**Cranium**	**Maxilla**	**Mandibula**	**Dentes**	**Atlas / Axis**	**Vertebrae**	**Scapula**	**Humerus**	**Radius**	**Ulna**	**Ossa carpalia**	**Metacarpalia**	**Phalanges**	**Ossa coxae**	**Femur**	**Patella**	**Tibia**	**Fibula**	**Ossa tarsalia**	**Metatarsalia**	**Metapodia**	**Other**	**TOTAL**
2-5			1	21			1		3	1	11	1	12	1			1		4	4			61
5-7				1																1			2
6				1															1				2
6-7				2							1		1								1	1	6
7				1																			1
7-8																							–
8				1							5		6						1				13
8-10																							–
8-13													1										1
9																							–
10															1				1		1		3
10-11																							–
10-13													1										1
11																					1		1
11-12																							–
12																							–
12-13																							–
13				2																			2
13-14																							–
14													1										1
14-16																							–
16																							–
17																							–
17a											3				1				2				6
17-19																							–
18													1									1	2
20												1							2				3
21													1										1
OIS5													1						1				2
LU				1									1				1					1	4
Σ	–	–	1	30	–	–	1	–	3	1	20	2	26	1	2	–	2	–	12	5	3	3	112

12. JAMSKI MEDVED V NAJDIŠČU DIVJE BABE I: TAFONOMSKO-STRATIGRAFSKA ANALIZA

IVAN TURK in JANEZ DIRJEC

Fosilni ostanki jamskega medveda so, zaradi svoje številčnosti in zvezne porazdelitve v profilu najdišča, druga največja zakladnica podatkov in informacij o najdišču, takoj za sedimenti. So pomemben del sistema, ki ga predstavlja najdišče kot celota. V tem in nadaljnjih poglavjih povzemamo samo del vsega, kar ti ostanki ponujajo raziskovalcem. Veliko žal ostaja neraziskanega zaradi pomanjkanja časa in dobrih idej ter predvsem neustreznih raziskovalnih metod.

12.1. UVOD V TAFONOMSKO ANALIZO

Izvleček

Vsi ostanki jamskega medveda, pridobljeni z mokrim sejanjem na sitih z odprtino luknjic 0,5 mm, 3 mm in 10 mm, iz bloka stratificiranih sedimentov s prostornino 95 m^3 na t. i. površini B in delu površine A izkopnega polja (*sl. 1.3*), so bili sistematično kvantitativno in kvalitativno obdelani. Ker imajo sedimenti vseh stratigrafskih enot, tj. sedimentacijskih nivojev v bloku enako prostornino (glej poglavje 1 v tem zborniku), pri obdelavi najdb ni bilo treba operirati z njihovimi deleži ali najdb uteževati. Blok sedimentov predstavlja samo 5 % vse razpoložljive prostornine v stratigrafskem nizu najdišča, vendar je dovolj reprezentativen v primerih, ko vsebuje veliko število najdb in analitskih podatkov, kar je za blok običajno (glej *tab. 12.2.1, 12.3.1* in *12.4.1*). Poseben preizkus je pokazal, da so povsem zanesljivi samo podatki, zbrani v sedimentacijskih nivojih s površino, večjo od 15 m^2 (glej *sl. 1.4a, b; 1.5a, b; tab. 1.2; 1.3*). Površina vsakega sedimentacijskega nivoja v bloku sedimentov je bila 21 m^2.

Tafonomske raziskave imajo v Sloveniji dolgo zgodovino, ki kaže da niso nastale čez noč. Prvi poskusi segajo v obdobje S. Brodarja (1935), ki je podal sistematični semikvantitativni-kvalitativni popis skeletnih najdb jamskega medveda v najdišču Njivice. Brodarjev poskus je ostal osamljen vse do raziskav v Divjih babah I (Turk, Dirjec 1988–1989, 1991; Turk *et al.* 1988–1989, 1990, 1992) in Potočki zijalki (Pacher 2004b; Pacher, Marinelli 2004), čeprav je bilo v Sloveniji od takrat pa do danes odkritih veliko paleolitskih najdišč s številnimi ostanki jamskega medveda[1].

Vzorec fosilnih ostankov jamskega medveda predstavlja celotno najdišče Divje babe I. Ker ni mogoče raziskati celega najdišča in ker je treba pustititi kontrolni blok sedimentov, lahko vse najdene ostanke označiva kot podvzorec. Ostankov v podvzorcu je toliko, da bi analiza vseh vzela preveč časa, razen tega je med izkopavanji prišlo do različnih motenj, kot so podori, spremembe v geometriji jamskega tlorisa ipd., ki so negativno vplivale na skrbno načrtovano analizo[2]. Po koncu druge faze izkopavanj in temeljitem pregledu vsega razpoložljivega gradiva sva se zato odločila analizirati najdišče na podlagi bloka sedimentov s prostornino 95 m^3 na t. i. površini B in delu površine A izkopnega polja (glej Turk 2003a in poglavje 1 v tem zborniku, *sl. 1.3*). Blok sedimentov predstavlja samo 5 % vse razpoložljive prostornine v stratigrafskem nizu najdišča, vendar meniva, da je dovolj reprezentativen v primerih, ko vsebuje veliko število najdb in analitskih podatkov, kar je za blok običajno. Razen tega so vsebine in analitski podatki v bloku (podvzorcu) fizično še obvladljive, medtem ko bi analiza večjega podvzorca zahtevala veliko več časa, pri čemer ne bi bil zagotovljen bistveno boljši rezultat.

Pri kvantitativno-kvalitativni analizi fosilnih ostankov jamskega medveda sva se zavedala, da so ti podvrženi zakonitostim skupne vsote. Skupno vsoto predstavlja število skeletnih delov in zob, ki je pri vsakem medvedu enako. Zato morajo biti rezultati kvantitativnih analiz na podlagi vsakega skeletnega dela ali zoba v normalnih

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[1] Nemara je bila prav številčnost ostankov kriva, da se te najdbe niso posebej obravnavale. Obdelava in razlaga velikega števila najdb zahteva namreč veliko časa, predvsem pa posebno metodologijo. Oboje pri maloštevilnih najdbah, o katerih se lahko na dolgo in široko razpišemo, ni potrebno. Razen tega sta rezultat in razlaga takoj na dlani.

[2] Izkopavanja v letih 1989–1999 so zajela 265 m^3 sedimentov. V njih je bilo 29.093 stalnih zob (od tega 11.669 stalnih adultnih, 852 adultnih kaninov in 2.488 juvenilnih kaninov), 44.856 mlečnih zob (od tega 20.186 kaninov in od teh 7.811 z resorbirano koreninо), 29.886 zobnih fragmentov in več kot miljon kostnih ostankov, ki so tehtali 2.300 kg. Med kostmi je bilo 95 % odlomkov, manjših od 5 cm. Določljivih odlomkov je bilo 14 %. Podrobnejši pregled kosti je podan v *tab. 12.3.1, 12.4.1, 12.4.5* in *12.4.7.*

okoliščinah[3] primerljivi z rezultatom na podlagi katerega koli drugega skeletnega dela ali zoba. Povezave, ki izhajajo iz skupne vsote, ne morejo služiti kot dokaz za pravilnost neke metode, uporabljene v analitskem postopku. Ker metoda pogojuje rezultat, je pričakovati podobne rezultate pri vseh tafonomskih analizah skeletnih delov in zob, v kolikor je podvzorec dobro izbran in nimamo opraviti z izjemnimi okoliščinami oz. tafonomskimi motnjami.

Kot pri vseh zgodovinskih raziskavah, ki temeljijo na materialnih virih, shranjenih v nederjih zemlje, sta tudi pri tafonomskih nadvse pomembna prostor in čas. V vlogi prostora je pomembna njegova razsežnost. Ključno vprašanje je, kakšna velikost prostora je reprezentativna v smislu zanesljivosti izsledkov raziskav in njihovih interpretacij. Odgovor za naše najdišče sva poiskala s pomočjo preprostega preizkusa.

V dveh sedimentacijskih nivojih (–81 cm = facija A in –381 cm = facija B) z različno gostoto vseh najdb sva izbrala nekaj podatkov, ki so predmet analize v tem zborniku in njihove vrednosti seštela kumulativno po kvadratih in režnjih (glej poglavje 1 v tem zborniku, *tab. 1.2; 1.3*). Tako sva postopno večala prostorsko komponento najdišča, ne da bi teoretično spreminjala časovne. Najdbe sva izbrala tako, da sva upoštevala najpogostejše in najmanj pogoste. Podatke o najdbah v posameznih prostorskih enotah sva spremenila v razmerja in jih prikazala v diagramih (glej poglavje 1 v tem zborniku, *sl. 1.4a, b; 1.5a, b*). Razmerja v majhnih prostorskih enotah (1–14 m^2) zelo variirajo. Rezultati in razlage so zato nezanesljivi. Zanesljiv rezultat lahko dobiva zgolj naključno. Razmerja v prostorskih enotah, večjih od 14 m^2, so bistveno manj spremenljiva, zato so rezultati in razlage zanesljivejši.

Videti je, da se zakonitost prostora ne spreminja, če se spreminjata gostota najdb in čas. Dolge velike kosti okončin so med najmanj pogostimi najdbami, vendar se na velikost prostora odzivajo podobno kot najpogostejše najdbe. Meja med nezanesljivim in zanesljivim rezultatom je nekako pri 15 m^2 (*tab. 1.2*). Do podobnega sklepa sva prišla s primerjanjem dveh različno bogatih sedimentacijskih nivojev, ki predstavljata različna časovna horizonta (*sl. 1.5a, b*). Edino izjemo predstavljajo zgornje čeljustnice, ki jih je v nivoju –381 cm skoraj trikrat manj kot v nivoju –81 cm, čeprav bi jih moralo biti več (prim. *tab. 1.2* in *1.3*). To pomeni resno motnjo v razmerju med zgornjimi in spodnjimi čeljustnicami (*sl. 1.5 b*), ki zahteva ločeno obravnavo. O tem več v nadaljevanju.

12.2 IZOLIRANI ZOBJE

Izvleček

Izolirane zobe sta avtorja analizirala kvantitaivno in kvalitativno v bloku sedimentov, razdeljenem v dva dela (facija A in B), ki skupaj obsegata 37 stratigrafskih enot, tj. sedimentacijskih nivojev. Ugotovila sta, da je v faciji A več mlečnih zob (*sl. 12.2.1*), toda manj mlečnih kaninov, vključno s kanini z resorbirano korenino (*sl. 12.2.9a,b*). V faciji A je tudi več spodnjih zob (*sl. 12.2.3*) in adultnih kaninov (*sl. 12.2.7a,b*), več je tudi zobnih fragmentov (*sl. 12.2.2*). Razlike razlagata s spremembo v strukturi medvedje populacije, prisotne v jami, na katero je vplivala klima, predvsem padavine, in z dejavnostjo paleolitskega človeka, ki je domnevno odnašal lobanje in kanine. Razlike med facijami so skladne z razlikami, ki temeljijo izključno na sedimentoloških podatkih. Razlikovanje med plastmi na podlagi posamično najdenih zob ni možno.

Zastopanost izoliranih zob (ZIZ) je podobno kot zastopanost skeletnih delov (ZSD) pomemben del tafonomske analize.

Veliko najdenih izoliranih zob dokazuje, da so zobje večinoma izpadli iz čeljustnic po smrti. To nedvomno drži za stalne zobe, manj za mlečne. Resorbirane korenine mlečnih zob, zlasti kaninov, namreč dajo slutiti, da so nekateri mlečni zobje izpadli pri izraščanju stalnih zob. Zob, ki so ostali v čeljustnicah, v analizi nisva upoštevala, vendar jih je tako malo, da ne vplivajo na njen rezultat.

Zobje so tako kot kosti fragmentirani. O tem pričajo zelo številni nedoločljivi odlomki zob (*tab. 12.2.1*). V povprečju sva zabeležila en odlomek na en stalen zob. Dejansko je moralo biti fragmentov bistveno več, ker smo s preverjanjem ugotovili, da smo jih pobrali le za vzorec, morda povprečno 20 %. Za razliko od kosti zobje razpadajo brez posredovanja ljudi in zveri. Fragmentacija je zlasti pogosta pri mlečnih in stalnih zobeh v fazi izraščanja, ko so zobje votli.

METODA IN GRADIVO

Vzorec analiziranih zob je bil pridobljen z mokrim sejanjem vseh sedimentov na treh sitih hkrati, pri čemer je imelo spodnje sito premer luknjic 0,5 mm, preostali dve pa 3 mm in10 mm.

Takšen način vzorčenja je veliko natančnejši od vzorčenja brez sejanja, ki smo ga uporabljali pred letom 1990. To dokazuje primerjava vzorca, objavljenega leta 1992 (Turk *et al.*), ki je v bloku sedimenta s prostornino 40 m^3 vseboval 2.003 stalne zobe (Turk *et al.* 1992, tab 2), medtem ko novi vzorec v bloku sedimentov s prostornino 95 m^3 vsebuje 13.851 stalnih zob (*tab. 12.2.1*). Oba vzorca, ki sta oddaljena drug od drugega 4 m, obsegata iste plasti. Razlika v količini je velika in ni edina. Različna je tudi struktura zob. V starem vzorcu je bilo 1.469 adultnih zob in 534 juvenilnih. Pri enakem kriteriju za adultne in juvenilne zobe je v novem vzorcu 4.736 adultnih zob in 9.115 juvenilnih, da o velikih razlikah

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[3] Normalne okoliščine so vse okoliščine razen izjemnih. Npr. normalno sedimentacijo predstavljajo manjši bloki, grušč, pesek in melj, izjemno (katastrofično) pa veliki bloki.

Tab. 12.2.1: Izolirani zobje, razvrščeni po sedimentacijskih nivojih na površini B (21 m^2, skupno 83 m^3 ali 33 nivojev po 2,5 m^3 sedimenta). Prvi štirje nivoji so s površine A (25 m^2, skupno 12 m^3 ali 4 nivoji po 3 m^3 sedimenta). Stolpci 10–22 so stalni adultni zobje. Vse gradivo je določil J. Dirjec.

Tab. 12.2.1: Isolated teeth classified by sedimention level in area B (21 m^2, total 83 m^3 or 33 levels of 2.5 m^3 of sediment). The first four levels are from area A (25 m^2, total 12 m^3 or 4 levels of 3 m^3 of sediment). Columns 10–22 are permanent adult teeth. All material determined by J. Dirjec.

Sedimentation level (cm)	Facies	Permanent	Deciduous	Fragments	Permanent, adul.	Canines permanent, adul.	Canines permanent, juv.	Canines deciduous	Canines deciduous, resorbed
-20	A	103	165		24	3	12	80	
-32	A	211	481	845	42	4	25	208	11
-44	A	252	631	719	60	5	35	258	11
-56	A	315	741	542	87	5	32	303	21
-68	A	245	553	371	71	4	22	207	10
-81	A	356	773	445	95	7	47	302	21
-94	A	370	647	283	109	3	40	241	12
-106	A	280	473	209	83	7	25	178	18
-117	A	131	351	220	34	1	18	124	7
-129	A	111	292	200	34	3	9	95	4
-141	A	137	354	187	37	5	18	121	9
-153	A	126	389	135	32	0	12	158	10
-165	A	126	402	175	40	4	12	153	6
-177	A	132	374	178	32	2	10	137	1
-189	A	93	287	176	37	2	3	122	8
-201***	A	92	315	222	35	3	6	125	6
-213	A	339	505	336	144	17	26	261	21
-225	A	771	806	620	331	46	54	501	87
-237	B	907	1039	743	396	28	73	659	187
-249	B	653	726	500	286	16	57	473	190
-261	B	387	458	274	124	4	24	278	172
-273	B	325	296	199	100	6	32	153	109
-285	B	434	373	247	131	7	46	204	140
-297	B	377	293	217	121	9	41	147	107
-309	B	333	314	165	85	6	31	162	107
-321	B	409	312	203	85	9	42	150	116
-333***	B	623	578	285	152	13	54	284	206
-345	B	471	449	222	150	13	36	216	148
-357	B	545	541	263	201	14	48	248	185
-369	B	586	610	254	248	14	51	318	237
-381	B	859	977	415	326	21	69	508	406
-393	B	688	1016	418	253	19	63	508	402
-405***	B	567	798	333	184	18	54	358	206
-417	B	509	565	182	167	18	51	257	182
-429	B	517	519	227	177	15	49	235	155
-441	C-1	342	469	203	150	9	19	188	135
-453	C-1	129	297	112	73	2	6	129	85
SUM	*A–C-1*	*13851*	*19169*	*11325*	*4736*	*362*	*1252*	*9049*	*3738*
MEDIAN		*342*	*473*	*237*	*100*	*7*	*32*	*208*	*97*
25th%		*137*	*351*	*199.5*	*42*	*4*	*18*	*150*	*10.5*
75th%		*517*	*631*	*393*	*167*	*14*	*49*	*284*	*177*
SUM	*A*	*4190*	*8539*	*5863*	*1327*	*121*	*406*	*3574*	*263*
SUM	*B*	*9190*	*9864*	*5147*	*3186*	*230*	*821*	*5158*	*3255*

continued...

Tab. 12.2.1 (nadaljevanje / cont.)

Sedimentation level (cm)	I1 superior	I2 superior	I3 superior	P4 superior	M1 superior	M2 superior	I1 inferior	I2 inferior	I3 inferior	P4 inferior	M1 inferior	M2 inferior	M3 inferior
-20	2	4	2	2	0	0	3	3	4	2	3	0	1
-32	3	3	7	2	1	0	8	6	6	3	3	1	2
-44	3	4	10	2	4	0	10	11	4	9	9	1	1
-56	7	5	11	3	2	2	15	8	13	14	7	4	2
-68	8	8	9	2	3	1	11	4	12	5	9	5	1
-81	8	11	11	4	3	1	11	21	9	8	8	4	1
-94	7	23	14	5	2	0	22	12	11	6	4	2	5
-106	7	14	9	7	4	1	14	9	9	2	6	4	3
-117	4	1	3	3	2	1	7	5	3	1	3	4	0
-129	2	3	4	4	0	1	3	5	5	5	0	1	1
-141	2	3	3	1	1	2	4	7	5	7	5	2	1
-153	2	8	3	2	0	0	1	6	5	3	3	0	1
-165	4	6	3	2	0	1	5	6	4	5	5	0	1
-177	4	5	2	2	0	0	4	5	1	5	5	1	2
-189	4	6	5	1	1	1	3	3	5	4	4	0	1
-201***	1	5	2	3	1	3	4	7	4	4	4	2	0
-213	17	13	15	10	9	1	18	25	11	8	12	13	6
-225	38	41	25	17	17	8	34	47	43	23	32	24	23
-237	42	38	27	25	20	25	44	41	48	44	37	19	18
-249	35	24	34	13	12	11	35	28	24	35	18	12	14
-261	7	18	16	7	4	3	20	17	18	7	14	0	1
-273	9	10	16	3	3	2	14	13	12	9	9	2	1
-285	12	18	19	5	5	7	14	12	16	11	12	3	1
-297	6	15	23	4	5	2	13	17	16	14	8	4	5
-309	2	4	13	3	3	2	19	25	9	3	3	2	2
-321	3	8	10	6	6	6	18	13	8	4	6	3	2
-333***	10	13	15	9	12	8	17	24	23	11	17	4	4
-345	11	18	18	9	8	5	23	14	19	14	6	9	5
-357	17	24	17	12	11	8	29	23	29	14	20	3	5
-369	28	28	23	12	21	8	37	29	18	16	19	8	16
-381	34	38	25	21	13	7	44	40	44	26	29	17	7
-393	16	23	25	24	14	15	37	35	34	14	14	17	7
-405***	12	25	38	7	7	10	21	15	21	16	17	25	6
-417	17	18	15	9	8	6	23	16	22	16	11	8	7
-429	20	12	19	9	14	8	20	23	17	15	17	8	7
-441	5	20	23	9	8	7	17	22	17	17	12	8	3
-453	4	8	7	3	2	0	16	16	8	5	2	1	3
SUM	*413*	*525*	*521*	*262*	*226*	*163*	*638*	*613*	*557*	*405*	*393*	*221*	*166*
MEDIAN	*7*	*12*	*14*	*5*	*4*	*2*	*16*	*14*	*12*	*8*	*8*	*4*	*2*
25th%	*4*	*5*	*7*	*3*	*2*	*1*	*8*	*7*	*5*	*5*	*4*	*1*	*1*
75th%	*16*	*20*	*19*	*9*	*9*	*7*	*22*	*23*	*19*	*14*	*14*	*8*	*6*
SUM	*123*	*163*	*138*	*72*	*50*	*23*	*177*	*190*	*154*	*114*	*122*	*68*	*52*
SUM	*281*	*334*	*353*	*178*	*166*	*133*	*428*	*385*	*378*	*269*	*257*	*144*	*108*

*** Sedimentacijski nivo z ostanki ognjišča. / Sedimentation level with the remains of a hearth.

pri mlečnih zobeh sploh ne govoriva. Te ponazarja naslednja primerjava:

V 54 m^3 sedimenta plasti 16–21 smo našli 1986. leta, ko sedimentov nismo spirali, 126 mlečnih kaninov

Tab. 12.2.2: Izolirani zobje: Spearmanova korelacija ranga za izbrane podatke.
Tab. 12.2.2: Isolated teeth: Spearman's rank correlation for selected data.

	Permanent	Deciduous	Fragments	Permanent, adul.	Canines permanent, adul.	Canines permanent, juv.	Canines deciduous
Permanent	1.00						
Deciduous	0.71	1.00					
Fragments	0.54	0.78	1.00				
Permanent, adul.	0.95	0.70	0.52	1.00			
Canines permanent, adul.	0.89	0.64	0.48	0.91	1.00		
Canines permanent, juv.	0.95	0.75	0.61	0.89	0.88	1.00	
Canines deciduous	0.83	0.93	0.77	0.83	0.75	0.84	1.00
Canines deciduous, absorbed	0.90	0.53	0.35	0.90	0.80	0.84	0.72

Vse korelacije so značilne ($p < 0,05$).
All correlations are significant ($p < 0.05$).

in zanemarljivo število drugih mlečnih zob, ki so precej manjši kot kanini. V samo 1 m^3 sedimenta istih plasti smo našli leta 1997, ko smo sedimente plasti sprali, 120 mlečnih zob, vključno s kanini. Ocenjujeva, da bi v 54 m^3 sedimenta moralo biti 6.480 mlečnih zob. Torej smo jih našli samo 1,9 %. Delo na terenu je bilo v obeh primerih opravljeno z enako natančnostjo, vendar z metodama, ki sta dali drugačen rezultat.

Vse najdbe zob so se na koncu vsake terenske akcije vnesle v posebne obrazce, in sicer za vsak kvadrat in reženj posebej[4]. Opredelitev in vnos je v celoti opravil drugi avtor po vnaprej določenih stalnih kriterijih. Podatki so se pozneje z obrazcev prenesli v računalnik in s pomočjo posebnega programa združili v sedimentacijske nivoje kot osnovne stratigrafske enote, ki so zamenjale na terenu določene plasti. Ker imajo vsi sedimentacijski nivoji enako prostornino, sva lahko analizirala ZIZ brez pretvarjanja osnovnih podatkov v deleže.

Izolirane zobe sva analizirala izključno na na podlagi števila določljivih ostankov (ŠDO), ki sva jih podobno kot pri kosteh razdelila v tri starostne skupine: *adultus*, *juvenilis* in *lactalis*. V skupini *adultus* in *juvenilis* so stalni zobje, ki se razlikujejo po tem, ali so polni ali votli. V skupini *lactalis* so mlečni zobje. Pri tem je treba poudariti, da ni nujno, da se te skupine ujemajo s starostnimi skupinami pri kosteh. To zlasti velja za neonatne kosti in mlečne zobe. Medtem ko pri starostnih skupinah pri kosteh ni prekrivanja, pri zobeh je. V določeni fazi ontogenetskega razvoja zobovja nastopajo skupaj mlečni in juvenilni stalni zobje oziroma stalni juvenilni in adultni zobje. To povzroča velike težave pri analizi zastopanosti izoliranih zob in predvsem pri razlagi izsledkov analiz.

Zobe sva analizirala in interpretirala skupinsko, razdeljene, kot rečeno, v stalne in mlečne. Edino izjemo sva naredila pri stalnih adultnih zobeh, ki sva jih preučila ločeno od drugih zob. Ti zobje so imeli zaradi svoje trdnosti največ možnosti, da se ohranijo, zaradi velikosti pa smo jih tudi najlažje našli.

Za kvantitativno analizo podatkov sva uporabila statistično metodo, in sicer parametrično za normalno porazdeljene podatke in neparametrično za nenormalno porazdeljene podatke.

TEMELJNE ZNAČILNOSTI VZORCA, VARIABILNOST IN TAFONOMSKI DEJAVNIKI

Vse glavne skupine zob so med seboj močno in značilno povezane (*tab. 12.2.2*), kar je pričakovano glede na to, da pripadajo populaciji, ki je poginila v jami. Izjema so mlečni kanini z resorbirano korenino in nedoločljivi zobni fragmenti. Prvi pripadajo populaciji, ki domnevno ni poginila v najdišču. Drugi niso bili tako sistematično pobrani kot celi zobje.

V faciji A je značilno več mlečnih zob na stalni zob kot v faciji B (*sl. 12.2.1*), kar pomeni, da je bilo več mladičev in posledično tudi več samic. Več mladičev kaže na spremenjeno funkcijo brloga. Sprememba je povezana z vedenjskim vzorcem medvedjih populacij, na katerega so vplivali zunanji, predvsem klimatski dejavniki. Klima v faciji A ni bila tako vlažna kot v faciji B

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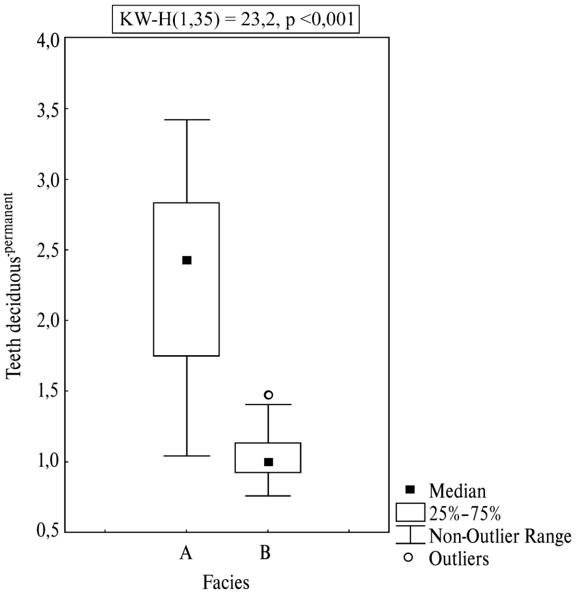
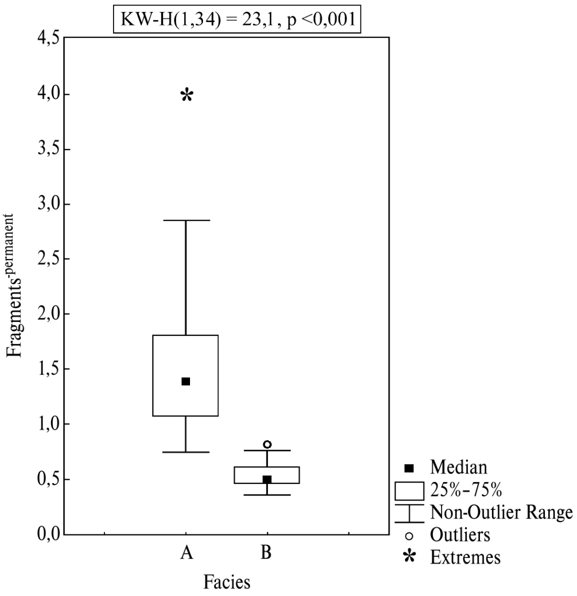
[4] Izpolnili smo 2.208 obrazcev, od katerih je imel vsak 81 okenc. Originalne obrazce hrani arhiv Inštituta za arheologijo ZRC SAZU in arhiv Narodnega muzeja Slovenije.



Sl. 12.2.1: Razmerje mlečni zobje : stalni zobje v facijah A in B. Podan je tudi rezultat Kruskalovega in Wallisovega testa.
Fig. 12.2.1: *Fig. 12.2.1*: Ratio of milk teeth: permanent teeth in facies A and B. The results of the Kruskal-Wallis test are also given.



Sl. 12.2.2: Razmerje nedoločljivi zobni fragmenti : stalni zobje v facijah A in B. Podan je tudi rezultat Kruskalovega in Wallisovega testa.
Fig. 12.2.2: Ratio of unidentifiable tooth fragments : permanent teeth in facies A and B. The results of the Kruskal-Wallis test are also given.

(glej poglavje 5 v tem zborniku). Ker so jamski medvedi iskali zavetje v jami predvsem pred vlago in ne pred mrazom, je prišlo v faciji B domnevno do vdora dominantnih, odraslih samcev v jamski brlog. Zato je tedaj prezimovalo manj samic z mladiči.

Povprečni količnik med nedoločljivimi zobnimi fragmenti in stalnimi zobmi je 1. Popolnoma jasno je, da je podcenjen. V faciji A je ta količnik značilno večji kot v faciji B (*sl. 12.2.2*). To se ujema z večjo splošno fragmentacijo kosti v faciji A, ki sva jo razložila z delovanjem zveri (glej podpoglavje 12.3 v tem zborniku). Ker pri fragmentaciji zob takšna razlaga ne pride v poštev, saj gre bolj ali manj za naraven, abiotski proces, je vprašanje, kako razložiti skladnost izsledkov pri zobeh in kosteh. Z odgovorom je treba počakati do konca analize zobnih kvot.

Kvote stalnih adultnih zob (*tab. 12.2.1*) sva podrobneje analizirala, ker so bili ti zobje med vsemi najdbami jamskega medveda najzanesljiveje pobrani in ker so nekateri še vedno iskana trofeja in spominek.

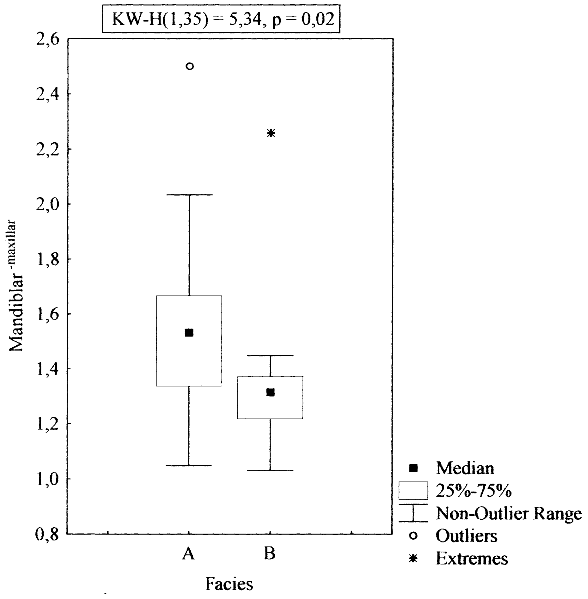
Temeljna značilnost kvot adultnih zob je, da je spodnjih vedno več kot zgornjih. To velja za vsak zob posebej in za vse skupaj ter pomeni, da v raziskanih sedimentacijskih nivojih sistematično manjka določeno število teh zob ali njim pripadajočih lobanj. Stanje lahko razloživa: 1.) s fragmentacijo, 2.) z izraščanjem zob, in 3.) z odnašanjem čeljustnic.

Po vrsti si oglejmo razlage za vse tri dejavnike, ki so domnevno vplivali na zobe in povzročili razlike v zastopanosti zgornjih in spodnjih zob.

Na en zgornji zob pride povprečno 1,3 spodnjega, če spodnje zobovje številčno izenačiva z zgornjim, tako da izločiva bodisi vse druge spodnje molarje bodisi vse tretje. V faciji A je ta količnik značilno večji kot v faciji B (*sl. 12.2.3*). To pomeni bodisi da so bili zgornji zobje v faciji A bolj fragmentirani bodisi da je bilo v faciji A selektivno odstranjenih več lobanj in zgornjih čeljustnic kot spodnjih čeljustnic.

Ker je adultna lobanja običajno v enem kosu, spodnja čeljustnica pa v dveh, so možnosti za naravne premike pri spodnjih čeljustnicah večje in bi zato pričakovala v takšnem primeru več zgornjih zob. Ti so v povprečju večji kot spodnji, zato bi bili lahko bolj fragmentirani, in sicer najbolj kanini, nekoliko manj zgornji drugi molarji itd. Že bežen pogled v *tab. 12.2.1* pove, da ni tako. Če so zgornji zobje naravno bolj razpadli, se je povečala kvota nedoločljivih fragmentov, kar je dejansko razvidno v faciji A. Po tej razlagi bi zobe doletela podobna usoda kot kosti, iz česar bi sledilo, da so nepravilnosti pri zobnih kvotah povzročile zveri, ki so bodisi požrle bodisi zdrobile zobe. To je seveda nesprejemljivo podobno kot je nesprejemljivo, da so vse kosti razpadale selektivno v času zaradi delovanja abiotskih dejavnikov.

Zgornji in spodnji zobje izraščajo pri rjavem medvedu sočasno, vprašanje pa je, če so tudi pri jamskem medvedu in če so se sočasno tudi zapolnili z dentinom. Če bi spodnji zobje izraščali pred zgornjimi in se prej zapolnili, bi lahko prišlo do nesorazmerne ohranjenosti zaradi naravne fragmentacije. Domnevo sva preverila na spodnjih zobeh, pri katerih se najprej zapolni prvi molar, sledita pa mu približno obenem četrti premolar



Sl. 12.2.3: Razmerje stalni adultni spodnji zobje : stalni adultni zgornji zobje v facijah A in B. Podan je tudi rezultat Kruskalovega in Wallisovega testa.
Fig. 12.2.3: Ratio of permanent adult lower teeth : permanent adult upper teeth in facies A and B. The results of the Kruskal-Wallis test are also given.

in drugi molar (glej Debeljak 1996). Po številu najdenih primerkov je na prvem mestu četrti premolar (405 zob), sledi prvi molar (393 zob), zadnji pa je drugi molar (221 zob). To ne ustreza zaporedju zapolnjevanja zob, ki je enako zaporedju izraščanja.

Za selektivno fragmentacijo izoliranih zob, ki bi imela osnovo v velikosti in obliki zob, ni dokazov. Vendar še vedno ostane nerešeno vprašanje odmika v izraščanju zob. Za uspešnejše žvečenje je namreč potrebno čim več spodnjih zob in ne obratno. Če bi spodnji zobje zaradi tega zrastli pred zgornjimi, bi se prej zapolnili in bi jih lahko bilo v najdišču več, glede na preverjeno večjo fragmentacijo votlih zob. Zato te možnosti ne moreva povsem izključiti, in to kljub drugačnim ugotovitvam pri sedanjih medvedih. Vendar je treba poudariti, da je tudi spodnjih čeljustnic več kot zgornjih, kar bi kazalo, da se je nekaj dogajalo s kostmi, ne pa z zobmi. Poleg tega se z odmikom v izraščanju zob ne da razložiti razlika med facijami.

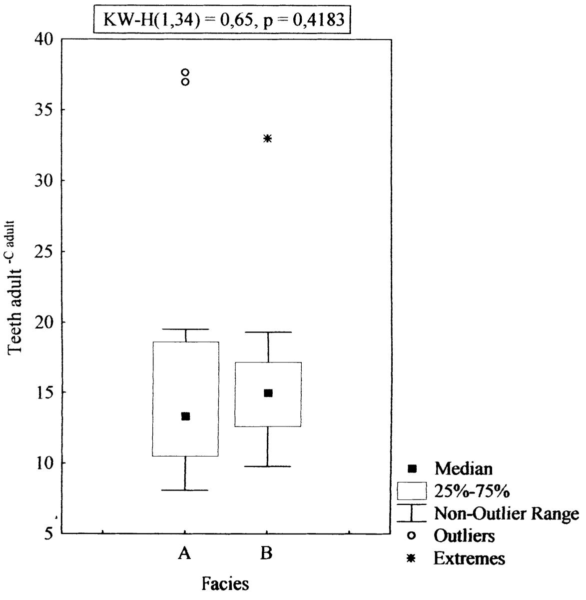
Tretji dejavnik, ki je lahko povzročil nesorazmerno zastopanost spodnjih in zgornjih zob, je povezan s človekom, ki je lahko deloval selektivno v času in prostoru. Če so nepravilnosti v ZIZ povzročili ljudje, so morali redno obiskovati jamo, pri čemer velikokrat niso pustili prepoznavnih ostankov, ki bi pričali o njihovi prisotnosti. Odnašanje lobanj ni bilo vezano na druge, arheološko zaznavne dejavnosti, kot sta kurjenje in prinašanje orodij, je pa lahko povezano s splošno fragmentacijo kosti, ki je prav tako večja v faciji A. To fragmentacijo je težko povezati s selektivno fragmentacijo zob, če nanjo nista vplivali velikost in oblika zob, lahko pa jo poveževa z odmikom v izraščanju zgornjih in spodnjih zob.

Na začetku sva ugotovila, da je v faciji A več odlomkov zob na cel zob kot v faciji B in da se to ujema s splošno fragmentacijo kosti. Vzrok za takšno stanje je zelo verjetno odnašanje lobanj in zgornjih čeljustnic z najdišča, kar je vplivalo tako na sliko fragmentacije zob kot kosti, saj so lobanje skeletni del z največjim številom fragmentov.

PRIMANJKLJAJ KANINOV

Posebnost med zobmi so kanini, ki so bili zaradi svoje velikosti zelo dobro pobrani med izkopavanji in so pozneje služili raznim raziskavam (glej Debeljak 1996, 2002a-c). Po drugi strani so bili zlasti adultni kanini lahko predmet zanimanja paleolitskih obiskovalcev, kar bi imelo za posledico primanjkljaj določenega števila določenih kaninov. Ker so kanini samcev bistveno večji kot kanini samic, bi lahko bili bolj priljubljeni pri paleolitskih zbiralcih trofej.

Če vzameva za primerjavo stvarni količnik med stalnimi zobmi in kanini, ki je 9 (26:4 = 9), in izračunava odstopanja količnikov po sedimentacijskih nivojih, so ti količniki v vseh nivojih, razen v -20 cm, -141 cm in -225 cm, večji. Minimalni količnik je 8,1, maksimalni 37,7 in povprečni 16,9. Največji količniki so v nivojih -94 cm (37,7), -117 cm (37,0), - 261 cm (33,0) in -453 cm (37,5). Med facijama A in B ni statistično značilne raz-



Sl. 12.2.4: Razmerje stalni adultni zobje : stalni adultni kanini v facijah A in B. Podan je tudi rezultat Kruskalovega in Wallisovega testa.
Fig. 12.2.4: Ratio of permanent adult teeth : permanent adult canines in facies A and B. The results of the Kruskal-Wallis test are also given.

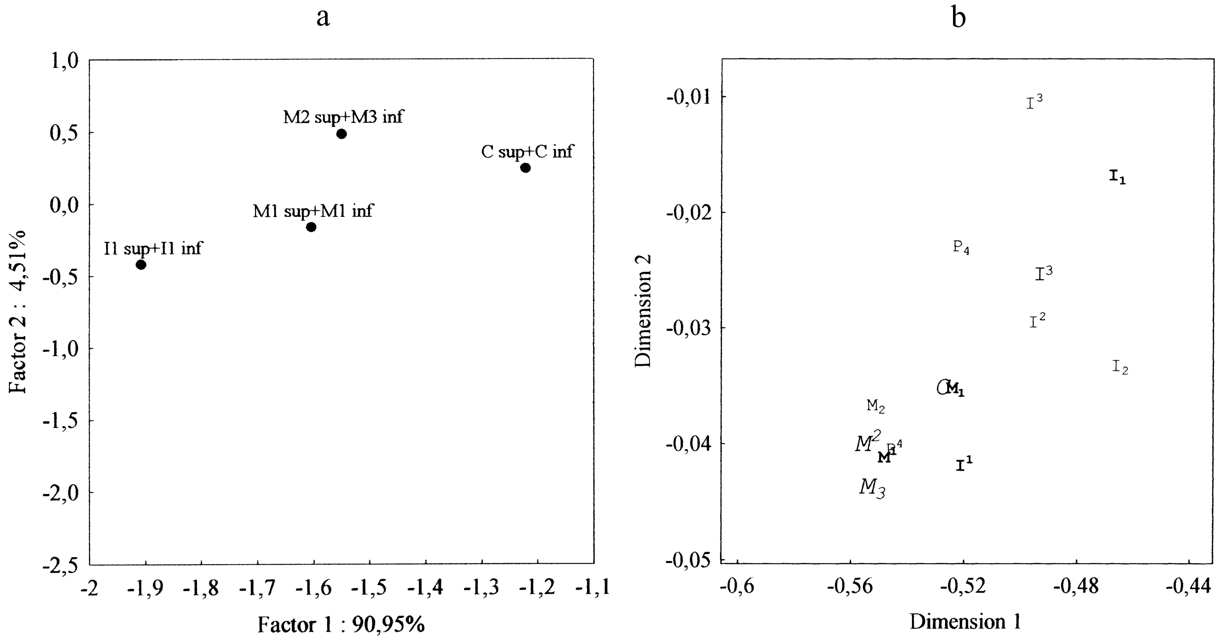
like v vrednosti količnika, kar ne podpira domneve o posegu človeka (*sl. 12.2.4*).

Na premajhne kvote adultnih kaninov je lahko vplivalo ali selektivno razpadanje ali izraščanje in ukoreninjanje stalnih zob v povezavi z obdobjem, v katerem je nastopila smrt. Selektivno razpadanje zaradi preperevanja je malo verjetno, ker smo našli relativno malo, zlahka prepoznavnih fragmentov kaninov, ki sva jih prav zato opredelila za kanine. Ker se kanini ukoreninijo zadnji, jih je lahko vedno manj kot drugih stalnih zob, ki lahko pripadajo večji množici medvedov, katerih stalni zobje so dobili zaprte korenine malo pred kanini. Zato je umestna primerjava kaninov v facijah tako z M^2 in M_3, ki dosežeta fazo *adultus* tik pred kanini, kot z zgornjimi in spodnjimi I1 ter M1, ki dosežejo fazo *adultus* prvi in precej pred kanini. Ker so vsi podatki korenjeni z drugim korenom normalno porazdeljeni, sva za primerjavo med facijami lahko uporabila parametrične statistike (*sl. 12.2.5a,b* in *12.2. 6*).

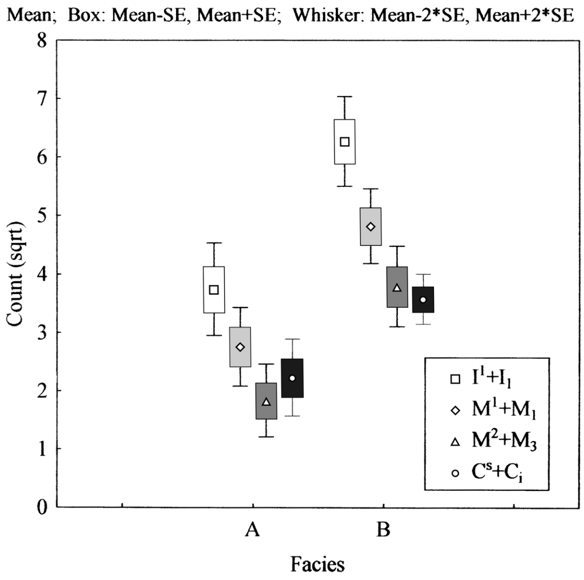
Sl. 12.2.5a kaže zgoraj naštete stalne adultne zobe, ki sva jih s pomočjo analize glavnih komponent (PCCA) razdelila v ločene skupine po faktorjih 1 in 2, ki skupaj pojasnita dobrih 95 % odnosa med zobmi in faktorji. Faktor 1 najbolj ločuje kanine od prvih incizivov. Zato bi lahko predstavljal izraščanje zob. Vendar bi potem prvi molarji ne smeli tvoriti posebne skupine, ki je zelo oddaljena od prvih incizivov, drugi zgornji in tretji spodnji molar pa bi morala biti kot skupina bliže kaninom kot prvim molarjem. Ker ni tako, faktor 1 ne predstavlja izraščanje zob, temveč nekaj povsem drugega. Misliva, da poseg človeka, kar se posebno močno kaže pri nekaterih zobeh.

Da stalni zobje niso zastopani tako, kot izraščajo, je potrdilo tudi dvodimenzionalno skaliranje, ki je zajelo vse stalne zobe (*sl. 12.2.5b*). Nobena od dimenzij ne ločuje skupine zob, ki izrastejo prvi ali zadnji (na sliki so označeni krepko oz. z večjimi črkami in ležeče). Zaporedju izraščanja ne sledijo tudi kvote drugih zob. Tretji incizivi in četrti premolarji, ki izraščajo sočasno, so npr. ločeni po obeh dimenzijah, namesto da bi se grupirali. Zato misliva, da posamično najdeni zobje v Divjih babah I niso primerni za določanje najmanjšega števila medvedov v stratigrafskih enotah oz. da so sklepi, osnovani na takšnih določitvah lahko skrajno nezanesljivi.

Sl. 12.2.6 kaže absolutne razlike med facijama in številom zob na podlagi srednje vrednosti. Vse razlike med facijama so statistično značilne (F-test, $p < 0,001$). Kar naju tokrat zanima, so odnosi med zobmi. V sedimentacijskih nivojih in facijah je največ prvih incizivov, ki jim sledijo prvi molarji, najmanj pa je zadnjih spodnjih in zgornjih molarjev ter kaninov. Ker prvi incizivi in molarji izrastejo hkrati, bi morali biti številčno izenačeni, vendar niso. To je težko razložiti kot posledico metode, saj so incizivi manjši kot molarji, zamenjava z drugim incizivom (I2) pa tudi ne pride v poštev, ker je teh še več kot prvih (glej *tab. 12.2.1*). Pomembno je, da sta zadnji zgornji molar in spodnji številčno izenačena s kanini, kar potrjujejo zgoraj izraženo domnevo, da različni zobje pripadajo številčno različno velikim skupinam medvedov iz



Sl. 12.2.5a, b: Rezultat PCCA za stalne adultne zobe, ki izraščajo eden za drugim. PCCA je bila narejena na podlagi kovariance na nestandardiziranih podatkih (a). Rezultat dvodimenzionalnega skaliranja na podlagi evklidskih razdalj (stres = 0,001) za vse stalne zobe (b).
Fig. 12.2.5a, b: Result of PCCA for permanent adult teeth, which emerge one after another. PCCA was made on the basis of covariance on nonstandardised data (a). Result of two-dimensional scaling on the basis of Euclidian distances (stress = 0.001) for all permanent teeth (b).



Sl. 12.2.6: Primerjava številčnega stanja zaporedno izraščajočih zob v sedimentacijskih nivojih facije A in B.
Fig. 12.2.6: Comparison of the numerical state of successively erupting teeth in the sedimentation levels of facies A and B.

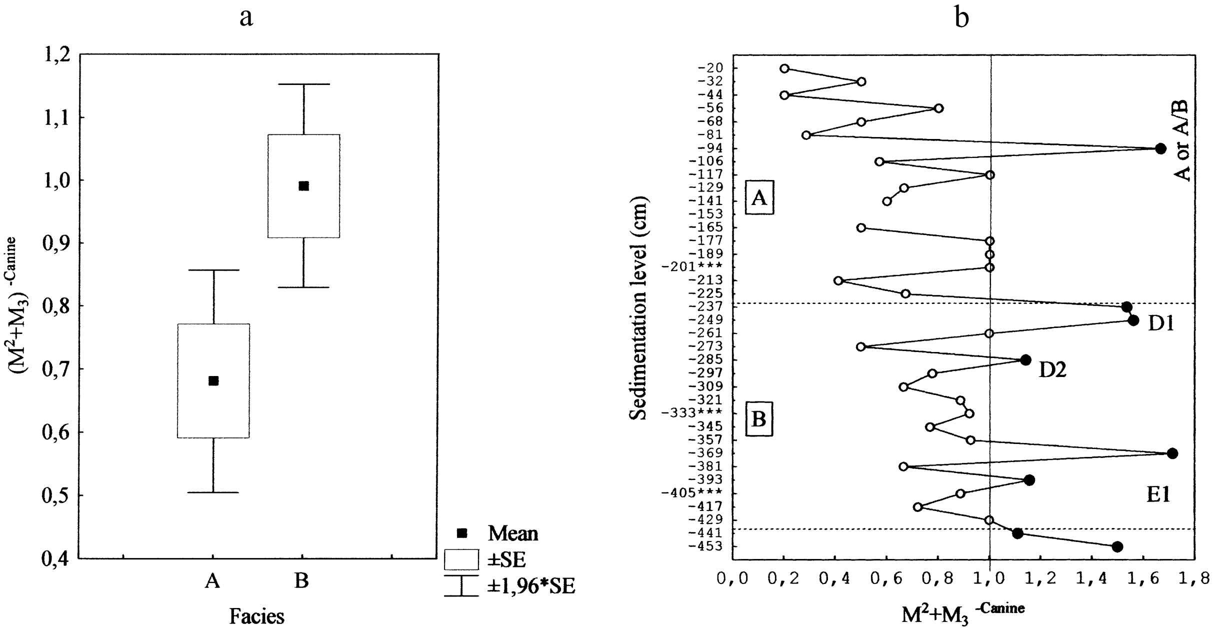
iste starostne skupine, zaradi česar je adultnih kaninov vedno manj od vseh drugih adultnih zob.

Ko sva pobliže preučila odnos med kanini in zadnjimi molarji v facijah, sva ugotovila, da je kaninov v faciji B relativno manj kot v faciji A. Razen tega je razlika med številom kaninov in drugih zob kot tudi med drugimi zobmi v faciji B večja kot v faciji A. Ali je prva razlika značilna ali ne, sva ugotovila s pomočjo razmerja zadnji molarji (M^2 in M_3) : kanini (*sl. 12.2.7a*). Ker so vrednosti količnika normalno porazdeljene, sva uporabila test "t", ki je potrdil, da se faciji značilno razlikujeta ($p = 0{,}02$). Ker se premajhne kvote kaninov v faciji B ujemajo z večjim številom paleolitskih najdb, stanje razlagava z delovanjem paleolitskih obiskovalcev jame, ki so odnašali kanine odraslih samcev kot trofeje v širšem pomenu besede. Premajhne kvote kaninov se v sedimentacijskih nivojih ujemajo s paleolitskimi horizonti A ali A/B, D in E z natančnostjo ± 1 ali ± 2 sedimentacijska nivoja (*sl. 12.2.7b*), če jih primerjava z najdbami ožganih kosti (glej podpoglavje 12.3 v tem zborniku, *tab. 12.3.1*). Za primerjavo z najdbami artefaktov bo treba počakati do izida drugega dela monografije, ki bo potrdila ali o-vrgla morebitno vzročno-posledično zvezo med kanini in zbirateljskimi nagnjenji paleolitskih obiskovalcev Divjih bab I.

Med kanini na eni strani in prvimi incizivi ter molarji na drugi strani v facijah ni razlik (*sl. 12.2.8*), pri čemer so kvote kaninov pričakovano premajhne s povprečno 3,5 prvega inciziva na kanin oz. 1,9 prvega molarja.

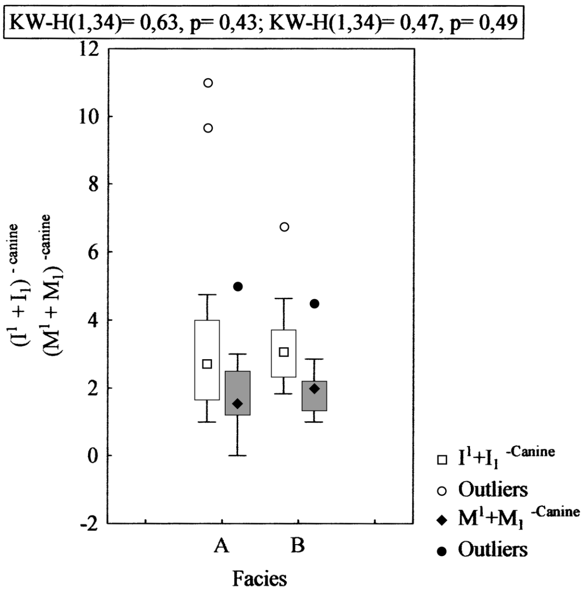
STAROSTNI SESTAV

Mlečnih zob je bilo najdenih povprečno 1,7-krat več kot stalnih. Glede na to, da nam ni uspelo pobrati



Sl. 12.2.7a, b: Razmerje M^2 in M_3 : kanini v facijah A in B (a) in podrobna stratigrafija razmerja z označenimi količniki, večjimi od 1, in njim ustrezajočimi paleolitskimi horizonti (b). Količniki, večji kot 1, predstavljajo premajhne kvote kaninov. Ognjiščni nivoji so na ordinati označeni s tremi zvezdicami.
Fig. 12.2.7a, b: Ratios M^2 and M_3: canines in facies A and B (a) and detailed stratigraphy of ratios with quotients greater than 1 marked and the corresponding palaeolithic horizons (b). Quotients greater than 1 represent too small a quota of canines. Hearth levels are marked on the ordinate with three stars.

toliko mlečnih zob kot stalnih, je dejanski količnik precej večji od ugotovljenega. Količnik med mladiči in odraslimi medvedi se na podlagi zob dodatno poveča spričo dejstva, da se del stalnih zob prekriva z mlečnimi. Zato ni mogoče ugotoviti pravega razmerja med odraslimi in mladiči, podobno kot to ni mogoče pri kosteh.



Sl. 12.2.8: Razmerje prvi inciziv : kanini in prvi molar : kanini v facijah A in B. Podan je tudi rezultat Kruskalovega in Wallisovega testa.

Fig 12.2.8: Ratios of first incisors : canines and first molar: canines in facies A and B. The results of the Kruskal-Wallis test are also given.

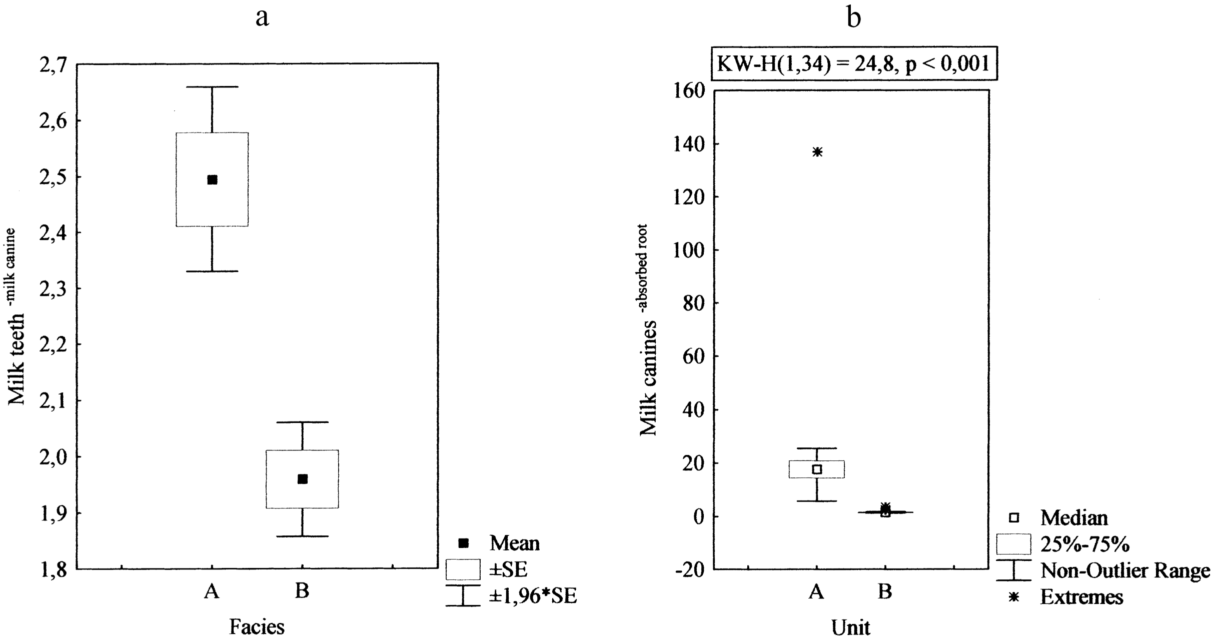
Pri izkopavanjih v letih 1980–1986 smo našli predvsem stalne zobe in zelo malo mlečnih, ker sedimentov nismo pregledovali s sejanjem. Starostni sestav je bil popolnoma drugačen od tukaj ugotovljenega (prim. Turk *et al.* 1992).

Preizkus na podlagi zaporedja izraščanja zob je pokazal, da se med t. i. adultnimi zobmi skrivajo še ne povsem odrasli medvedi, zato je razmerje odrasli – mladiči samo na podlagi uporabljene klasifikacije zob nemogoče zanesljivo oceniti. Razen tega je treba računati z določenim primanjkljajem adultnih kaninov v nekaterih nivojih, kar lahko povzroči resne težave pri interpretaciji starostnih razredov in razmerja med spoloma na podlagi kaninov.

Popolnoma drugačno sliko so dali juvenilni in mlečni kanini. Vendar je treba ponovno poudariti, da so bili ti zobje, vključno z incizivi, premolarji in molarji, slabše pobrani. Ker vsi podatki niso normalno porazdeljeni, lahko domnevo o vplivu človeka preveriva nasproti domnevi o naravnem preperevanju zob samo neparametrično. Vprašanje bi se dalo na elegantnejši način osvetliti s pomočjo parametričnih statistik.

Na en mlečni kanin pride povprečno samo 2,2 mlečnega zoba. Količnik, ki je izjemoma normalno porazdeljen, je v faciji A značilno večji (p < 0,001) kot v faciji B (*sl. 12.2.9a*), kar pomeni, da je v faciji A manj mlečnih kaninov.

Na en resorbiran mlečni kanin pride povprečno



Sl. 12.2.9a, b: Razmerje mlečni zobje : mlečni kanini (a) in mlečni kanini : mlečni kanini z resorbirano korenino (b) v facijah A in B. Podan je tudi rezultat Kruskalovega in Wallisovega testa.

Fig. 12.2.9a, b: Ratios of first incisors : canines and first molar: canines in facies A and B. The results of the Kruskal-Wallis test are also given.

12,2 kanina. Količnik je tudi tokrat v faciji A značilno večji kot v faciji B (*sl. 12.2.9b*). Razlika je izredno velika in pomeni, da je bilo v času odlaganja plasti v faciji B prisotnih veliko mladičev v fazi menjavanja zobovja, ki so lahko v jami tudi poginili. Razliko razlagava s spremenjeno funkcijo brloga, tj. vdorom agresivnih samotarskih samcev. Rešitev vprašanja, kdaj se je to zgodilo glede na facijo, sva nakazala na podlagi razmerja stalnih in mlečnih zob. Vdor samcev lahko predvidiva v faciji B.

Izolirani zobje se zaradi pregovorno boljše ohranjenosti kot kosti običajno uporabljajo za oceno najmanjšega števila medvedov (NŠM). Glede na ugotovljeno sta vsaka takšna ocena in njena razlaga za Divje babe I skrajno nezanesljivi, zato sva se temu tokrat namenoma izognila.

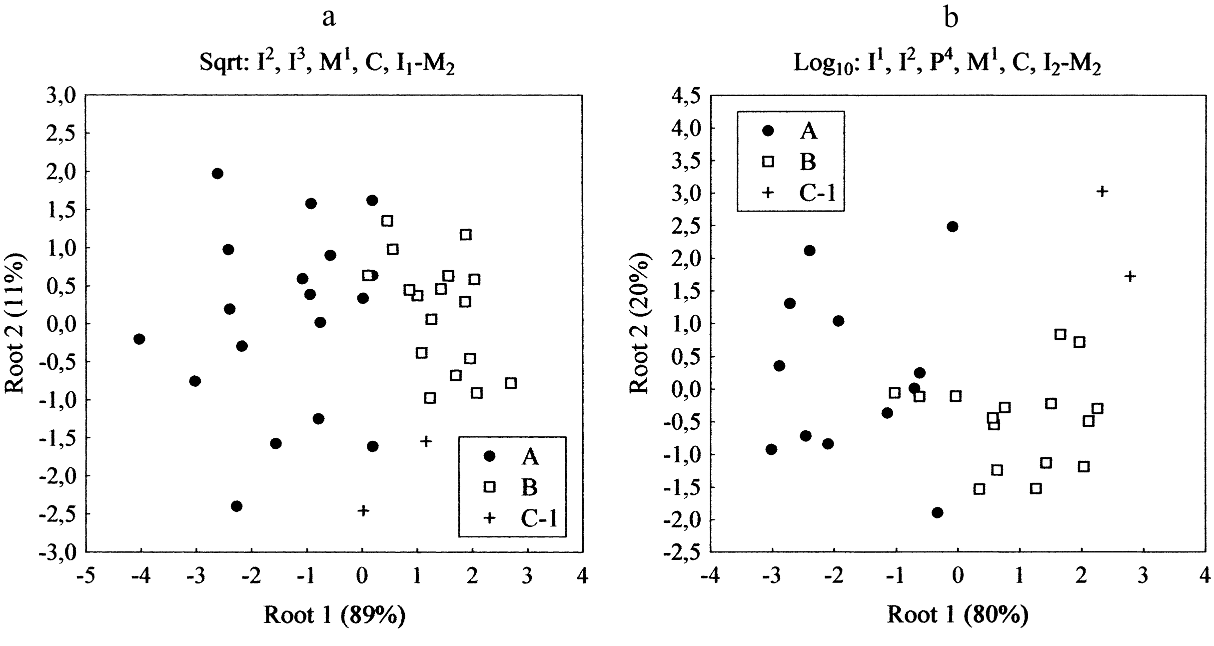
KLASIFIKACIJA SEDIMENTACIJSKIH NIVOJEV NA PODLAGI IZOLIRANIH ZOB

Klasifikacijo sedimentacijskih nivojev na faciji A in B na podlagi sedimentoloških podatkov (glej Turk 2006 in podpoglavji 5.2 in 5.3 v tem zborniku) sva preverila z diskriminantno funkcijsko analizo (DFA), analizo glavnih komponent (PCCA) in večdimenzionalnim skaliranjem (MDS) na podlagi izoliranih zob. Če so facije resnično del sistema, se mora rezultat na podlagi izoliranih zob skladati z rezultatom na podlagi sedimentnih značilnosti.

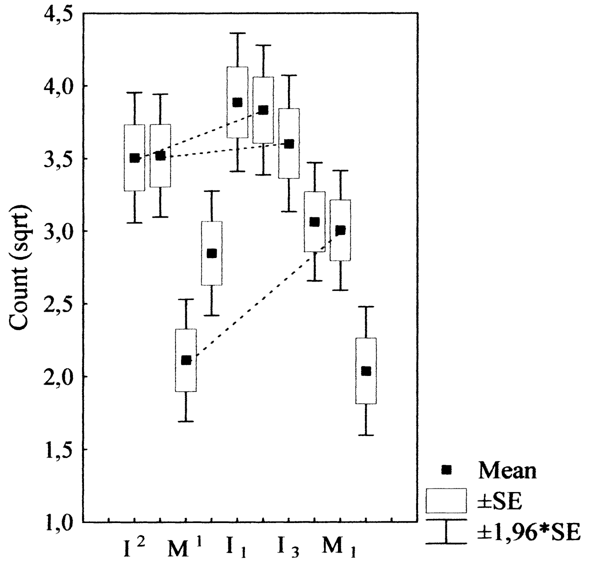
Diskriminantna funkcijska analiza (DFA) na podlagi korenjenih (drugi koren) in logaritmiranih ($\log_{10}$) podatkov za tiste adultne zobe, ki so normalno porazdeljeni, je pokazala, da se faciji A in B razlikujeta samo po prvi diskriminantni funkciji (root 1), katere delež pri razlikovanju je 80 % oz. 89 % glede na izbrano kombinacijo zob (*sl. 12.2.10a, b*). Prvo diskriminantno funkcijo bi v danem primeru lahko med drugim predstavljalo človekovo udejstvovanje, povezano z lobanjami.

V faciji A je na podlagi klasifikacijskih funkcij pravilno opredeljenih 15 od 18 sedimentacijskih nivojev ali 83 %, v faciji B pa vseh 17. Subfacija C-1 ni vredna upoštevanja, in to zaradi samo dveh sedimentacisjkih nivojev, od katerih je eden pravilno umeščen in drugi narobe. V celoti je pravilno umeščenih 89 % vseh sedimentacijskih nivojev. Rezultat multivariatne statistike se ujema z ugotovitvijo o različnem razmerju med mandibularnimi in maksilarnimi zobmi v facijah A in B. Če ga primerjava s podobnim rezultatom za kosti, ugotoviva, da je razlikovanje med facijami pri zobeh slabše (glej podpoglavje 12.3 v tem zborniku, *sl. 12.3. 8*), kar je v nasprotju z dejstvom, da se zobje ohranijo bolje kot kosti.

Ker naju je zanimalo, kako se grupirajo posamezni zobje, sva naredila tudi analizo glavnih komponent s poudarkom na klasifikaciji (PCCA), in sicer na podlagi normalno porazdeljenih korenjenih podatkov za 10 zob. Podatkov o zobeh, ki transformirani niso normalno porazdeljeni, nisva upoštevala.Vse najdbe izbranih zob so med seboj močno povezane, kar je pričakovano glede na izvor. Korelacijski količnik znaša 0,72–0,90 (p = 0,05). Ker imajo vsi zobje skoraj enako standardno odstopanje (*sl. 12.2.11*), je analiza kovariance primerno izhodišče za PCCA.



Sl. 12.2.10a, b: Izolirani zobje: rezultat diskriminantne funkcijske analize facijev na podlagi spremenjenih, normalno porazdeljenih podatkov (a: drugi koren, b: $\log_{10}$).
Fig. 12.2.10a, b: Isolated teeth: Result of discriminant function analysis of facies on the basis of transformed normally distributed data (a: root two, b: $\log_{10}$ transformation).



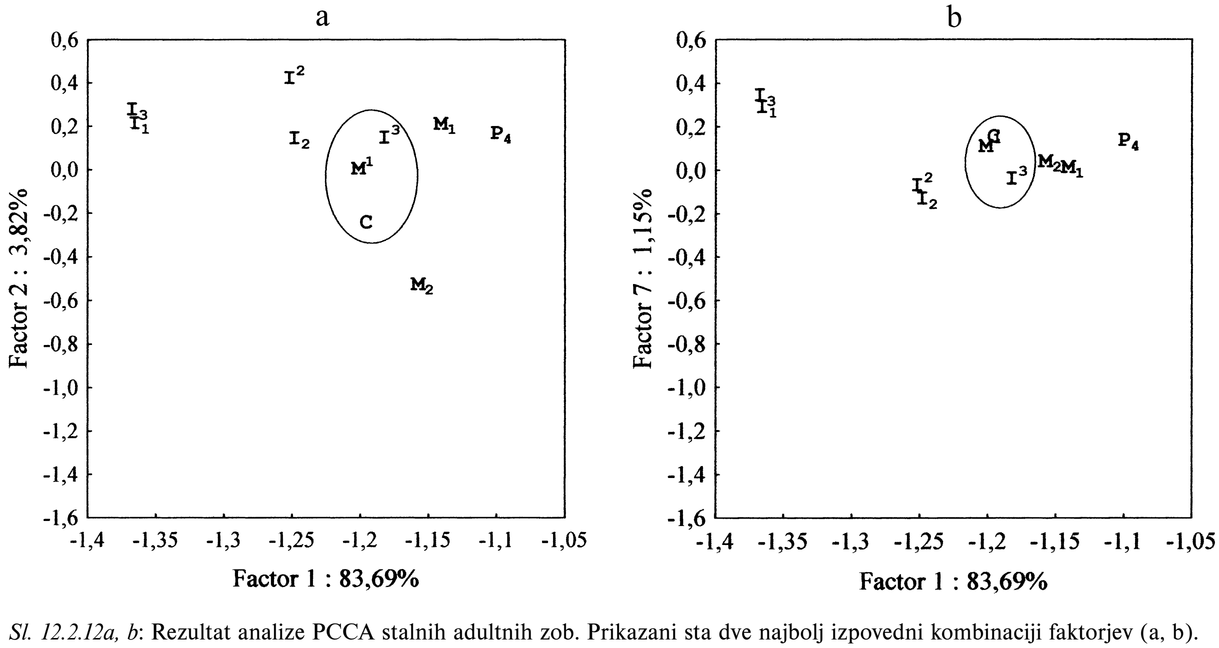
Sl. 12.2.11: Standardna odstopanja spremenjenih podatkov za adultne zobe.
Fig. 12.2.11: Standard deviation of transformed data for adult teeth.

Prvi faktor, ki domnevno predstavlja delovanje človeka, pojasni kar 83,7 % odnosa med zobmi in faktorjem. Dejansko je tako pojasnjeni delež, z upoštevanjem vpliva količinskih razlik med facijami, verjetno bistveno manjši. Preostalih 9 faktorjev enakomerno padajoče pojasnjujejo preostalih 16 %. Projekcija zob na ravnini dveh faktorjev kaže, da prvi faktor ločuje zobe v več manjših skupin ali eno manjšo (I_1 in I_3) in večjo (vsi drugi zobje). Kanini in eden od zgornjih zob (M^1), morda dva (M^1 in I^3) od treh, kolikor nama jih je uspelo vključiti v analizo, predstavljajo samostojno skupino (*sl. 12.2.12a, b*). Skupina predstavlja zobe, ki jih je v primerjavi z drugimi premalo.

Povprečni prispevek zob k variabilnosti faktorjev je 10 %. Zoba, ki največ prispevata k prvemu faktorju, sta I_1 in I_3, vsak po 12 %. Najmanj prispeva P_4 (8 %). Vsi zobje so v obratnem sorazmerju s prvim faktorjem, kar pomeni, da večja ko je bila dejavnost ljudi, manj je bilo vseh zob. S prvim faktorjem je najbolj povezan I_3 (R = -0,95), najmanj pa M_2 (R = -0,86). Rezultate je težko uskladiti s predlagano razlago prvega faktorja ali katero koli drugo razlago, ker skupine zob in njihov prispevek k prvemu faktorju niso povezane niti z velikostjo zob niti z zaporedjem izraščanja, ki je pri rjavem medvedu I1 in M1, I2, I3 in P4, M2, M3, C. Kaže, da so kvote zob bolj ali manj naključne, vendar bi do njih lahko prišlo, če bi bili nekateri zobje odstranjeni z najdišča.

Vprašanje, ki naju je posebej zanimalo, je bilo, kako zobje vplivajo na stratigrafsko ločevanje. Splošno prepričanje je, da se zobje boljše ohranijo kot kosti. Ker so podobno kot kosti prisotni v vseh globinah in po celi jami v različnih količinah in razmerjih, je pričakovati zelo dobre biostratigrafske izsledke na podlagi zob. Glede na domnevno boljšo ohranjenost zob, bi morali biti ti izsledki boljši kot pri kosteh.

Zaradi različnega standardnega odstopanja izbranih podatkov (*sl. 12.2.13*), spremenjenih z drugim korenom, tako da so normalno porazdeljeni, sva jih za PCCA standardizirala in analizo izpeljala na podlagi korelacije. Standardizirani podatki imajo srednjo vrednost 0 in standardno odstopanje ± 1. Vendar s standardizacijo analiziranih vrednosti bodisi po stolpcih (spremenljivkah) bodisi po vrsticah (sedimentacijskih nivojih) ni mogoče odpraviti količinskih razlik med facijami, ki jih povzročajo skrajne vrednosti (*outlayers* in *ex-*



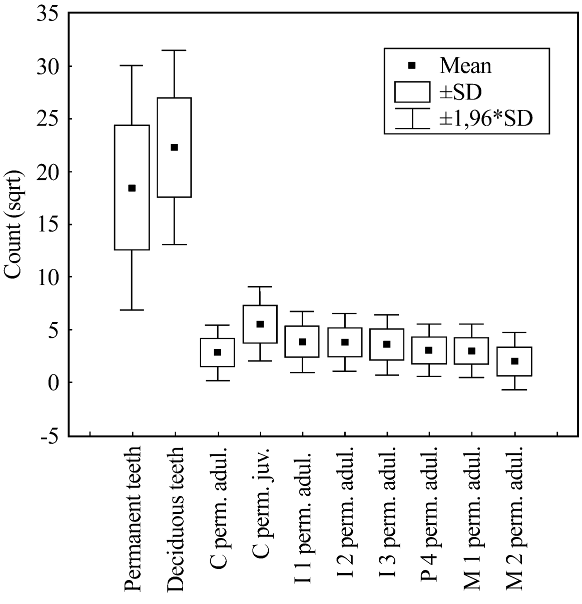
Sl. 12.2.12a, b: Rezultat analize PCCA stalnih adultnih zob. Prikazani sta dve najbolj izpovedni kombinaciji faktorjev (a, b).
Fig. 12.2.12a, b: Result of PCCA analysis of permanent adult teeth. The two most expressive combinations of factors are shown (a, b).

tremes). Prav tako ni mogoče odpraviti učinka skupne vsote, ki jo predstavlja vseh 28 zob vsakega medveda. Oboje nedvomno vpliva na rezultat PCCA v smislu klasifikacije facijev v ločene skupine po enem od faktorjev. Teh težav ni bilo v takšnem obsegu pri podobni analizi sedimentnih podatkov.

Prva dva faktorja pojasnita 86,2 % odnosa med zobmi in faktorji, od tega prvi faktor 82 %. Ta faktor bi lahko predstavljal, kot rečeno, vpliv človeka na zobe, predvsem pa količino, ki je odvisna od vedenjskih vzorcev medvedje populacije, na katere sta vplivala zlasti klima in okolje.

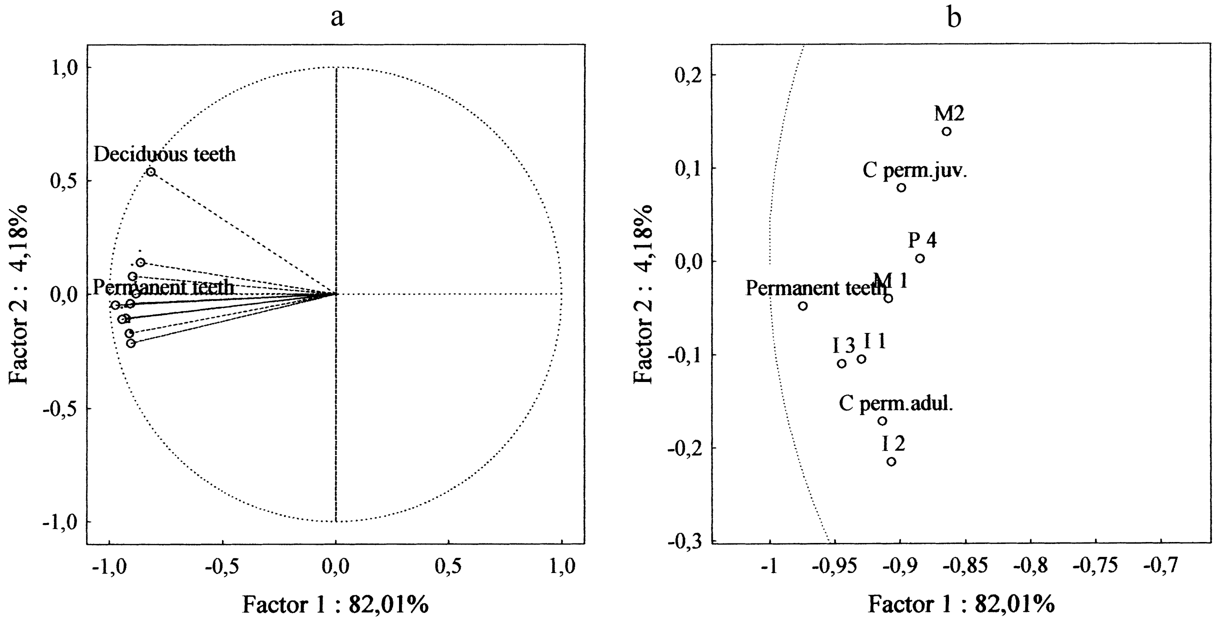
Projekcija številčnega stanja zob na faktorsko ravnino prvih dveh faktorjev omogoča prepoznati dve skupini: stalne zobe in mlečne (*sl. 12.2.14a*). Zobje obeh skupin so v obratnem sorazmerju s prvim faktorjem, kar pri mlečnih zobeh ni v prid domnevi, da ta faktor predstavlja vpliv človeka na zobe. Zobje precej enakomerno prispevajo k prvemu faktorju. Največ, 12 %, prispevajo stalni zobje. Mlečni zobje prispevajo 8 %, posamezni stalni zobje pa okoli povprečja, ki je 10 %. Juvenilni in adultni kanini tvorijo ločeno skupino, kar je mogoče razložiti s trdnostjo zob (*sl. 12.2.14b*). Vendar naju glede na postavljeno vprašanje bolj kot projekcija zob na faktorsko ravnino zanima projekcija sedimentacijskih nivojev na faktorsko ravnino (*sl. 12.2.15a, b*).

Sedimentacijski nivoji ne tvorijo ločenih skupin, ki bi jih lahko povezala s plastmi (*sl. 12.2.15a*). Nivoji z ostanki ognjišč so med seboj ločeni, zato ne moreva govoriti o kakšnemu bistvenemu vplivu človeka, ki ga domnevno predstavlja prvi faktor. Vpliv človeka je treba znižati daleč pod 82 % deleža, ki ga ima pri ločevanju zob prvi faktor.

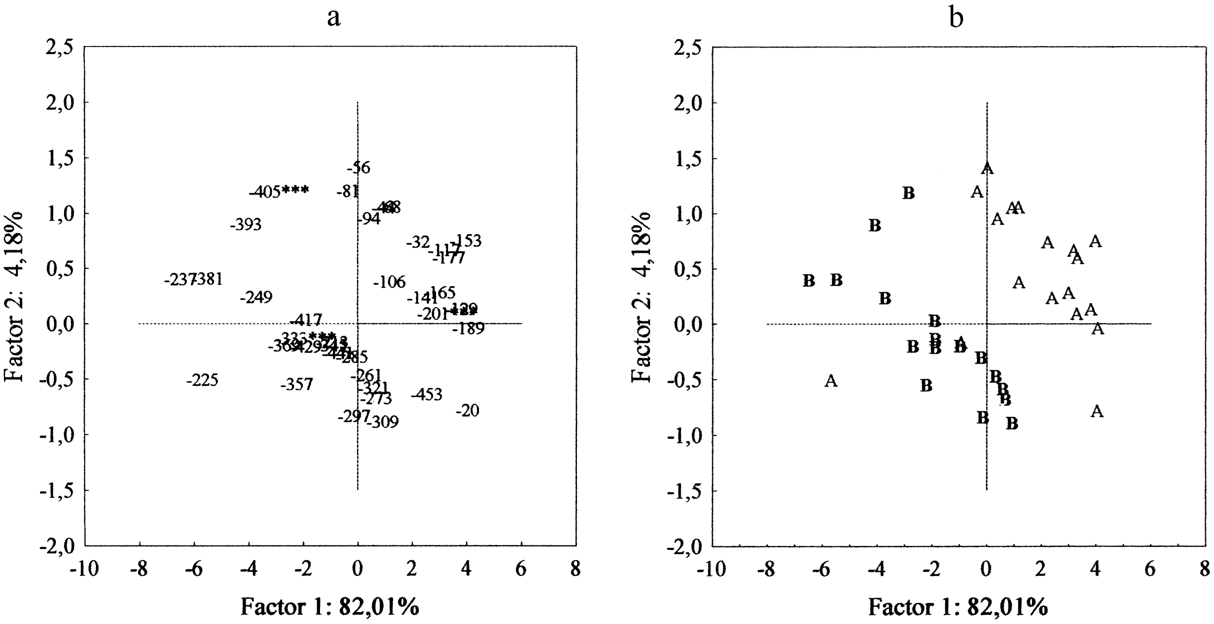


Sl. 12.2.13: Standardno odstopanje spremenjenih normalno porazdeljenih podatkov za izbrane zobe.
Fig. 12.2.13: Standard deviation of transformed normally distributed data for selected teeth.

Faciji A in B ločuje samo prvi faktor, katerega delež pri ločevanju je 82 % (*sl. 12.2.15b*). Ločevanje je slabše kot pri kosteh, saj se več nivojev, ki pripadajo facijama A in B, prekriva. Najbolj moteča je umestitev nivoja -225 (facija A) v četrtem kvadrantu. Ker prvi faktor domnevno predstavlja vpliv človeka in hkrati njegov vedenjski vzorec, je razumljiva pozitivna povezanost facije A in negativna facije B. Več lobanj in zob v faciji A, kjer je



Sl. 12.2.14a, b: Projekcija spremenjenih normalno porazdeljenih podatkov o številčnem stanju zob na faktorsko ravnino prvih dveh faktorjev. *Slika b* prikazuje povečan detajl *slike a*.
Fig. 12.2.14a, b: Projection of transformed normally distributed data on the number of teeth on the factor plane of the first two factors. *Fugure b* shows enlarged detail of *Figure a*.



Sl. 12.2.15a, b: Izolirani zobje: projekcija sedimentacijskih nivojev (a) in facijev (b) na faktorsko ravnino prvih dveh faktorjev.
Fig. 12.2.15a, b: Isolated teeth: Projection of sedimentation levels (a) and facies (b) on the factor plane of the first two factors.

teh malo, pomeni temeljitejši poseg ljudi vanje, več lobanj in zob v faciji B, kjer je teh veliko, pa pomeni manj temeljit poseg. Nekaj nivojev facije A in B sploh ni povezanih s prvim faktorjem. Od teh sta dva nivoja v faciji A (–81 cm in –91 cm) in dva v faciji B (–285 cm in –293 cm) v superpoziciji. V teh primerih sva pri kaninih predvidela poseg človeka, medtem ko vsi zobje skupaj takšnega posega ne kažejo.

Kvote vseh določljivih stalnih zob sva analizirala tudi z metodo večdimenzionalnega skaliranja (MDS – *multidimensional scaling*), ki predstavlja alternativo faktorski analizi, vendar ne zahteva normalne porazdelitve podatkov. Za izdelavo matrike evklidskih razdalj s srednjo vrednostjo vseh sedimentacijskih nivojev 0 in standardnim odstopanjem ±1 so bili podatki predhodno standardizirani glede na sedimentacijske nivoje, kar je nekoliko omililo količinske razlike med facijami, ki vplivajo na rezultat analize.

Slika *12.2.16a, b* kaže porazdelitev sedimentacijskih nivojev in facijev v ravnini prvih dveh dimenzij, ki zadoščata za ugotavljanje podobnosti oz. različnosti med sedimentacijskimi nivoji in facijami. O tem sta naju prepričala Shepardov diagram (prim. podpoglavje 12.4 v tem zborniku, *sl. 12.4.7*) in majhna vrednost stresa.

Prva dimenzija opredeljuje tri skupine sedimentacijskih nivojev oz. facije A, B in C-1. Nivoji, ki so na meji posameznih facijev, so opredeljeni v enega od njih ali v vmesno skupino, ki jo sestavljajo sedimentacijski nivoji vseh treh facijev. Po prvi dimenziji so v tri različne skupine opredeljeni tudi ognjiščni nivoji. Zato prva dimenzija zanesljivo ne predstavlja bistvenega poseg človeka v zobne kvote.

Druga dimenzija opredeljuje tri skupine sedimentacijskih nivojev, ki pa nimajo nič skupnega s facijami.

Nekatere podskupine izjemoma predstavljajo sedimentacijski nivoji, ki so v stratigrafski superpoziciji in zato ustrezajo plastem. Večina sedimentacijskih nivojev v podskupinah pa nedvomno pripada različnim plastem.

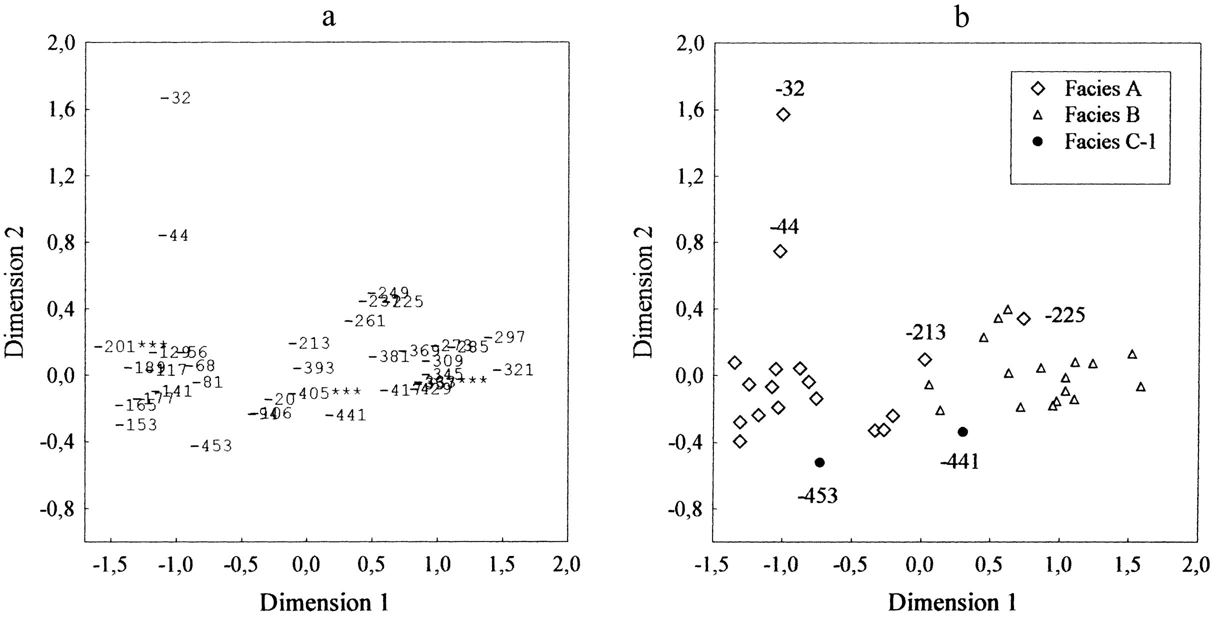
Rezultat PCCA za facije kaže dvoje. Prvič, da podobne dejavnike opredeljuje relativno veliko analiziranih znakov. Ker večina znakov v bistvu izraža isto stvar (tj. količnske odnose?), rezultat niti ni mogel biti drugačen. Drugič, da so izolirani zobje del sistema najdišča, ki ga je izoblikoval čas.

PCCA in MDS sta potrdila smotrnost delitve stratigrafskega stolpca na faciji A in B, nista pa potrdila smotrnosti delitve na plasti, ki je interpretacijsko veliko bolj problematična. Variacije, povezane z zobmi, po posamičnih plasteh namreč ni mogoče smiselno razložiti skladno z drugimi paleookoljskimi podatki. Za razlago plasti bi potrebovali veliko več podatkov oz. veliko večji obseg raziskanega prostora. Zato so raziskave, ki temeljijo na plasteh kot stratigrafskih enotah, nezanesljive in jih ne priporočava.

12.3. FRAGMENTACIJA ANATOMSKO DOLOČLJIVIH KOSTI IN DRUGE ZNAČILNOSTI KOSTNIH OSTANKOV

Izvleček

Kostne ostanke sta avtorja analizirala kvantitaivno in kvalitativno v bloku sedimentov, razdeljenem v dva dela (facije A in B), ki skupaj obsegata 37 stratigrafskih enot, tj. sedimentacijskih



Sl. 12.2.16a, b: Rezultat dvodimenzionalnega skaliranja evklidskih razdalj (stres = 0,04) za vse ostanke določljivih adultnih zob, ki so navedeni v *tab. 12.2.1*, in sicer po sedimentacijskih nivojih (a) ter facijah (b).
Fig. 12.2.16a, b: Result of two-dimensional scaling of Euclidian distances (stress = 0.04) for all remains of identified adult teeth, which are given in *Tab. 12.2.1*, by sedimentation levels (a) and facies (b).

nivojev. Ugotovila sta, da so kosti juvenilnih in neonatnih medvedov v obeh facijah bolj fragmentirane kot kosti adultnih medvedov. V skupini *juvenilis* in *neonatus* je povprečno desetkrat več fragmentov na celo kost kot v skupini *adultus*. Juvenilnih diafiz je povprečno devetnajstkrat več kot adultnih (glej *tab. 12.3.1*). V faciji A so vsi kostni fragmenti manjši in številnejši (*sl. 12.3.4a, b; sl. 12.3.5*). V faciji A je več kosti s sledovi grizenja (*sl. 12.3.7*), juvenilne in neonatne kosti pa so bolj fragmentirane (*sl. 12.3.8a, b; sl. 12.3.9a, b*). V faciji A je v zgornjem delu več kosti juvenilnih medvedov (*sl. 12.3.10*). Razlike med facijami avtorja razlagata z delovanjem zveri in ljudi, razliko v faciji A pa s spremembo v strukturi medvedje populacije, prisotne v jami. Razlike med facijami so skladne z razlikami, ki temeljijo izključno na sedimentoloških podatkih. Razlikovanje med posameznimi plastmi na podlagi kostnih najdb ni mogoče.

V zvezi z rubriko "obgrizene kosti" v *tab. 12.3.1* avtorja poudarjata in opozarjata, da med njimi ni preluknjanih kosti. So samo takšne z odtiski zob na juvenilnih metafizah, izjemoma tudi na adultnih epifizah (glej *tab. 12.3.1*). V celotnem vzorcu je samo ena "preluknjana" kost, in sicer proksimalna metafiza juvenilnega femurja z izjedkano luknjo, najdena v kvadratu 23 na globini -273 cm. To posebej navajata zaradi žolčne polemike o najdbi domnevne koščene piščali v kvadratu 17 na globini -285 cm, ki jo nekateri razlagajo kot posledico zverske dejavnosti, sklicujoč se na splošen pojav preluknjanih kosti v najdiščih z jamskim medvedom (d'Errico *et al.* 2003, 35ss). Med 89.811 pregledanimi določljivimi kostmi je samo ena večkrat preluknjana kost, ki se razlaga kot domnevna piščal (Turk *et al.* 1995b; 2005b), in ena enkrat preluknjana kost, ki jo glede na položaj luknje v bližini epifize lahko eventualno razložita kot posledico delovanja zveri. O drugih relativno maloštevilnih preluknjanih kosteh z najdišča sta prvi avtor in M. Brodar že večkrat poročala (Brodar 1999, t. 6: 8,9; Turk 1984-1986, 10; Turk *et al.* 2001b, tab. 5, sl. 19). Pri tako ali drugače preluknjanih kosteh v Divjih babah I nikakor ne gre za splošen pojav, ampak kvečjemu za izjemen pojav.

Fragmentacija kostnih ostankov jamskega medveda je splošen pojav. Vendar se lahko razlikuje v času in prostoru oz. od najdišča do najdišča in v najdišču. Nepoznavanje ali celo neupoštevanje fragmentacije ima lahko resne posledice pri razlagi kostnih ostankov. Zato vsekakor zasluži posebno obravnavo.

Kosti se fragmentirajo predvsem v predsedimentni fazi, ko so izpostavljene različnim tafonomskim dejavnikom, med katerimi so na prvem mestu biogeni, vključno z antropogenimi. Preperevanje pospešuje fragmentacijo in je zlasti pri čistem kemijskem preperevanju močnejše pri majhnih fragmentih in kosteh. Majhen delež fragmentov je nastal pri izkopavanju. Največji je v cementiranih sedimentih, tj. v sedimentacijskih nivojih -225 cm do -321 cm, kjer smo pri izkopavanju uporabljali pnevmatično kladivo (*tab. 12.3.1*).

Glavni tafonomski dejavnik, ki je v Divjih babah I uravnaval fragmentacijo, je bil domnevno biotske narave. Domnevno zato, ker opažava le posledice tega dejavnika, vendar jih ne moreva neposredno povezati z ostanki zveri in arheološkimi najdbami, kar bi kazalo na obstoj vzročno-posledične zveze. Tako zveri kot ljudje so lahko vplivali na kosti, ne da bi pustili druge prepričljive sledove svoje prisotnosti v najdišču. Začetni biotski fragmentaciji je sledila abiotska zaradi preperevanja.

Preperevanje ni bistveno prispevalo k fragmentaciji celih kosti. To sklepava na podlagi trdnosti kostnega tkiva, v katerem se je pogosto izjemno dobro ohranil kolagen, kar je razvidno iz vrednosti δ ^{15}N in δ ^{13}C, ki so zelo blizu tistim v sveži kosti (Nelson 1997; Nelson *et* *al.* 1998). Učinki preperevanja so vidni predvsem na robovih in vogalih odlomkov vseh velikosti, ki so praviloma bolj ali manj zaobljeni. Nekaj podobnega lahko opazujemo na dolomitnih klastih vseh velikosti v profilu in prostoru. Tako za kosti kot klaste velja, da je zaobljenost robov pogostejša pri majhnih odlomkih. Zato meniva, da zaobljenosti robov na kosteh ni pripisati samo trenju v sedimentu (*charriage à sec* po Kobyju 1941), temveč tudi kemičnemu preperevanju, ki je najmočnejše prav na robovih. Število zaobljenih fragmentov in stopnja zaobljenosti sta v različnih sedimentacijskih nivojih različna. Močno zaobljeni večji fragmenti so zlasti pogosti pri dnu analiziranega profila v sedimentacijskih nivojih -417 cm do -453 cm. Mehansko odstranjene fosfatne inkrustacije na izpostavljenih delih so dokaz za intenzivne postsedimentne premike kosti. Inkrustacije, ki so značilne za spodnjo polovico profila, so bile pretežno odstranjene predvsem na meji plasti 7 in 8 v sedimentacijskih nivojih -213 cm do - 237 cm. Torej v neposredni bližini sedimentacijske vrzeli (glej poglavji 6 in 7 v tem zborniku).

Kosti s sledovi eksfoliacije (*sl. 12.3.1*), značilne za predsedimentno preperevanje na prostem, zaradi delovanja sonca, vlage in zmrzali, v najdišču seveda ni, so pa kosti v nekaterih sedimentacijskih nivojih in plasteh površinsko, redkeje tudi globinsko mineralizirane zaradi izspiranja in nadomeščanja kolagena. Do izspiranja kolagena je prišlo predvsem v plasteh, za katere je značilno močno povečanje vlage, povezano z močnejšimi padavinami. Takšne kosti so zaradi globinske preperelosti lahke in krhke in se v skrajnih primerih luščijo po plasteh. Redke kosti so vzdolžno počene ali razklane. Razpoke in vzdolžno razklani odlomki so domnevno nastali pri izsuševanju. Nekateri večji fragmenti so nastali tudi posedimentno pod težo sedimentov (*sl. 12.3.2*). Med posebnimi fragmenti morava omeniti okoli 100 t. i. koščenih gumbov, ali bolje rečeno psevdogumbov različnih velikosti in izvedb (glej Turk 1988).

Za najdišče kot celoto je značilno, da so med seboj pomešane različno preperele in obarvane kosti, kar razlagava s sekundarnim mešanjem kosti iz različnih mikrookolij. Zaradi takšnega mešanja je zelo težko klasificirati stopnjo preperelosti in jo analizirati po sedimentacijskih nivojih, skupaj z močno preperelimi dolomitnimi klasti, kar bi bilo vsekakor koristno in bi dalo zanimiv rezultat (prim. Campy 1989).

Barva kosti je odvisna od sedimentnega okolja in se razlikuje v posameznih sedimentacijskih nivojih. Najpogostejši sta rumena in rjava barva, najredkejši pa temno siva in prvotna bela. Rjava barva je značilna za oksidacijsko okolje, povezano z nihanjem talne vode, temno siva pa za redukcijsko, povezano z daljšim zastojem podtalnice. Majhni kostni fragmenti so običajno drugače obarvani kot veliki in cele kosti. Prav tako so razlike v obarvanosti zunanje površine kostne lupine in medularnega kanala. Ta je običajno močneje obarvan kot zunanja površina. Kot zanimivost naj omeniva, da so nekatere fosilne kosti, ki smo jih pustili več let ležati na prostem, postale ponovno bele in bleščeče, kot da bi bile sveže.

Sl. 12.3.1: Primer eksfoliacije na recentni kosti iz Krnskega pogorja. Kost je iz prve svetovne vojne in je bila 80 let izpostavljena močnim atmosferskim vplivom. Fotografija M. Zaplatil.

Fig. 12.3.1: Example of exfoliation on a recent bone from the Mt. Krn (2244 m) group. The bone is from the First World War and was exposed to strong atmospheric influences for 80 years. Photograph M. Zaplatil.

METODA IN GRADIVO

Vse gradivo je bilo pridobljeno s pomočjo mokrega sejanja vseh sedimentov na treh sitih hkrati, ki so imela premer luknjic od 10 mm do 0,5 mm. Vse najdbe sva na koncu vsake terenske akcije vnesla v posebne obrazce, in sicer za vsak kvadrat in reženj posebej[5]. Opredelitev in vnos je za facijo A v celoti opravil prvi avtor, za facijo B pa drugi avtor po vnaprej določenih stalnih kriterijih. Podatki so se pozneje z obrazcev prenesli v računalnik in s pomočjo posebnega, doma narejenega programa združili v sedimentacijske nivoje kot osnovne stratigrafske enote, ki so zamenjale na terenu določene plasti. Ker imajo vsi sedimentacijski nivoji enako prostornino, sva lahko analizirala kostne ostanke brez pretvarjanja osnovnih podatkov v deleže.

Cele kosti in določljive kostne fragmente sva razdelila v tri starostne skupine: *adultus*, *juvenilis* in *neonatus* na podlagi splošno veljavnih kriterijev.

Fragmentacijo kostnih ostankov lahko razdeliva na splošno in posebno. Splošna fragmentacija obravnava

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[5] Izpolnili smo 2.208 obrazcev, od katerih je imel vsak 314 okenc. Originalne obrazce hrani arhiv Inštituta za arheologijo ZRC SAZU in arhiv Narodnega muzeja Slovenije.

Sl. 12.3.2: Primeri postsedimentno poškodovanih kosti zaradi pritiska sedimentov v Divjih babah I. Fotografija C. Narobe.
Fig. 12.3.2: Examples of post-sedimentarily fragmented bones because of the pressure of sediments in Divje babe I. Photograph C. Narobe.

vse kosti skupaj, posebna pa posamezne skupine kosti. Dalje lahko fragmentacijo obravnavava v kontekstu najdišča kot celote ali v ločenih kontekstih, npr. ognjiščnih. Tokrat bova fragmentacijo obravnavala samo v kontekstu najdišča kot celote, ki je predpogoj za pravilno razumevanje in razlago ločenih kontekstov, o katerih bo govora v drugem delu monografije. Zato v *tab. 12.3.1* ni najdb iz ognjišč razen ožganih kosti. Druge kostne najdbe iz ognjišč predstavljajo tako majhen delež, da ne vplivajo na izsledke analize fragmentacije in drugega.

Stopnjo splošne fragmentacije kosti sva ocenila na dva načina. Prvič s povprečno težo fragmentov, ki je podana z razmerjem teža : število fragmentov, in drugič s kombinacijo razmerij teža fragmentov : teža celih kosti in število fragmentov : število celih kosti. Predzadnje razmerje pove, kolikokrat je teža fragmentov večja v primerjavi s težo celih kosti, zadnje pa, koliko je fragmentov na celo kost. S kombinacijo obeh razmerij sva lahko ugotovila, kje prevladujejo večji fragmenti, kje manjši in koliko je enih in drugih. Če je razmerje teže manjše od številčnega, prevladujejo majhni fragmenti, ki so tudi številčnejši kot v primeru, ko je razmerje teže večje od številčnega. Če sta razmerji izenačeni, ni mogoče sklepati o velikosti in številčnosti posameznih fragmentov. Pri tem je treba poudariti, da sva pri teži razpolagala samo s podatkom za vse fragmente, tj. določljive in nedoločljive, ker obeh skupin fragmentov nisva ločila po teži. Vendar to ni vplivalo na rezultat, saj so vsi obravnavani podatki (teža in število celih kosti in fragmentov) močno in značilno povezani (*tab. 12.3.2*). Ob *tab. 12.3.1* morava poudariti, da so v profilu normalno poprazdeljeni samo podatki za vse fragmente (določljive in nedoločljive) ter nekatera razmerja.

TEMELJNE ZNAČILNOSTI VZORCA, VARIABILNOST IN TAFONOMSKI DEJAVNIKI

Fragmentov je v vseh sedimentacijskih nivojih bistveno več kot celih kosti (*tab. 12.3.1*).

Veliko kosti je bilo fragmentiranih do nerazpoznavnosti. To dokazuje velik delež najdenih nedoločljivih fragmentov (*tab. 12.3.1*). V sklopu plasti facije A je povprečno 4,3 nedoločljiva fragmenta na en določljiv fragment, v sklopu plasti facije B pa povprečno 5,1. Ker so vrednosti številčnega razmerja določljivi fragmenti : nedoločljivi fragmenti normalno porazdeljene, sva razliko med facija-

Tab. 12.3.1: Kostni ostanki, razvrščeni po sedimentacijskih nivojih na površini B (21 m^2, skupno 83 m^3 ali 33 nivojev po 2,5 m^3). Prvi štirje nivoji so s površine A (25 m^2, skupno 12 m^3 ali 4 nivoji po 3 m^3). Stolpci 2, 4–11, 13 in 14 so izključno določljive kosti. V drugih stolpcih, razen v 12 so tako določljive kot nedoločljive kosti. V stolpcih 13 in 14 so zajete samo diafize humerusa, radiusa, ulne, femorja, tibije in fibule. Ožgane kosti so koncentrirane v ognjiščih. Vse gradivo sta določila J. Dirjec in I. Turk.

Tab. 12.3.1: Bone remains classified by sedimentation level in area B (21 m^2, total 83 m^3 or 33 levels of 2.5 m^3 of sediment). The first four levels are from area A (25 m^2, total 12 m^3 or 4 levels of 3 m^3 of sediment). Columns 2, 4–11, 13 and 14 are exclusivively identifiable bones. In other columns, except 12, there are both identifiable and unidentifiable bone remains. In columns 13 and 14 are included only diaphyses of: humerus, radius, ulna, femor, tibia and fibula. Burned bones are concentrated in the hearths. All material determined by J. Dirjec and I. Turk.

Sedimentation level (cm)	Facies	Complete (kg)	Fragments, all (kg)	Complete, adul. (count)	Fragmented, adul. (count)	Complete, juv. (count)	Fragmented, juv. (count)	Complete, neon. (count)	Fragmented, neon. (count)	Complete, sum	Fragmented, sum	Fragments, indet. (count)	Diaphyses, adul. (count)	Diaphyses, juv. (count)	Burned (count)	Cut (count)	Gnawed (count)	Etched (count)
-20	A	0.6	3.5	37	45	16	389	4	14	57	448	1455	0	17	0	1	3	7
-32	A	1.3	5.5	106	63	56	879	1	26	163	968	4609	0	22	0	0	3	1
-44	A	2.9	8.4	161	125	82	1130	4	38	247	1293	5759	2	74	3	0	5	1
-56	A	2.4	8.8	193	133	109	1216	2	36	304	1385	4001	3	77	0	0	11	6
-68	A	2.9	9.9	186	157	55	919	2	55	243	1131	4077	1	50	0	0	4	6
-81	A	4.7	13.4	284	221	116	1331	2	108	402	1660	5792	1	88	1	0	9	18
-94	A	4.3	15.1	239	226	92	1137	8	76	339	1439	3797	4	70	2	0	9	14
-106	A	4.1	15.9	176	282	67	824	4	43	247	1149	2790	3	35	1	0	12	12
-117	A	5.4	11.1	120	162	44	598	2	40	166	800	2166	3	26	1	0	4	10
-129	A	4.3	12.5	113	204	33	605	1	57	147	866	2266	6	21	1	0	4	2
-141	A	2.3	11.1	126	122	53	789	5	132	184	1043	3548	1	23	0	0	6	6
-153	A	3.8	9.7	97	160	51	844	20	145	168	1149	4973	1	31	0	2	7	2
-165	A	1.3	10.6	85	108	34	751	11	84	130	943	4869	0	34	0	0	3	1
-177	A	1.1	7.9	77	82	56	731	9	81	142	894	5219	4	22	2	0	2	0
-189	A	1.6	6.8	61	75	33	529	3	65	97	669	4623	0	18	11	0	0	0
-201***	A	2	13.8	86	180	59	527	7	64	152	771	5482	1	20	222	0	2	6
-213	A	5.3	30.9	274	272	81	1156	11	88	366	1516	10259	6	53	193	0	2	9
-225	A	7.8	44.5	535	504	153	1833	9	88	697	2425	14184	7	137	101	0	3	11
-237	B	9.8	60.1	755	592	186	2212	27	102	968	2906	16150	12	173	53	0	1	13
-249	B	10.2	53.1	634	558	169	1965	7	129	810	2652	13517	11	137	32	0	3	8
-261	B	8.5	35.1	406	398	189	1650	54	204	649	2252	9413	9	114	73	0	3	12
-273	B	5.5	26.4	371	437	162	1379	29	169	562	1985	8200	8	56	17	0	5	11
-285	B	7	34.5	575	639	220	1733	85	273	880	2645	11600	6	68	15	0	8	17
-297	B	8.1	33.5	473	615	203	1445	47	122	723	2182	11676	9	92	5	0	1	29
-309	B	6.4	29.3	470	527	198	1039	92	283	760	1849	9907	6	89	2	0	12	19
-321	B	8.2	29	454	569	262	1281	41	160	757	2010	11190	6	77	1	0	6	33
333***	B	9.7	42.1	760	653	293	1568	44	194	1097	2415	18635	4	97	1467	0	6	29
-345	B	13.1	40.6	573	586	386	1557	62	315	1021	2458	13279	8	118	349	0	7	33
-357	B	8.7	43.9	604	735	357	1753	141	269	1102	2757	13758	8	141	103	0	8	44
-369	B	8.5	38.8	642	589	421	1867	89	219	1152	2675	15662	6	124	2	0	2	34
-381	B	8	37.9	917	603	493	2362	86	321	1496	3286	19481	7	181	0	0	2	24
-393	B	6.7	35.3	580	701	413	2393	71	323	1064	3417	15938	6	168	1	0	4	16
405***	B	4.8	32.9	401	544	267	2327	27	270	695	3141	13833	12	118	13	1	8	21
-417	B	6.1	27.6	426	489	243	1967	101	287	770	2743	10174	17	105	0	0	2	27
-429	B	9.8	27.8	576	586	304	2084	148	331	1028	3001	11236	10	152	0	0	0	10
-441	C-1	7.7	21.4	524	486	302	1739	50	237	876	2462	10262	6	75	0	0	1	2
-453	C-1	2.1	9	191	201	146	895	30	302	367	1398	5588	3	29	1	0	3	0
SUM	*A–C-1*	*207*	*897.7*	*13288*	*13629*	*6404*	*49404*	*1336*	*5750*	*21028*	*68783*	*329368*	*197*	*2932*	*2672*	*4*	*171*	*494*
MEDIAN		*5.4*	*26.4*	*371*	*398*	*153*	*1281*	*20*	*129*	*562*	*1849*	*9413*	*6*	*75*	*2*	*0*	*4*	*11*
25th%		*2.9*	*10.6*	*126*	*160*	*56*	*844*	*4*	*65*	*184*	*1131*	*4623*	*2*	*31*	*0*	*0*	*2*	*6*
75th%		*8.1*	*35.1*	*573*	*586*	*262*	*1753*	*54*	*269*	*876*	*2645*	*13279*	*8*	*118*	*17*	*0*	*7*	*19*
SUM	*A*	*58.1*	*239.4*	*2956*	*3121*	*1190*	*16188*	*105*	*1240*	*4251*	*20549*	*89869*	*43*	*818*	*538*	*3*	*89*	*112*
SUM	*B*	*139.1*	*627.9*	*9617*	*9821*	*4766*	*30582*	*1151*	*3971*	*15534*	*44374*	*223649*	*145*	*2010*	*2133*	*1*	*78*	*380*

*** Sedimentacijski nivo z ostanki ognjišča.

*** Sedimentation level with the remains of a hearth.

Tab. 12.3.2: Kosti: Spearmanova korelacija ranga za izbrane podatke.
Tab. 12.3.2: Bones: Spearman's rank correlation for selected data.

	Complete (kg)	Fragments, all (kg)	Complete, sum
Complete (kg)	1.00		
Fragments, all (kg)	0.90	1.00	
Complete, sum	0.88	0.84	1.00
Fragmented, sum	0.81	0.82	0.93

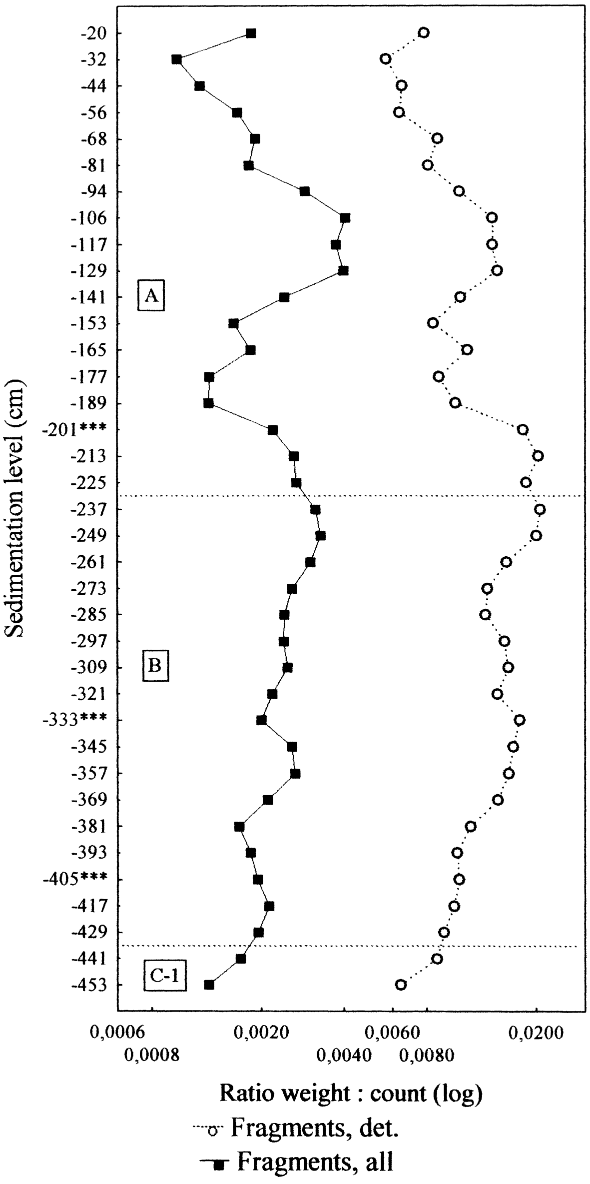
Vse korelacije so značilne ($p < 0,05$).
All correlations are significant ($p < 0.05$).

mi preverila s testom "t", ki je pokazal, da je razlika med facijama A in B na meji značilnosti (p = 0,06). Razliko, ki ni skladna z večino razlik med facijami, ki sva jih ugotovila pri preučevanju fragmentacije, gre pripisati bolj zmogljivoti terenske ekipe kot stopnji fragmentarnosti. Nesporno je dejstvo, da je bilo nedoločljivih fragmentov dejansko bistveno več, kot jih je ekipi uspelo pobrati. Nepobrani so ostali predvsem fargmenti, manjši od 10 mm, zaradi česar je bilo zabeleženih samo 20 % vseh kostnih najdb, večjih od 3 mm, navedenih v *tab. 12.3.1*. Zato je število nedoločljivih fragmentov dejansko večje od 1,5 milijona. Vse to je lahko bistveno vplivalo na rezultat, ki so ga dali nedoločljivi fragmenti. Zato rezultat ne more služiti v interpretacijske namene. Nevšečnostim bi se dalo izogniti, če bi lahko uporabila težno razmerje, za kar pa, žal, nimava ustreznih podatkov.

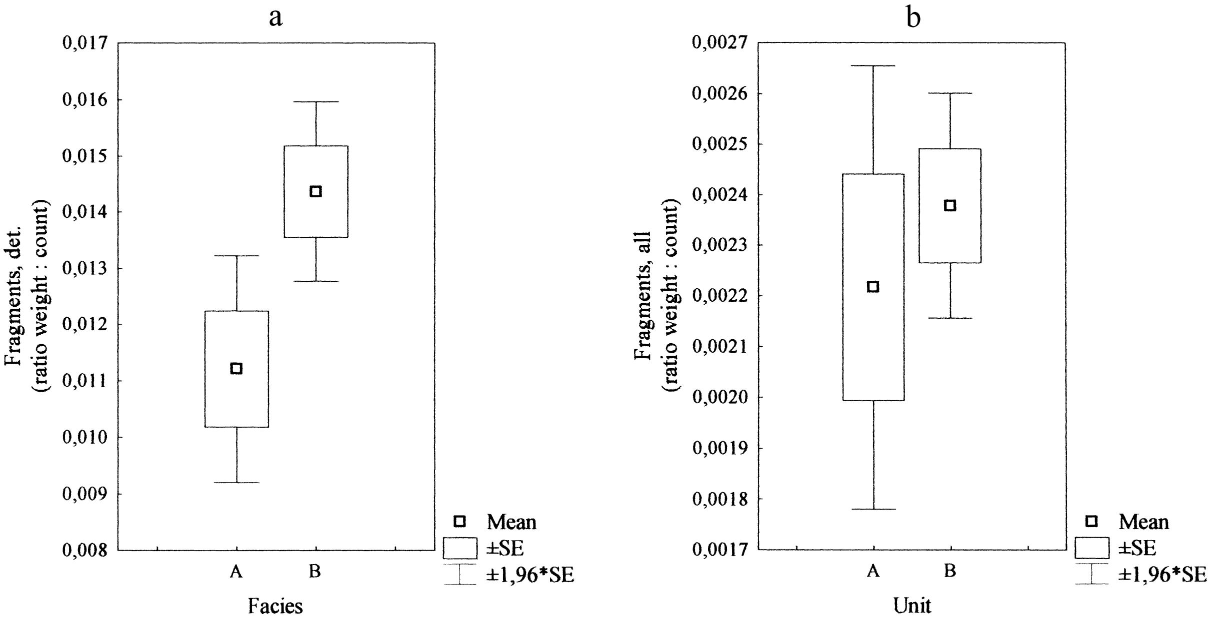
Splošno fragmentacijo sva ocenila in preučila na podlagi povprečne teže fragmentov, ki sva jo izračunala tako, da sva enkrat težo vseh fragmentov delila samo s številom določljivih fragmentov in drugič s številom vseh fragmentov, tj. določljivih in nedoločljivih. Dobila sva primerljiv rezultat (*sl. 12.3.3*). Ker so razmerja obakrat normalno porazdeljena, sva lahko testirala razliko v razmerju med facijama A in B s testom "t" za neodvisne skupine vzorcev. Test je potrdil, da so fragmenti facije A po prvem razmerju značilno lažji (beri manjši) v primerjavi s facijo B (p = 0,02), po drugem pa je teža oz. velikost enaka (p = 0,53) (*sl. 12.3.4a, b*). Vendar je tudi pri drugem razmerju jasno nakazana težnja k lažjim fragmentom oz. manjšim v faciji A.

Splošno fragmentacijo sva bolj zanesljivo ocenila s primerjanjem razmerij teža fragmentov : teža celih kosti in število fragmentov : število celih kosti (*sl. 12.3.5*). Pri tem je treba poudariti, da sva pri teži upoštevala vse fragmente, pri številu pa samo določljive. Ker med nedoločljivimi fragmenti prevladujejo odlomki, manjši od enega centimetra, ne vplivajo bistveno na težo vseh fragmentov, ki je določena predvsem s težo večjih določljivih odlomkov. S primerjanjem težnih in številčnih razmerij fragmentov sva minimizirala vpliv količine kostnih ostankov na razlago fragmentacije.

Sl. 12.3.5 jasno kaže, da se faciji A in B razlikujeta v fragmentaciji in da med razmerji ni korelacije, čeprav bi jo pričakovali glede na naravo vhodnih podatkov. Da korelacije ni, so krivi neznani tafonomski dejavniki. Fragmenti v faciji B so relativno težji (večji) in redkejši. Slednje pomeni, da je več celih kosti, kar so potrdila tudi terenska opažanja, zlasti v plasti 8. V faciji A je slika obratna, vendar neenotna. Manjšinski del sedimentacijskih nivojev (plast 5a, 5 in 6), katerih sedimenti so pretežno odsev podobne klime kot v večini sedimentov

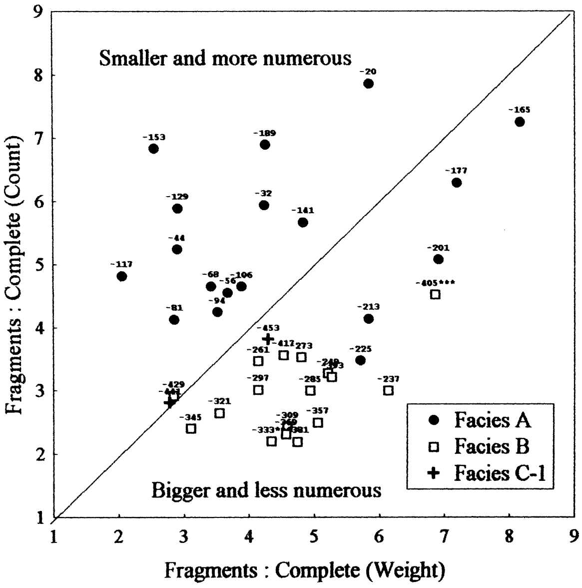


Sl. 12.3.3: Razmerje teža : število pri določljivih fragmentih in vseh fragmentih. Skala je logaritemska. A–C-1 so facije.
Fig. 12.3.3: Ratio weight : number, in relation to identified fragments and all fragments. The scale is logarithmic. A–C-1 are facies.



Sl. 12.3.4a, b: Razmerje teža : število pri določljivih fragmentih (a) in vseh fragmentih (b) v facijah A in B.
Fig. 12.3.4a, b: Ratio weight : number, in relation to identified fragments (a) and all fragments (b) in facies A and B.

facije B, se v fragmentaciji ne razlikuje od facije B. Za večinski del sedimentacijskih nivojev (plasti 2–4) so značilni relativno lažji (manjši) in številčnejši odlomki. Enotna oz. neenotna slika fragmentacije v facijah A in B se dobro sklada s sliko vlažnosti oz. padavin v obeh facijah. Facija B je bila ekstremno vlažna in brez izrazitih suhih obdobij, facija A pa izmenično suha in vlažna. Razlike v fragmentaciji so povezane na eni strani s količino kostnih ostankov, ki je domnevno funkcija klime, natančneje padavin, in na drugi strani domnevno z vedenjskim vzorcem bioloških povzročiteljev fragmentacije. Na sliko fragmentacije vplivajo tudi zastoji v sedimentaciji.



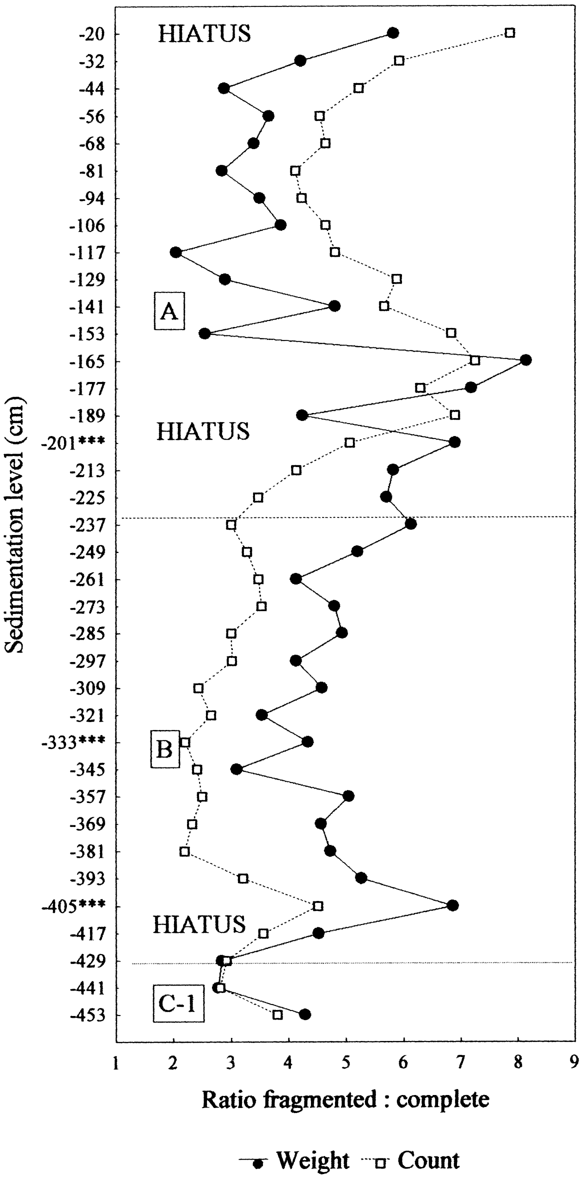
Sl. 12.3.5: Kosti: splošna fragmentacija na podlagi težnih in številčnih razmerij kostni fragmenti : cele kosti v faciji.
Fig. 12.3.5: Bones: General fragmentation on the basis of weight and numerical ratios of bone fragments: whole bones in facies.

Isti rezultat kot *sl. 13.3.5* nam kaže *sl. 12.3.6*, le da je tu viden določen trend, ki ga lahko smiselno interpretirava. Trend sočasnega povečevanja količnika težnih in številčnih razmerij med fragmenti in celimi kostmi, od spodaj navzgor v profilu (*sl. 12.3.6*), dobro ustreza dvema zastojema v sedimentaciji na začetku in koncu profila in nekoliko slabše tretjemu v sredini. Vsi zastoji oz. vrzeli so bile ugotovljene na podlagi radiometričnih in sedimentoloških analiz (glej poglavje 5 in 6 v tem zborniku). Med vrzelmi so razlike v fragmentaciji. Za prvi dve vrzeli od spodaj navzgor so značilni večji in maloštevilni fragmenti, za tretjo, zadnjo vrzel pa so značilni manjši in številnejši fragmenti. V bližini vseh hiatov je več fragmentov in manj celih kosti, fragmenti so težji (večji) in cele kosti so lažje (manjše), kar lahko poveževa s povečanim preperevanjem med upočasnjeno ali prekinjeno sedimentacijo, ki je imela za posledico uničenje majhnih fragmentov.

Faciji A in B se razlikujeta v splošni fragmentaciji kostnih ostankov. Razmerja med fragmenti in celimi kostmi so podobna. Vendar je v faciji B manj fragmentov kot v A, so pa zato večji. Razliko povezujeva z različno količino kostnih ostankov ter pogostnostjo obiskov in množičnostjo ljudi in večjih zveri.

Zastopanost večjih zveri je glede na skromne ostanke v obeh facijah bodisi enaka ($\chi^2 = 1{,}67$, $p = 0{,}19$) bodisi značilno večja v faciji B, če sklepava samo po podvojenih ostankih volka ($p_{\text{razmerje A:B}} = 0{,}03$) (*tab. 12.3.3*). Prisotnost ljudi je bila, glede na najdbe, prav tako večja v faciji B, kar naju navaja na misel, da so se volkovi radi zadrževali v bližini človeških bivališč, ali da so bili plen ljudi.

Ljudje, kot glavni dejavnik splošne fragmentacije kosti, ne pridejo v poštev zaradi različne količine artefaktov v obeh facijah, predvsem pa zaradi manjše fragmentarnosti adultnih kosti v primerjavi z juvenilnimi in skoraj popolne odsotnosti vrezov na kosteh (prim. *tab 12.3.1*). Adultne kosti imajo bistveno več mozga, ki je bil dostopen izključno ljudem in hijenam, vendar slednjih v najdišču ni bilo.



Sl. 12.3.6: Razmerje določljivi kostni fragmenti : cele kosti, izraženo enkrat s težo in drugič s številom. A–C-1 so facije. Posebej so označene vrzeli, ugotovljene na podlagi radiometričnih in sedimentoloških raziskav. Pri branju grafa je treba biti pozoren na križanje krivulj v zgornjem delu profila.
Fig. 12.3.6: Ratios of identified bone fragments : whole bones, expressed firstly by weight and secondly by number. A–C-1 are facies. Hiatuses established on the basis of radiometric and sedimentological research are marked individually. In reading the graph, attention must be paid to the crossing of the curves in the upper part of the profile.

Tab. 12.3.3: Število določljivih ostankov srednje velikih in velikih zveri v sedimentacijskih nivojih facijev A in B.
Tab. 12.3.3: Number of identifiable remains (NISP) of medium large and large carnivores in the sedimentation levels of facies A and B.

Facies	*U. arctos*	*C. lupus*	*P. pardus, P. spelaea*
A	14	14	4
B	16	30	3

Zveri pridejo bolj v poštev, prvič, ker ni razlik med facijama A in B v fragmentaciji kosti in zastopanosti zveri in drugič, zaradi relativno večje fragmentacije juvenilnih kosti. Vlogo zveri lahko razloživa z večjim delovanjem, za kar mora biti podan razlog. Kostnih ostankov je v faciji A bistveno manj kot v faciji B. Če je kosti malo, zveri nimajo izbire in temeljiteje opravijo svoje delo. Drugače je, če je kosti veliko. Tedaj se marsikatera kost izogne poškodbam in uničenju, zaradi česar se spremeni slika fragmentacije. Človek ravna podobno. Vpliv človeka bi se lahko kazal predvsem v fragmentaciji adultnih kosti, ki jih srednje velike zveri ne morejo zdrobiti. Vendar se ne kaže. V faciji A, kjer je ostankov paleolitskih obiskov bistveno manj kot v faciji B, ni znakov o zmanjšani fragmentaciji, temveč prej nasprotno, kar pa ne izključuje možnosti, da so ljudje v faciji A povečali svojo dejavnost, osredotočeno izključno na kosti, predvsem v okolici ognjišč. Ta možnost bo obdelana v drugem delu monografije.

POSEBNA FRAGMENTACIJA

Posebno fragmentacijo kosti sva preučila v povezavi s tremi starostnimi skupinami: *neonatus*, *juvenilis* in *adultus*. Tako cele kosti kot fragmentirane, vseh starostnih skupin, so med seboj bolj ali manj močno in značilno povezane (*tab. 12.3.4*).

Fragmentacijo sva po starostnih skupinah interpretirala na podlagi razmerja kostni fragmenti : cele kosti in razmerja juvenilne diafize : adultne diafize. Nobeno od razmerij ni normalno porazdeljeno.

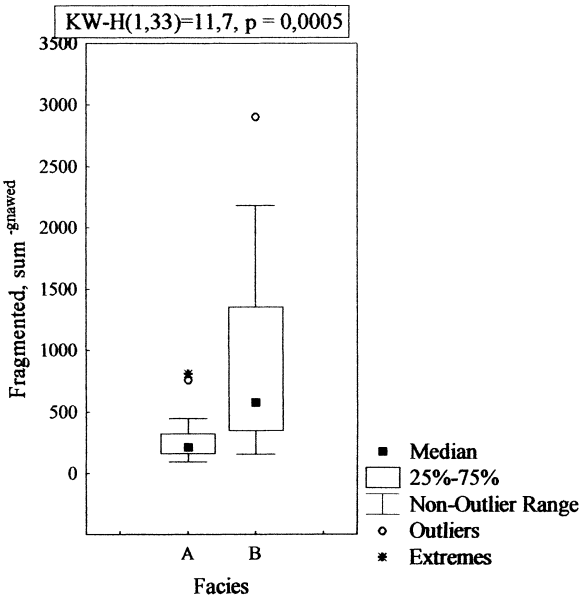
V skupini *juvenilis* in *neonatus* je povprečno desetkrat več fragmentov na celo kost kot v skupini *adultus*. Juvenilnih diafiz je povprečno devetnajstkrat več kot adultnih. Vse to kaže, da so juvenilne in neonatne kosti bistveno bolj fragmentirane kot adultne. Na podlagi juvenilnih diafiz, ki imajo pogosto odgrizene metafize, sklepava, da so bile glavni povzročitelj fragmentacije zveri. Ker so fragmentirane pretežno juvenilne in neo-

Tab. 12.3.4: Spearmanova korelacija ranga za ontogenetske starostne kategorije kosti.
Tab. 12.3.4: Spearman's rank correlation for ontogenetic age categories of bones.

	Complete, adul.	Fragmented, adul.	Complete, juv.	Fragmented, juv.	Complete, neon.
Complete, adul.	1.00				
Fragmented, adul.	0.93	1.00			
Complete, juv.	0.90	0.88	1.00		
Fragmented, juv.	0.90	0.81	0.87	1.00	
Complete, neon.	0.70	0.76	0.82	0.66	1.00
Fragmented, neon.	0.69	0.72	0.81	0.69	0.88

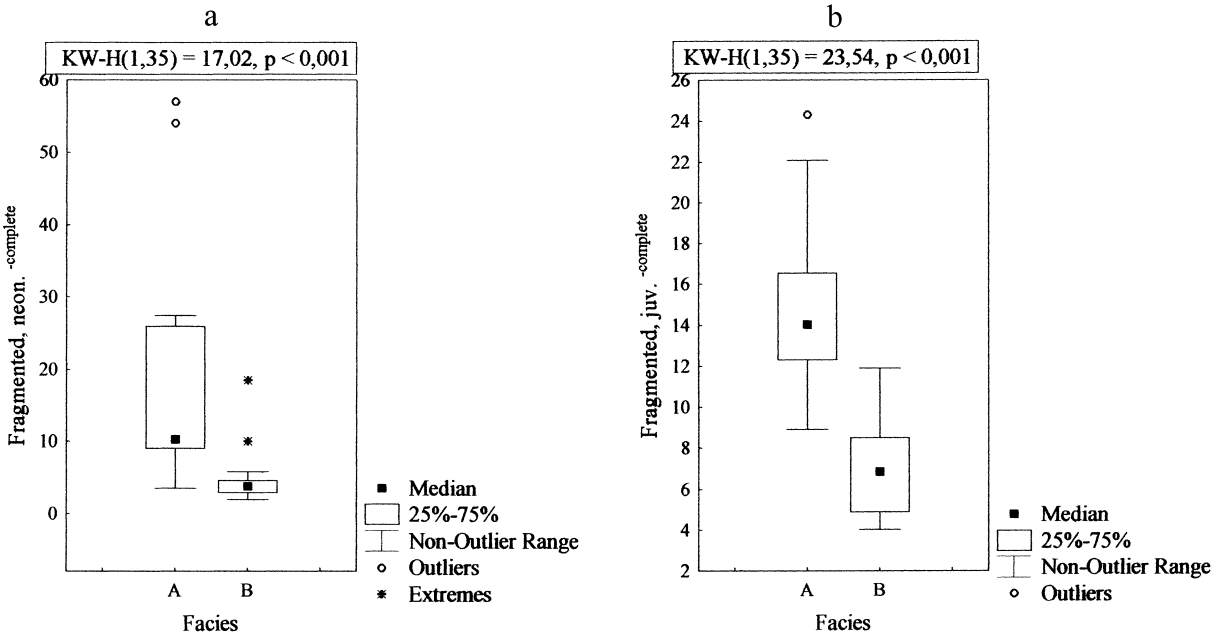
Vse korelacije so značilne ($p < 0,05$).
All correlations are significant ($p<0.05$).

natne kosti, sklepava da gre za majhne do srednje velike zveri. V poštev pride predvsem volk. Statistika določljivih kostnih fragmentov na kost s sledovi grizenja kaže, da je obgrizenih kosti značilno več v faciji A, ker je tam manj fragmentov na takšno kost (*sl. 12.3.7*). To podpira zgoraj izraženo domnevo o povezavi splošne fragmentacije kosti z delovanjem zveri. Sodeč po obgrizenih kosteh je bilo v faciji A bodisi več zveri bodisi so zveri bolj grizle, ker je bilo kosti manj kot v faciji B. Intenzivnejše grizenje lahko razloživa z vedenjskim vzorcem zveri.

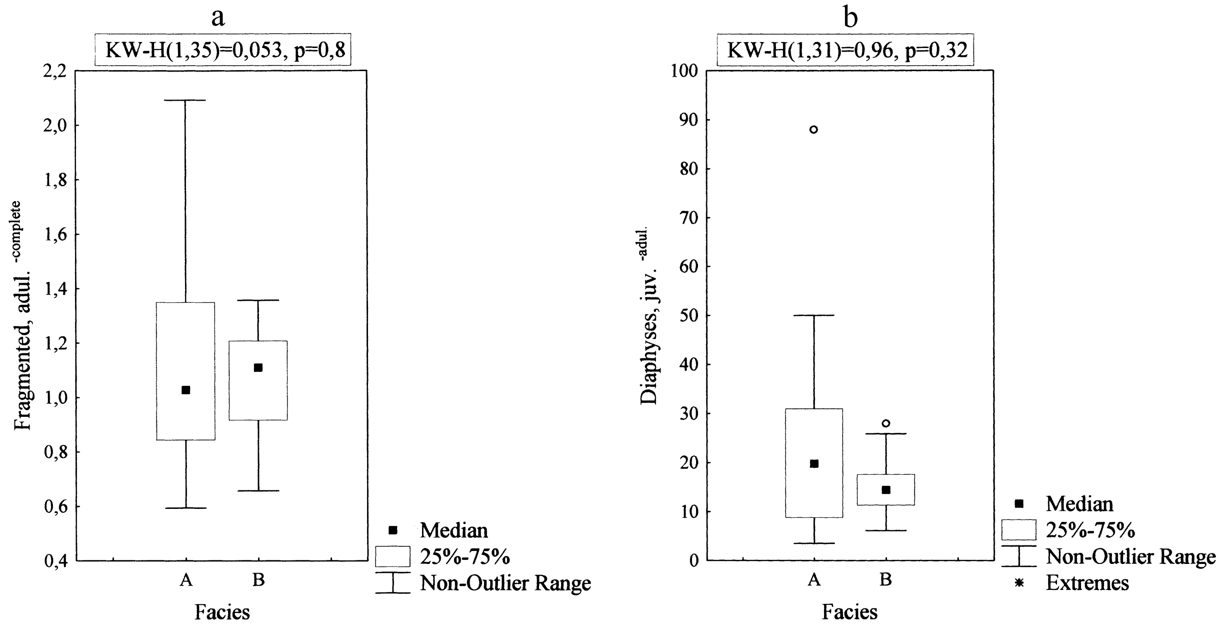


Sl. 12.3.7: Število kostnih fragmentov na obgrizeno kost v facijah A in B. Podan je tudi rezultat Kruskalovega in Wallisovega testa.
Fig. 12.3.7: Number of bone fragments per gnawed bone in facies A and B. Results of the Kruskal-Wallis test are also given.

V zvezi z rubriko "obgrizene kosti" v *tab. 12.3.1* morava pripomniti, da med njimi ni preluknjanih kosti. So samo takšne z odtiski zob na juvenilnih metafizah, izjemoma tudi na adultnih epifizah. V celotnem vzorcu je samo ena preluknjana kost, in sicer proksimalna metafiza juvenilnega femurja z izjedkano lukn-



Sl. 12.3.8a, b: Število neonatnih fragmentov na celo neonatno kost (a) in juvenilnih na celo juvenilno (b) v facijah A in B. Podan je tudi rezultat Kruskalovega in Wallisovega testa.
Fig. 12.3.8a, b: Number of neonatal fragments per whole neonatal bone (a) and juvenile per whole juvenile (b) in facies A and B. Results of the Kruskal-Wallis test are also given.



Sl. 12.3.9a, b: Število adultnih fragmentov na celo adultno kost (a) in število juvenilnih diafiz na adultno (b) v faciji A in B. Podan je tudi rezultat Kruskalovega in Wallisovega testa.
Fig. 12.3.9a, b: Number of adult fragments per whole adult bone (a) and juvenile diaphysis per adult (b) in facies A and B. Results of the Kruskal-Wallis test are also given.

jo, najdena v kvadratu 23 na globini -273 cm. To posebej navajava zaradi žolčne polemike o najdbi domnevne koščene piščali v kvadratu 17 na globini -285 cm, ki jo nekateri razlagajo kot posledico zverske dejavnosti, sklicujoč se na splošen pojav preluknjanih kosti v najdiščih z jamskim medvedom (d'Errico *et al.* 2003, 35ss). Med 89.811 pregledanimi določljivimi kostmi je samo ena večkrat preluknjana kost, ki se razlaga kot domnevna piščal (Turk *et al.* 1995; 2005b), in ena enkrat preluknjana kost, ki jo glede na položaj luknje lahko eventualno razloživa kot posledico delovanja zveri. O drugih maloštevilnih preluknjanih kosteh z najdišča smo že večkrat poročali (Turk 1984-1986, 10; Brodar 1999, t. 6: 8,9; Turk *et al.* 2001b, tab. 5, sl. 19). Pri tako ali drugače preluknjanih kosteh v Divjih babah I nikakor ne gre za splošen pojav, ampak kvečjemu za izjemen pojav.

Fragmentacijo kostnih ostankov v treh starostnih skupinah sva primerjala med facijami. V sakupini *neonatus* in *juvenilis* je fragmentacija značilno večja v faciji A, ker je bilo tam najdenih več fragmentov na celo kost (*sl. 12.3.8a, b*). To se delno ujema s splošno sliko fragmentacije (prim. *sl. 12.3.4a*). V skupini *adultus* in pri diafizah ni značilnih razlik med facijami (*sl. 12.3.9a, b*). Ker ni razlik, sklepava, da v času ni bilo bistvenih kakovostnih sprememb pri adultnih kosteh, lahko pa je prišlo do strukturnih sprememb populacijskega značaja, kot kažejo analize zob in metapodijev (glej poglavji 17 in 18 v tem zborniku), in sicer v razmerju med spoloma. Od tega je bilo odvisno tudi število mladičev, ki se je nedvomno spreminjalo v času.

STAROSTNA SESTAVA

Zaradi velikih razlik v fragmentaciji adultnih ostankov na eni strani in juvenilnih ter neonatnih na drugi, je nemogoče pravilno oceniti razmerje med odraslimi in mladiči. Ta ocena se pogosto pojavlja v literaturi, vendar meniva, da je v večini primerov popolnoma nezanesljiva.

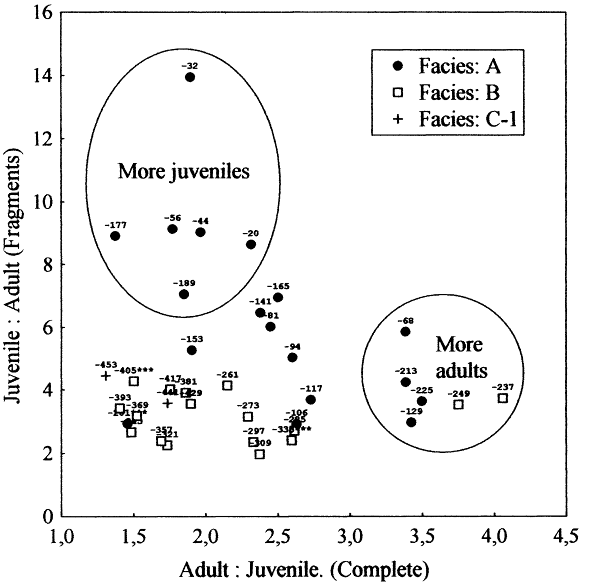
Na eno juvenilno celo kost sta v Divjih babah I povprečno 2,3 cele adultne kosti, kar zanesljivo ne ustreza dejanskemu razmerju med odraslimi in mladiči, saj je mladih vedno več kot starih.

Na en adultni fragment je povprečno 5,2 juvenilnega in neonatnega fragmenta. Količnik je po najini oceni prevelik in ne ustreza dejanskemu razmerju med mladiči in odraslimi.

Starostno sestavo kostnih ostankov sva lahko zanesljiveje ocenila s primerjanjem razmerij juvenilne cele kosti : adultne cele kosti in adultni kostni fragmenti : juvenilni kostni fragmenti (*sl. 12.3.10*). Na ta način sva minimizirala vpliv fragmentacije in količine kostnih ostankov na interpretacijo starostne sestave.

Na *sl. 12.3.10* vidimo negativno korelacijo ($r = 0{,}51$, $p = 0{,}03$) med obema razmerjema v faciji A. Takšna korelacija je pričakovana glede na naravo podatkov. V faciji B ni korelacije, kar pripisujeva vplivu neznanih tafonomskih dejavnikov.

Majhne vrednosti enega razmerja in velike drugega so najzanesljivejši znak za večjo prisotnost adultnih oz. juvenilnih kostnih ostankov. V večini sedimentacijskih nivojev, vključno z ognjiščnimi, ugotavljanje starost-



Sl. 12.3.10: Kosti: starostni sestav na podlagi številčnega razmerja med juvenilnimi in adultnimi kostmi in odnosa celo-fragmentirano.
Fig. 12.3.10: Bones: Age composition on the basis of numerical ratio between juvenile and adult bones and the ratio whole-fragmented.

ne strukture in iz tega izhajajočih razlik ni mogoče oz. bi bilo to skrajno nezanesljivo. Kaže, da je v faciji A več mladičev v zgornjih sedimentacijskih nivojih, ki pripadajo plastem 2-6, in da so starejši medvedi pogostejši v plasti 5a in 6, za kateri je značilna hladna klima. V plasti 5a je bila klima tudi zelo vlažna, podobno kot v faciji B, v kateri je več odraslih medvedov.

KLASIFIKACIJA SEDIMENTACIJSKIH NIVOJEV NA PODLAGI KOSTNIH OSTANKOV

Klasifikacijo sedimentacijskih nivojev v faciji A in B na podlagi sedimentoloških podatkov (Turk 2006 in poglavje 5 v tem zborniku) sva preverila z diskriminantno funkcijsko analizo (DFA) in analizo glavnih komponent (PCCA) na podlagi kostnih ostankov. Če so facije resnično del sistema, se mora rezultat na podlagi kostnih ostankov ujemati z rezultatom na podlagi sedimentnih značilnosti. Drugače povedano, faciji A in B se morata razlikovati.

V ta namen sva vse podatke transformirala s kvadratnim korenom, da sva za 10 podatkov od 17 razpoložljivih dobila normalno porazdelitev. Tako spremenjeni so bili podatki, navedeni v *tab. 12.3.1* pod zaporednimi številkami 2-4, 6, 7, 11-13, 17 in 18.

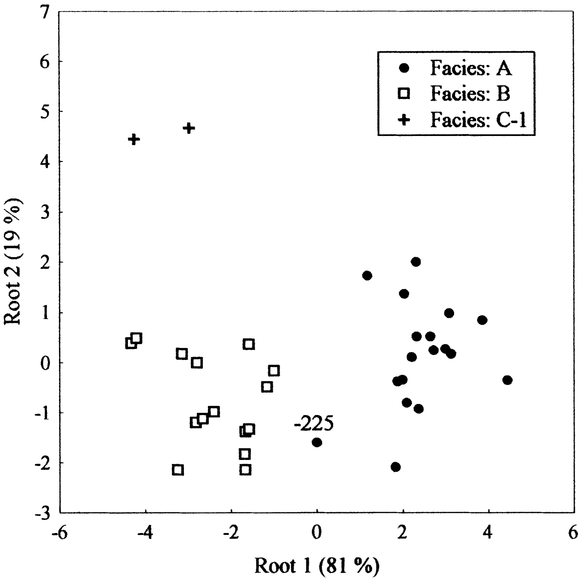
Diskriminantna funkcijska analiza (DFA) je pokazala, da k ločevanju na facije po prvi diskriminantni funkciji (root 1), katere delež je 81 %, prispevajo vsi spremenjeni podatki (*sl. 12.3.11*). V facijo A je s pomočjo klasifikacijske funkcije pravilno umeščenih 17 sedimentacijskih nivojev od 18 ali 94,4 %, v facijo B pa vsi. V celoti je skupaj s subfacijo C-1, ki je umeščena 100 %, pravilno umeščenih 97 % sedimentacijskih nivojev ali 34 od 35, kar je zelo dober rezultat. Nepravilno je umeščen sedimentacijski nivo na globini -225 cm, in sicer v facijo B. Napačna umestitev se da razložiti s tem, da je nivo -225 cm na meji facij A/B (glej *sl. 12.3.6*).

Kaj predstavlja prva in hkrati glavna diskriminantna funkcija, je težko predvideti. Meniva, da biotske dejavnike, na katere je preko vedenjskega vzorca ljudi in zveri vplivala količina kosti, na količino kosti pa je preko jamskega medveda vplivala klima, natančneje vlaga.

Analizo glavnih komponent s poudarkom na klasifikaciji sedimentacijskih nivojev (PCCA) sva naredila s pomočjo korelacije in standardiziranih, spremenjenih podatkov. Ti imajo namreč zelo različno standardno odstopanje, kot je razvidno s *sl. 12.3.12a, b,* in sva jih morala za izbrano varianto PCCA standardizirati, tako da je srednja vrednost 0 in odstopanje 1. Za PCCA kosti veljajo isti pomisleki kot za PCCA posamično najdenih zob.

Prvi štirje faktorji pojasnijo 94,7 % odnosa med kostmi in faktorji, od tega prvi faktor 74,9 %. Prvi in glavni faktor bi, kot rečeno, lahko predstavljal biotske dejavnike, ki so posredno povezani s klimo, lahko pa tudi kvantiteto.

Projekcija podatkov na ravnino prvih dveh faktorjev kaže, da so vsi podatki, razen obgrizenih kosti in delno izjedkanih, močno negativno povezani s prvim faktorjem, kar pomeni pri povečani dejavnosti ljudi in



Sl. 12.3.11: Kosti: rezultat diskriminantne funkcijske analize facij na podlagi transformiranih, normalno porazdeljenih podatkov.
Fig. 12.3.11: Bones: Result of discriminant function analysis of facies on the basis of transformed normally distributed data.

zveri manjše vrednosti vseh podatkov. Število obgrizenih kosti ni povezano s prvim faktorjem in z ostalimi podatki, ki so med seboj pozitivno povezani. Obgrizene kosti predstavljajo zato skupino zase. Podobno, vendar manj izrazito skupino predstavljajo tudi izjedkane kosti.

Projekcija sedimentacijskih nivojev na faktorsko ravnino prvih dveh faktorjev omogoča razlikovati med skupinami sedimentacijskih nivojev (*sl. 12.3.13a, b*).

Sedimentacijski nivoji tvorijo manjše skupine, v katerih so združeni nivoji iz različnih delov profila, zato zanesljivo ne predstavljajo na terenu določenih plasti (*sl. 12.3.13a*). Posebno skupinico tvorita tudi dva nivoja z ostanki ognjišča, čeprav se nahajata na različni globini (-333 cm in -405 cm). Tretji ognjiščni nivo (-201 cm) tvori s sedimentacijskima nivojema -32 cm in -165 cm stratigrafsko heterogeno skupinico. Ognjiščni nivo -201 cm je antagonist drugima ognjiščnima nivojema, kar pomeni, da so analizirane vrednosti obratno sorazmerne. Prvi faktor, katerega delež pri ločevanju med sedimentacijskimi nivoji in facijami je 75 %, zelo dobro loči faciji A in B, medtem ko drugi faktor ne loči med facijami (*sl. 12.3.13b*).

Ker bi lahko pripisali tako dobro razlikovanje med facijami tudi količinskim razlikam, sva vse znake v *tab. 12.3.1*, razen kosti z vrezi, analizirala tudi s pomočjo multivariatne tehnike dvodimenzionalnega skaliranja (MDS), ki zaradi standardizacije vrstic namesto stolpcev do neke mere omili količinske razlike med facijami (*sl. 13.3.14a, b*). Shepardov diagram (prim. podpoglavje 12.4 v tem zborniku, *sl. 12.4.7*) in stres potrjujeta, da prvi dve dimenziji popolnoma zadoščata za ugotavljanje podobnosti oz. različnosti med sedimentacijskimi nivoji in facijami.

Faciji A in B se najbolje razlikujeta v drugi dimenziji, kjer odstopa le pet sedimentacijskih nivojev, ki so na sliki posebej označeni z globinami. Razlikovanje v prvi dimenziji je bistveno slabše, saj se skoraj polovica sedimentacijskih nivojev facije A v tej dimenziji ne razlikuje od facije B (*sl. 13.3.14b*).

V prvi dimenziji sta si podobna ognjiščna nivoja -201 cm in -333 cm, v drugi pa -333 cm in -405 cm. Plasti niso smiselno ločene oz. združene v ravnini obeh dimenzij. Kaj predstavljata obe dimenziji, je težko reči. Na tej stopnji raziskave je to vprašanje nepomembno.

Rezultat PCCA za facije kaže dvoje.

Prvič, da podobne dejavnike opredeljuje relativno veliko analiziranih znakov. Ker večina znakov v bistvu izraža isto stvar (tj. količnske odnose?), rezultat niti ni mogel biti drugačen kot je. Zato je zelo pomembno, da se pogostnost jamskega medveda, izražena z maso fragmentov, večjih od 3 mm, loči po prvem faktorju tudi, če jo projiciramo na faktorsko ravnino, določeno izključno s sedimentološkimi znaki[6]. To kaže na povezavo med jamskim medvedom in klimo, natančneje vlago kot glavnim razlikovalnim znakom, ki opredeljuje domnevni vpliv klime na sedimente v najdišču.

Drugič, da so kostni ostanki del sistema najdišča, ki ga je izoblikoval čas. PCCA in MDS sta potrdila smotrnost delitve stratigrafskega stolpca na faciji A in B, nista pa potrdila smotrnosti delitve na plasti. V tem se rezultat ujema z rezultatom, dobljenim na podlagi izoliranih zob.

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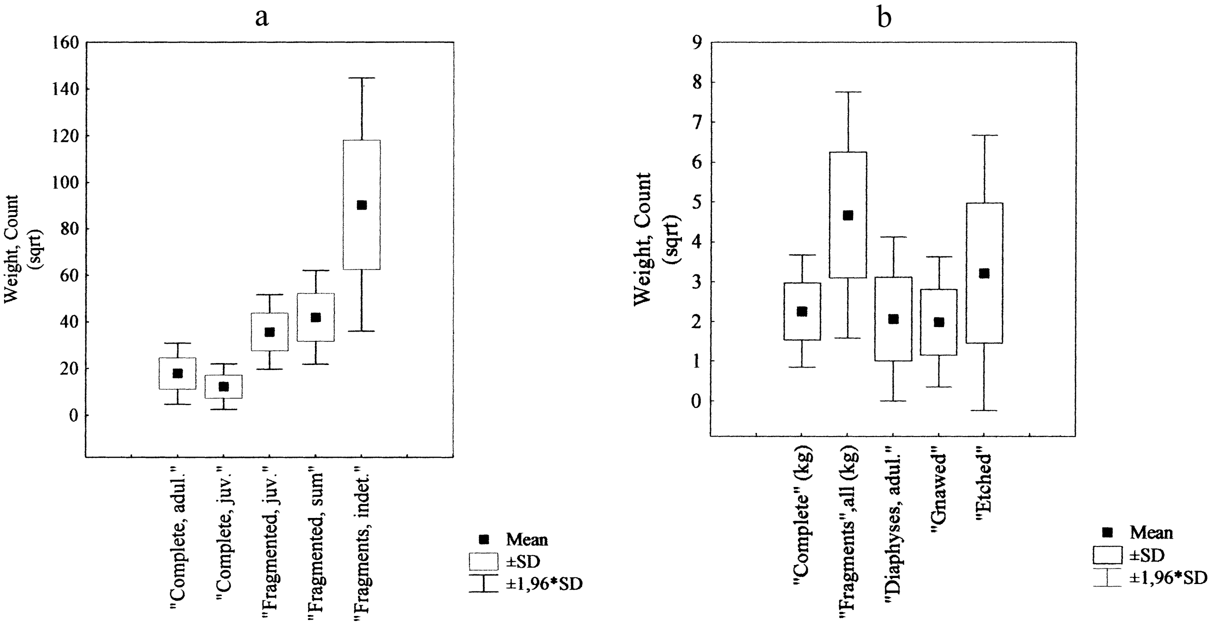
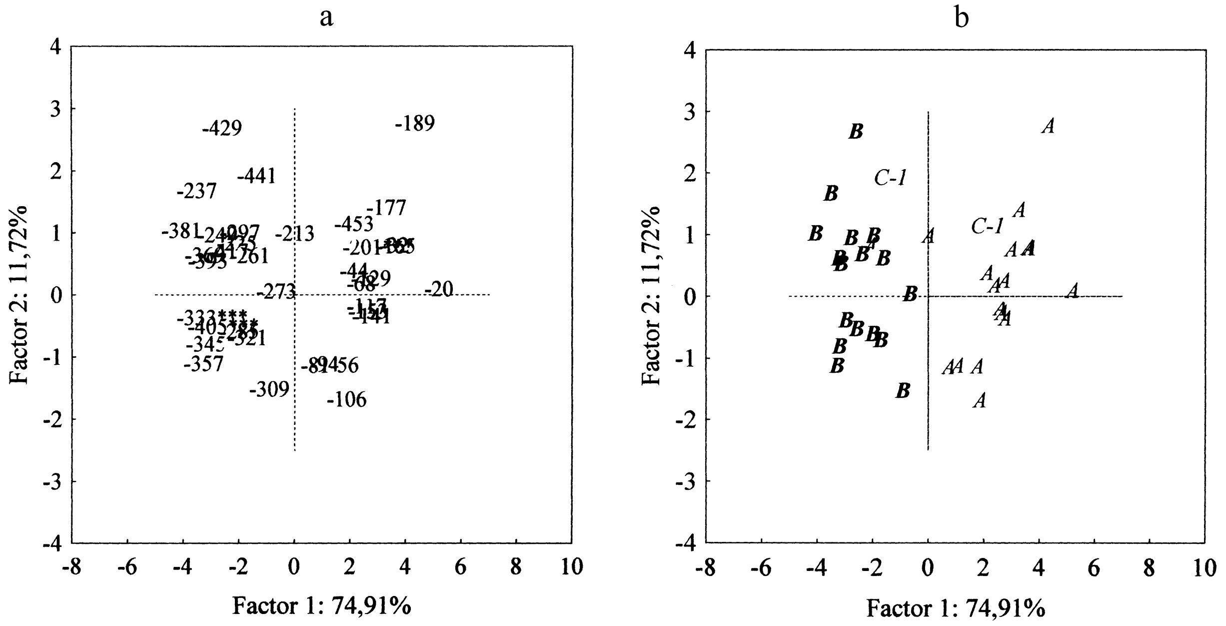
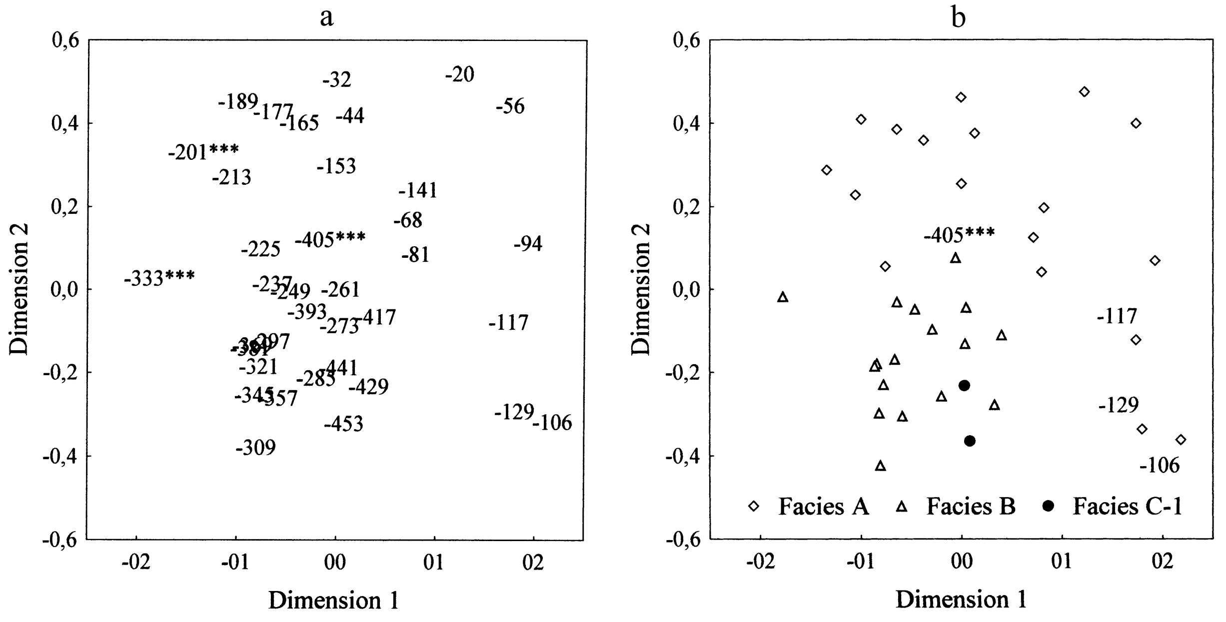
[6] Sedimentološki znaki niso pod vplivom skupne vsote, omiljen pa je tudi učinek količinskih razlik med facijami.



Sl. 12.3.12a, b: Kosti: standardno odstopanje spremenjenih, normalno porazdeljenih podatkov.
Fig. 12.3.12a, b: Bones: Standard deviation of transformed normally distributed data.



Sl. 12.3.13a, b: Kosti: projekcija sedimentacijskih nivojev (a) in facij (b) na faktorsko ravnino prvih dveh faktorjev.
Fig. 12.3.13a, b: Bones: Projection of sedimentation levels (a) and facies (b) on the factor plane of the first two factors.



Sl. 12.3.14a, b: Rezultat dvodimenzionalnega skaliranja evklidskih razdalj (stres = 0,03) za vse kostne ostanke, ki so navedeni v *tab. 12.3.1*, in sicer po sedimentacijskih nivojih (a) ter facijah (b). Izvzete so samo kosti z vrezi zaradi izredno majhnega števila.
Fig. 12.3.14a, b: Result of two-dimensional scaling of Euclidian distances (stress = 0.03) for all bone remains given in *Tab. 12.3.1*, by sedimentation levels (a) and facies (b). Only bones with incisions are excluded, because of the extremely small number.

12.4. ZASTOPANOST SKELETNIH DELOV

Izvleček

Avtorja sta kvantitativno-kvalitativno preučila zastopanost skeletnih delov med ontogentskimi skupinami v bloku sedimentov, sestavljenem iz 37 stratigrafskih enot. Ugotovila sta razlike v ontogenetskih skupinah skeletnih delov, kot so *neonatus*, *juvenilis* in *adultus*. Najboljše so zastopani juvenilni skeletni deli, najslabše neonatni (*sl. 12.4.1a-c*). Zastopanost je pri vseh skupinah slabša v zgornjem delu profila, kjer je manj skeletnih delov (*sl. 12.4.1a-c; 12.4.2*). Na zastopanost skeletnih delov najbolj vpliva število najdb. Določen vpliv ima tudi stopnja fragmentacije. Med zgornjim in spodnjim delom profila (faciji A in B) so tako količinske kot kakovostne razlike pri nekaterih skeletnih delih. V faciji A je več lobanjskih fragmentov kljub manjšemu številu lobanj (*sl. 12.4.9a, b; 12.4.10a, b*), večja je tudi fragmentacija adultnih nadlahtnic in golenic (*tab. 12.4.6*). Rezultati analize in izjem-

na najdba dokaj popolnega adultnega skeleta medvedke v faciji B, ki mu manjka po ena nadlahtnica in stegnenica, kažejo, da so bile lahko nekatere velike mozgovne kosti odstranjene z najdišča, lobanje pa namenoma razbite.

V povezavi z lobanjami avtorja omenjata dve izjemni najdbi lobanj, ki sta lahko dokaz, da so paleolitski ljudje dejansko nekaj počeli z njimi.

Prva je lobanja odraslega jamskega medvedega samca štev. 2349, najdena na dnu plasti 8 med podornimi bloki, kvadrat 39, reženj –333 cm (= sedimentacijski nivo –345 cm), 4 m vstran od ognjišča. Lobanja ima simetrično preluknjana oba masivna odrastka za mandibularno sklepno vdolbino in poškodovano širšo okolico *foramen occipitale magnum* (*sl. 12.4.11*). Poškodba je lahko nastala pri odstranitvi možganov. Vsekakor so nekatere manjše poškodbe nastale tudi postsedimentno zaradi jedkanja. Simetrija parnih lukenj za mandibularno sklepno površino je neobičajna. Lega in velikost lukenj sta prav tako nenavadni. Zato avtorja ne izključujeta možnosti, da so bile luknje narejene z namenom, da se lobanja čvrsto pritrdi ali obesi. Za nameček je lobanja ležala na temenu, kar je prav tako neobičajno, podprta z dvema kamnoma. Z gobcem je bila obrnjena proti zahodu. Vzporedno z njo je 12 cm višje ležala enako obrnejna še ena lobanja odraslega jamskega medveda, tokrat samičja štev. 2033. Ta je bila nepoškodovana, z gobcem obrnjena proti vzhodu, z rahlim odklonom proti jugu. Ker sta se lobanji dotikali, ni izključeno, da je do odklona lobanje štev. 2033 prišlo postsedimentno. Vsekakor je vse našteto (lega, orientacija, spol, poškodbe) zelo težko razložiti s spletom naključij.

Na koncu sta avtorja primerjala zastopanost skeletnih delov v Divjih babah I in v dveh orinjasjenskih jamskih najdiščih: Potočki zijalki v Sloveniji (*tab. 12.4.8, 12.4.9; sl. 12.4.15a*) in jami Chauvet v Franciji, kjer so se ohranila enkratna fosilna tla. Ugotovila sta precejšne razlike kljub podobnemu tipu najdišča. Pripisujeta jih različni strukturi medvedje populacije, ki je obiskovala te jame v bolj ali manj različnih časovnih obdobjih.

Zastopanost skeletnih delov (ZSD) je poleg zastopanosti izoliranih zob (ZIZ) najbolj zapleten analitski sklop. Vzrok zapletenosti je velika razčlenjenost (stratificiranost) vzorca, s katero se bo treba spoprijeti samo še pri paleolitskih orodnih tipih v drugem delu monografije.

Za ZSD je značilna zelo velika variabilnost, ki je povezana predvsem s prisotnostjo oz. odsotnostjo posameznih skeletnih delov in z njihovo fragmentacijo. Za variabilnost je veliko različnih vzrokov, od čisto metodoloških do tafonomskih. Slednji nedvomno prevladujejo nad prvimi. Pomemben dejavnik, ki je močno vplival na sliko ZSD jamskega medveda in drugih troglofilov je bila struktura žive populacije, prvotno prisotne v najdišču brlogu.

METODA IN GRADIVO

Vsi skeletni deli so bili zbrani s pomočjo mokrega sejanja vseh sedimentov na sitih. Takšen način vzorčenja je veliko natančnejši kot vzorčenje brez sejanja, ki smo ga uporabljali pred letom 1990. To dokazuje primerjava vzorca, objavljenega leta 1989 (Turk, Dirjec 1988–1989, T. 1, plasti 2–14), ki je v bloku sedimenta s prostornino 40 m^3 vseboval 8.006 skeletnih delov, medtem ko novi vzorec v bloku sedimentov s prostornino 95 m^3 vsebuje 89.237 skeletnih delov (*tab. 12.4.1*). Oba vzorca, ki sta oddaljena drug od drugega 4 m, obsegata iste plasti.

Skeletne dele sva po koncu vsake terenske akcije vnesla v posebne obrazce, in sicer vsak kvadrat, velikosti 1x1 m, in reženj, debeline 0,12 m, posebej[7]. Skeletne dele v obrazcih, ki se nanašajo na facijo A, je obdelal prvi avtor, skeletne dele, ki se nanašajo na facijo B, pa drugi avtor po približno enakih in stalnih kriterijih kot prvi avtor. Pri tem sva pazila, da pri opredeljevanju ni prišlo do večjih subjektivnih odstopanj. Podatki so se pozneje z obrazcev prenesli v računalnik in s pomočjo posebnega, doma izdelanega programa združili v sedimentacijske nivoje kot osnovne stratigrafske enote, ki so zamenjale na terenu določene plasti[8]. Ker imajo vsi sedimentacijski nivoji enako prostornino, sva lahko analizirala ZSD brez pretvarjanja osnovnih podatkov v deleže.

Kvantitativne in kvalitativne lastnosti skeletnih delov sva analizirala izključno na podlagi števila določljivih ostankov (ŠDO) v bloku sedimentov, sestavljenem iz 37 sedimentacijskih nivojev (*tab. 12.4.1*). V istem bloku sva preučila tudi fragmentacijo kosti in zob in zastopanost izoliranih zob (glej podpoglavji 12.2 in 12.3 v tem zborniku). Za ŠDO sva se odločila, ker meniva, da ta osnovni podatek povsem zadostuje za vse vrste sklepov na podlagi analize skeletnih delov. Različne izpeljanke iz ŠDO kot npr. število skeletnih elementov, najmanjše število medvedov idr. ne pripomorejo k novim dognanjem in sklepom in samo dodatno zapletajo že tako preveč zapleten vzorec.

Za analizo sva vse skeletne dele razdelila v tri starostne skupine: *adultus*, *juvenilis* in *neonatus*, in sicer po splošno veljavnih kriterijih, ki se nanašajo na velikost in ontogenetski razvoj posameznih kosti. Pri tem je lahko prišlo do nekaterih nedoslednosti, ki imajo za posledico metodološko pogojeno variabilnost posameznih ske-

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[7] Izpolnili smo 2.208 obrazcev, od katerih je imel vsak 296 okenc. Originalne obrazce hrani arhiv Inštituta za arheologijo ZRC SAZU in arhiv Narodnega muzeja Slovenije.

[8] Prvi avtor in urednik zbornika je pri računalniški obdelavi baz podatkov, potem ko je že pisal tekst tega poglavja, odkril v amatersko izdelanem računalniškem programu sistemsko napako, ki jo avtor programa ni znal odpraviti. Napaka se je pojavila pri določenih skeletnih delih. Ni mu preostalo drugega, kot da je sam ponovno vnesel vse prizadete podatke in izdelal pomožni program za njihovo obdelavo ter na novo napisal poglavje. V nasprotnem primeru bi šel v nič vložek več tisoč delovnih ur. Podoben zaplet se je zgodil z vitlom in žičnico eno leto pred najdbo piščali. Potem ko so bile izčrpane vse normalne možnosti, je bil avtor in urednik prisiljen sam skonstruirati in izdelati vitel, če je hotel nadaljevati z izkopavanji. Morda se bo zdelo to komu nenavadno, vendar ni, saj si večina avtorjev tega zbornika, vključno z urednikom, ni mogla nabaviti celotnega programa STATISTICA, ki so ga nujno potrebovali pri analizi podatkovnih baz izkopavanj. Odobrili in kupili so jim samo STATISTICA *basic*, kar je tako kot da bi nekomu namesto računalnika dali računalo.

Tab. 12.4.1: Vsi skeletni deli, razvrščeni po sedimentacijskih nivojih na površini B (21 m², skupno 83 m³ ali 33 nivojev po 2,5 m³). Prvi štirje nivoji so s površine A (25 m², skupno 12 m³ ali 4 nivoji po 3 m³). V sivo obarvanem stolpcu z izpisanim imenom skeletnega dela so prvi navedeni adultni primerki, ki jim sledijo juvenilni in neonatni.

Sedimentation level (cm)	Facies	Ossa cranii	juveniles	neonati	Maxillae	juveniles	neonati	Mandibulae	juveniles	neonati	Ossa hyoidea	juveniles	neonati
-20	A	6	232	4	1	9	0	0	16	0	0	2	0
-32	A	6	532	3	0	12	0	2	32	1	7	13	0
-44	A	4	711	3	0	14	0	5	36	0	21	9	0
-56	A	7	757	6	1	14	0	5	39	0	19	5	0
-68	A	4	505	8	1	12	0	7	27	0	15	12	0
-81	A	12	650	15	1	24	0	6	61	0	25	17	2
-94	A	18	573	13	1	19	0	8	47	0	12	6	0
-106	A	124	422	4	1	23	0	17	40	0	9	11	0
-117	A	66	362	6	0	15	1	8	23	0	3	8	1
-129	A	94	407	15	0	14	0	5	25	1	4	7	0
-141	A	12	538	37	2	11	1	6	23	2	11	3	0
-153	A	32	561	25	0	12	0	7	22	1	22	8	0
-165	A	35	494	10	2	6	0	1	11	0	11	1	0
-177	A	9	494	8	1	3	0	5	12	2	5	7	0
-189	A	8	373	6	0	3	0	1	9	0	2	5	0
-201***	A	44	290	7	1	18	0	5	15	1	12	4	0
-213	A	12	575	17	1	27	0	11	39	10	20	5	0
-225	A	45	971	19	1	31	0	31	40	6	31	15	4
-237	B	34	1186	8	1	34	0	41	68	4	25	25	14
-249	B	23	931	9	1	18	0	36	49	2	43	20	0
-261	B	42	720	8	4	23	0	13	57	0	25	21	10
-273	B	172	586	10	3	23	10	17	71	6	19	20	6
-285	B	105	717	10	5	17	3	16	78	12	69	39	28
-297	B	61	517	0	3	10	1	15	39	3	31	33	16
-309	B	54	338	21	7	15	10	25	40	6	41	39	38
-321	B	69	437	36	1	14	1	17	61	4	32	32	15
-333***	B	101	609	15	2	4	0	20	56	2	40	27	15
-345	B	119	552	44	6	18	4	29	58	18	64	36	28
-357	B	174	540	35	9	3	2	30	63	12	57	47	101
-369	B	39	612	17	1	8	1	34	55	4	45	51	44
-381	B	57	991	12	2	7	0	22	81	2	16	45	28
-393	B	236	1058	65	11	22	6	55	50	35	25	31	12
-405***	B	101	948	55	1	21	1	31	54	1	13	25	2
-417	B	27	859	72	9	27	5	31	57	8	33	64	12
-429	B	29	833	58	2	17	0	13	44	2	26	44	13
-441	C-1	15	632	38	1	6	0	16	10	1	22	28	11
-453	C-1	7	354	60	2	2	0	1	13	6	18	17	6
SUM	*A–C-1*	***2003***	*22867*	*779*	***85***	*556*	*46*	***592***	*1521*	*152*	***873***	*782*	*406*
MEDIAN		***35***	*573*	*13*	***1***	*14*	*0*	***13***	*40*	*2*	***21***	*17*	*2*
25th%		***12***	*494*	*8*	***1***	*9*	*0*	***5***	*23*	*0*	***12***	*7*	*0*
75th%		***69***	*720*	*35*	***2***	*21*	*1*	***25***	*57*	*6*	***31***	*32*	*14*
SUM	*A*	***538***	*9447*	*206*	*14*	*267*	*2*	*130*	*517*	*24*	*229*	*138*	*7*
SUM	*B*	***1443***	*12434*	*475*	*68*	*281*	*44*	*445*	*981*	*121*	*604*	*599*	*382*

Tab. 12.4.1: All skeletal parts classified by sedimentation level in area B (21 m^2, total 83 m^3 or 33 levels of 2.5 m^3 of sediment). The first four levels are from area A (25 m^2, total 12 m^3 or 4 levels of 3 m^3 of sediment). In the grey column, with the name of the skeletal part, adult specimens are stated first, followed by juvenile and neonatal.

Sedimentation level (cm)	Facies	Vertebrae	juveniles	neonati	Costae	juveniles	neonati	Ossa sterni	juveniles	neonati	Scapulae	juveniles	neonati
-20	A	2	26	2	12	11	0	1	9	0	0	28	0
-32	A	11	72	3	4	92	6	0	0	0	0	2	0
-44	A	27	64	4	21	109	9	1	0	0	1	3	1
-56	A	19	97	3	28	121	5	3	0	0	3	6	0
-68	A	33	70	2	43	139	6	1	1	1	2	4	1
-81	A	51	120	5	65	210	27	4	0	1	2	12	0
-94	A	41	108	4	64	182	12	3	6	0	2	10	0
-106	A	37	80	0	38	119	10	0	4	0	0	1	0
-117	A	19	44	1	30	55	9	1	0	1	2	8	1
-129	A	39	44	5	24	41	13	3	1	0	1	3	1
-141	A	24	60	24	30	72	17	0	1	1	9	4	0
-153	A	25	76	22	30	84	20	1	0	1	3	2	3
-165	A	14	77	12	25	77	13	1	0	0	2	4	2
-177	A	12	72	1	16	72	33	0	0	0	0	5	0
-189	A	16	45	5	14	57	17	0	1	0	3	3	1
-201***	A	38	83	4	30	76	17	1	3	1	5	6	2
-213	A	33	201	10	51	174	13	1	1	1	7	13	1
-225	A	35	253	4	49	204	13	2	2	0	24	17	2
-237	B	59	270	11	64	285	15	4	6	1	13	14	3
-249	B	82	300	11	91	311	31	3	17	1	10	13	3
-261	B	66	220	11	89	363	64	5	0	0	21	19	3
-273	B	68	144	9	121	355	36	6	0	0	12	20	7
-285	B	138	247	8	155	424	40	7	2	0	10	18	4
-297	B	146	220	6	150	383	30	13	0	0	4	13	4
-309	B	124	141	10	163	228	40	6	1	2	13	14	6
-321	B	168	168	10	115	334	26	7	1	1	14	6	5
-333***	B	137	177	14	143	417	33	2	3	0	17	23	4
-345	B	109	219	41	124	460	62	7	5	0	12	15	7
-357	B	107	287	19	177	505	28	5	3	0	10	20	8
-369	B	88	281	22	120	438	33	7	6	0	24	19	4
-381	B	76	283	30	82	477	35	3	34	0	5	14	10
-393	B	58	369	33	73	461	47	3	8	0	13	22	10
-405***	B	58	236	25	48	386	31	8	2	0	17	11	6
-417	B	67	232	52	72	430	45	2	3	1	12	18	9
-429	B	117	348	49	106	367	54	14	7	2	28	19	5
-441	C-1	94	358	29	90	361	34	9	4	2	5	13	2
-453	C-1	20	176	54	42	191	35	8	2	2	0	5	5
SUM	*A–C-1*	***2258***	*6268*	*555*	*2599*	*9071*	*959*	*142*	*133*	*19*	*306*	*427*	*120*
MEDIAN		***51***	*168*	*10*	*64*	*210*	*27*	*3*	*2*	*0*	*5*	*13*	*3*
25th%		***25***	*76*	*4*	*30*	*92*	*13*	*1*	*0*	*0*	*2*	*5*	*1*
75th%		***88***	*247*	*22*	*106*	*383*	*35*	*6*	*4*	*1*	*13*	*18*	*5*
SUM	*A*	*476*	*1592*	*111*	*574*	*1895*	*240*	*23*	*29*	*7*	*66*	*131*	*15*
SUM	*B*	*1668*	*4142*	*361*	*1893*	*6624*	*650*	*102*	*98*	*8*	*235*	*278*	*98*

Tab. 12.4.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Humeri	juveniles	neonati	Radii	juveniles	neonati	Ulnae	juveniles	neonati	Carpalia	juveniles	neonati
-20	A	0	1	5	0	8	2	0	2	0	6	0	0
-32	A	0	5	6	0	5	0	0	4	0	13	2	0
-44	A	0	13	11	0	17	1	0	3	3	17	5	0
-56	A	0	8	3	0	15	1	0	8	2	32	2	0
-68	A	1	15	9	1	15	0	0	8	4	27	2	0
-81	A	0	9	11	0	23	0	1	18	3	30	4	0
-94	A	0	5	11	0	12	1	3	7	2	26	4	0
-106	A	1	9	13	2	10	2	3	9	0	28	2	1
-117	A	2	3	9	0	2	0	2	5	1	20	0	0
-129	A	4	6	8	1	3	3	2	2	0	21	0	0
-141	A	2	6	15	0	4	2	0	1	2	15	1	0
-153	A	1	6	28	0	11	13	2	1	2	7	0	0
-165	A	0	5	16	0	9	2	0	5	2	12	0	0
-177	A	0	5	18	1	3	3	0	1	2	7	0	0
-189	A	1	1	10	0	3	2	0	1	0	3	0	0
-201***	A	0	4	9	1	2	2	0	6	5	14	1	0
-213	A	0	9	9	1	10	2	1	9	1	42	4	0
-225	A	2	29	13	1	26	2	1	11	3	68	3	0
-237	B	5	20	20	8	30	2	3	20	2	109	7	0
-249	B	4	26	15	5	25	0	5	18	5	107	8	0
-261	B	6	31	17	5	22	5	6	25	6	61	4	0
-273	B	5	11	29	4	9	2	7	17	7	40	9	0
-285	B	3	23	10	3	22	7	2	15	4	54	11	0
-297	B	6	21	13	4	14	0	2	7	2	58	6	0
-309	B	2	22	21	2	17	2	3	11	6	44	6	0
-321	B	7	13	16	3	12	1	0	11	2	46	8	0
-333***	B	1	20	18	5	32	3	5	11	6	72	6	0
-345	B	2	23	28	4	23	9	1	18	5	63	7	1
-357	B	3	17	24	1	35	2	5	30	2	60	5	0
-369	B	3	26	8	6	26	8	3	24	5	74	6	0
-381	B	2	20	27	2	40	9	5	21	10	105	9	0
-393	B	1	31	20	2	40	10	3	22	2	78	8	0
-405***	B	2	20	11	2	26	1	5	16	6	50	12	0
-417	B	2	23	11	9	22	7	5	10	7	73	5	0
-429	B	2	17	15	7	26	3	7	23	1	81	13	0
-441	C-1	2	15	19	10	16	8	2	4	4	73	17	0
-453	C-1	1	7	33	1	7	4	1	9	0	25	7	0
SUM	*A–C-1*	*73*	*525*	*559*	*91*	*622*	*121*	*85*	*413*	*114*	*1661*	*184*	*2*
MEDIAN		*2*	*13*	*13*	*1*	*15*	*2*	*2*	*9*	*2*	*42*	*5*	*0*
25th%		*0*	*6*	*10*	*0*	*9*	*1*	*0*	*5*	*2*	*20*	*2*	*0*
75th%		*3*	*21*	*19*	*4*	*25*	*4*	*3*	*18*	*5*	*68*	*7*	*0*
SUM	*A*	*14*	*139*	*204*	*8*	*178*	*38*	***15***	*101*	*32*	***388***	*30*	*1*
SUM	*B*	*56*	*364*	*303*	*72*	*421*	*71*	***67***	*299*	*78*	***1175***	*130*	*1*

Tab. 12.4.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Metacarpalia	juveniles	neonati	Coxae	juveniles	neonati	Sacrum	juvenilis	neonatus	Femora	juveniles	neonati
-20	A	6	4	0	0	1	0	0	0	0	0	1	1
-32	A	9	15	0	0	1	1	0	1	0	0	2	1
-44	A	20	24	0	0	1	0	1	0	0	0	4	1
-56	A	10	25	0	0	5	1	0	1	0	0	4	3
-68	A	20	8	0	0	5	2	0	1	2	2	6	4
-81	A	26	33	2	2	4	0	0	0	0	0	18	1
-94	A	26	21	0	2	5	1	0	0	0	2	8	8
-106	A	10	14	0	1	3	1	0	1	0	4	1	2
-117	A	8	9	1	0	0	2	0	0	0	1	6	4
-129	A	11	12	0	4	2	2	0	0	0	2	1	1
-141	A	10	12	1	4	3	5	1	0	0	0	5	7
-153	A	10	7	0	2	3	5	0	0	0	1	4	15
-165	A	6	7	0	1	2	2	0	0	0	0	2	9
-177	A	5	7	1	0	0	1	0	3	0	1	0	4
-189	A	3	3	0	1	1	4	1	0	0	0	2	4
-201***	A	12	8	0	0	1	3	0	0	0	0	3	5
-213	A	37	16	0	4	5	0	0	1	0	1	9	6
-225	A	65	25	1	6	5	1	0	4	0	1	26	8
-237	B	94	50	0	1	9	2	0	1	0	4	31	8
-249	B	83	36	0	2	11	5	1	1	0	4	23	11
-261	B	28	19	0	4	15	7	1	1	2	4	23	7
-273	B	28	16	0	4	21	7	1	3	0	1	24	11
-285	B	42	21	3	12	11	9	9	1	0	2	16	12
-297	B	44	20	0	4	10	4	1	3	0	2	15	2
-309	B	22	2	0	6	12	5	2	0	0	4	16	1
-321	B	47	4	0	2	16	8	1	0	0	5	19	0
-333***	B	41	2	0	7	14	5	1	1	0	3	22	3
-345	B	41	6	0	11	21	11	2	2	0	4	28	1
-357	B	56	3	0	7	17	5	3	0	0	0	26	5
-369	B	54	7	0	2	19	3	1	0	0	2	35	4
-381	B	60	5	0	2	13	6	0	0	0	0	28	2
-393	B	46	10	0	9	18	5	0	1	0	4	35	6
-405***	B	28	12	0	12	13	9	1	1	0	3	19	7
-417	B	44	5	0	7	15	11	1	0	0	3	13	4
-429	B	62	11	0	7	12	10	1	0	0	3	27	8
-441	C-1	38	9	0	3	10	6	0	1	0	5	25	6
-453	C-1	17	2	0	7	0	7	0	2	0	3	7	7
SUM	*A–C-1*	*1169*	*490*	*9*	*136*	*304*	*156*	*29*	*30*	*4*	***71***	*534*	*189*
MEDIAN		*28*	*10*	*0*	*2*	*5*	*4*	*0*	*1*	*0*	***2***	*15*	*4*
25th%		*10*	*6*	*0*	*1*	*2*	*1*	*0*	*0*	*0*	***0***	*4*	*2*
75th%		*44*	*19*	*0*	*6*	*13*	*6*	*1*	*1*	*0*	***3***	*24*	*7*
SUM	*A*	***294***	*250*	*6*	***27***	*47*	*31*	***3***	*12*	*2*	*15*	*102*	*84*
SUM	*B*	***820***	*229*	*3*	***99***	*247*	*112*	***26***	*15*	*2*	*48*	*400*	*92*

Tab. 12.4.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Patellae	juveniles	neonati	Tibiae	juveniles	neonati	Fibulae	juveniles	neonati	Tarsalia	juveniles	neonati
-20	A	1	0	0	0	4	1	0	7	1	2	1	0
-32	A	0	0	0	2	5	1	0	10	1	10	2	0
-44	A	1	0	0	1	11	0	5	39	0	27	1	0
-56	A	1	0	0	0	9	1	3	39	0	38	10	0
-68	A	3	0	0	2	9	0	2	21	0	34	0	0
-81	A	6	0	0	3	13	0	3	44	3	39	16	0
-94	A	1	1	0	3	12	0	7	47	2	36	9	2
-106	A	0	0	0	2	9	0	7	20	4	35	5	0
-117	A	2	0	0	6	3	0	2	14	1	26	5	0
-129	A	1	0	0	3	2	0	2	10	1	18	3	0
-141	A	2	0	0	0	4	0	2	9	4	23	2	0
-153	A	1	1	0	3	2	1	2	17	1	12	3	0
-165	A	0	0	0	0	3	0	0	19	1	11	1	0
-177	A	0	0	0	1	7	0	3	10	1	13	2	0
-189	A	0	0	0	1	2	0	2	11	0	12	0	0
-201***	A	3	0	0	4	1	3	0	12	1	10	3	0
-213	A	0	0	0	1	12	0	7	22	1	48	7	0
-225	A	6	1	0	4	10	1	17	72	0	90	4	0
-237	B	5	0	0	10	37	0	8	95	3	132	6	0
-249	B	9	1	0	8	31	2	13	51	8	114	8	0
-261	B	7	0	0	2	16	2	8	36	6	69	13	0
-273	B	6	2	0	5	14	1	4	12	9	57	16	0
-285	B	9	1	0	7	19	0	7	19	14	86	24	0
-297	B	8	0	0	5	12	0	5	38	4	87	12	0
-309	B	7	0	0	3	14	0	3	25	9	67	22	2
-321	B	8	2	0	6	14	1	6	32	6	84	22	0
-333***	B	7	5	0	6	18	0	6	30	5	83	27	0
-345	B	5	1	0	1	22	0	5	43	3	106	30	0
-357	B	10	3	0	5	27	0	6	41	6	80	31	0
-369	B	4	0	0	3	20	0	5	42	7	86	31	0
-381	B	7	2	0	7	25	0	9	81	8	99	44	0
-393	B	8	0	0	5	28	1	8	70	13	92	28	0
-405***	B	4	1	0	3	19	0	10	47	19	68	10	0
-417	B	4	1	0	8	20	0	12	49	16	73	19	0
-429	B	6	5	0	4	18	0	9	74	14	113	31	0
-441	C-1	10	0	0	4	15	0	6	36	11	115	22	0
-453	C-1	2	1	0	1	3	0	1	10	13	23	4	0
SUM	*A–C-1*	***154***	*28*	*0*	***129***	*490*	*15*	***195***	*1254*	*196*	***2118***	*474*	*4*
MEDIAN		***4***	*0*	*0*	***3***	*12*	*0*	***5***	*32*	*4*	***57***	*9*	*0*
25th%		***1***	*0*	*0*	***1***	*5*	*0*	***2***	*14*	*1*	***23***	*3*	*0*
75th%		***7***	*1*	*0*	***5***	*19*	*1*	***7***	*44*	*8*	***86***	*22*	*0*
SUM	*A*	*28*	*3*	*0*	*36*	*118*	*8*	*64*	*423*	*22*	*484*	*74*	*2*
SUM	*B*	*114*	*24*	*0*	*88*	*354*	*7*	*124*	*785*	*150*	*1496*	*374*	*2*

Tab. 12.4.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Metatarsalia	juveniles	neonati	Phalanges I	juveniles	neonati	Phalanges II	juveniles	neonati	Phalanges III	juveniles	neonati
-20	A	4	10	0	16	17	2	7	7	0	16	5	0
-32	A	8	27	1	31	36	0	27	33	0	39	25	0
-44	A	18	31	0	38	55	0	41	29	0	36	25	1
-56	A	12	38	0	54	58	0	38	34	0	51	22	0
-68	A	17	29	0	36	34	1	45	24	1	44	22	0
-81	A	20	33	0	57	57	0	69	37	1	75	30	0
-94	A	22	17	1	49	55	0	64	35	6	63	28	0
-106	A	11	19	0	36	30	1	36	31	1	51	19	0
-117	A	10	12	0	25	30	1	18	20	0	28	11	0
-129	A	8	8	0	25	19	0	16	8	0	29	13	0
-141	A	15	17	0	20	29	1	24	19	1	36	18	0
-153	A	10	12	1	31	21	1	16	27	0	38	14	1
-165	A	5	5	0	21	24	0	19	16	1	26	15	1
-177	A	14	15	0	17	26	1	18	26	1	30	15	1
-189	A	5	7	0	23	12	2	20	13	2	17	10	1
-201***	A	18	5	1	27	15	3	14	21	1	25	4	0
-213	A	51	8	5	83	28	5	72	30	1	59	23	3
-225	A	79	36	1	164	78	0	142	65	1	169	25	0
-237	B	85	65	0	205	80	0	201	49	1	195	36	0
-249	B	50	34	0	179	83	0	151	48	0	145	20	0
-261	B	33	33	1	89	59	2	76	32	0	92	36	0
-273	B	28	37	2	57	45	0	53	23	0	75	29	0
-285	B	41	23	0	110	54	0	83	39	0	120	32	0
-297	B	44	15	0	104	56	4	87	27	0	101	30	0
-309	B	26	2	0	76	57	1	58	20	3	79	29	0
-321	B	41	8	0	87	70	2	78	40	1	91	45	1
-333***	B	52	10	0	124	114	5	106	50	2	121	52	6
-345	B	34	9	0	117	105	5	89	44	3	128	60	1
-357	B	46	4	0	135	85	1	91	53	3	126	61	0
-369	B	35	19	0	135	133	11	135	56	3	152	52	0
-381	B	45	19	0	175	194	5	155	87	2	237	60	0
-393	B	43	13	1	138	152	7	134	75	7	141	57	1
-405***	B	28	14	0	112	111	10	83	60	9	141	42	4
-417	B	32	13	0	107	102	12	81	59	7	116	47	4
-429	B	29	11	0	164	122	7	110	72	4	154	59	3
-441	C-1	38	7	0	128	125	3	105	60	3	140	49	1
-453	C-1	15	2	0	38	41	13	38	31	9	67	21	0
SUM	*A–C-1*	***1072***	*667*	*14*	***3033***	*2412*	*106*	***2600***	*1400*	*74*	***3253***	*1141*	*29*
MEDIAN		***28***	*14*	*0*	***76***	*56*	*1*	***69***	*33*	*1*	***75***	*28*	*0*
25th%		***14***	*8*	*0*	***31***	*30*	*0*	***27***	*24*	*0*	***38***	*19*	*0*
75th%		***41***	*27*	*0*	***124***	*85*	*5*	***91***	*50*	*3*	***128***	*45*	*1*
SUM	*A*	*327*	*329*	*10*	*753*	*624*	*18*	*686*	*475*	*17*	*832*	*324*	*8*
SUM	*B*	*692*	*329*	*4*	*2114*	*1622*	*72*	*1771*	*834*	*45*	*2214*	*747*	*20*

Tab. 12.4.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Os penis	juvenilis	neonatus	Ossa sesamoidea	SUM
-20	A	0	0	0	24	*523*
-32	A	0	0	0	73	*1194*
-44	A	1	3	0	96	*1623*
-56	A	1	0	0	122	*1789*
-68	A	3	1	0	73	*1427*
-81	A	8	0	0	137	*2146*
-94	A	12	0	0	166	*1911*
-106	A	5	0	0	108	*1487*
-117	A	3	3	0	62	*1021*
-129	A	0	1	0	59	*1058*
-141	A	0	0	0	74	*1284*
-153	A	1	0	0	79	*1370*
-165	A	2	0	0	64	*1112*
-177	A	1	0	0	50	*1071*
-189	A	2	0	0	45	*796*
-201***	A	2	0	0	42	*954*
-213	A	2	2	0	160	*2020*
-225	A	9	4	0	367	*3445*
-237	B	12	7	0	468	*4311*
-249	B	10	3	0	433	*3801*
-261	B	3	3	0	249	*2950*
-273	B	6	1	3	123	*2585*
-285	B	7	5	0	198	*3342*
-297	B	7	4	0	167	*2753*
-309	B	8	0	0	162	*2261*
-321	B	4	0	0	169	*2613*
-333***	B	8	2	0	266	*3244*
-345	B	4	4	0	265	*3432*
-357	B	6	5	0	269	*3642*
-369	B	5	7	0	320	*3530*
-381	B	5	3	0	491	*4438*
-393	B	4	7	0	394	*4481*
-405***	B	0	3	0	261	*3396*
-417	B	9	6	1	232	*3454*
-429	B	3	2	0	265	*3812*
-441	C-1	4	1	0	321	*3258*
-453	C-1	0	3	0	194	*1703*
SUM	*A–C-1*	***157***	*80*	*4*	***7048***	*89237*
MEDIAN		***4***	*2*	*0*	***166***	
25th%		***1***	*0*	*0*	***74***	
75th%		***7***	*3*	*0*	***265***	
SUM	*A*	*52*	*14*	*0*	*1801*	*26231*
SUM	*B*	*101*	*62*	*4*	*4732*	*58045*

letnih delov. To se je lahko zgodilo predvsem pri podjezičnih kosteh, zapestnih in nartnih kosteh in povsod tam, kjer juvenilne kosti niso sestavljene iz več delov, ki se pri odraslih primerkih zrastejo v eno kost. Eventualnim posledicam pri razlagi izsledkov sva se izognila tako, da nisva upoštevala starostnih skupin, če to ni bilo potrebno.

Starostne skupine skeletnih delov so samo delno primerljive s podobnimi skupinami pri izoliranih zobeh. Skupina *adultus* je primerljiva s skupino *adultus* in *juvenilis* izoliranih zob, skupina *juvenilis* pa s skupino *juvenilis* in *lactalis* pri zobeh. Skeletni deli skupine *neonatus* nimajo ustrezne primerjave v zastopanosti izoliranih mlečnih zob.

Za analizo ZSD sva uporabila statistično metodo. Ker kvantitativni in kvalitativni podatki za skeletne dele niso normalno porazdeljeni razen izjemoma, sva za analizo izbrala predvsem neparametrične statistike iz paketa STATISTICA 0.6 StatSoft 2001.

TEMELJNE ZNAČILNOSTI VZORCA

Temeljne značilnosti ZSD so pogojene na eni strani s starostnimi skupinami ali ontogentsko, na drugi pa s sedimentacijskimi nivoji ali kronološko. Obakrat je prišlo do razlik v zastopanosti posameznih skeletnih delov. Pri tem je treba poudariti, da so razlike med starostnimi skupinami bolj vidne kot razlike med sedimentacijskimi nivoji.

Skeletni deli so v posameznih starostnih skupinah različno zastopani (*sl. 12.4.1a-c*).

Za skupino *adultus* je značilna slaba zastopanost velikih dolgih kosti nog v primerjavi z zapestnimi, nartnimi, stopalnimi in prstnimi kostmi (*sl. 12.4.1a*).

Za skupino *juvenilis* je značilna boljša zastopanost velikih dolgih kosti nog v primerjavi z zapestnimi, nartnimi, stopalnimi in prstnimi kostmi (*sl. 12.4.1b*). Zaslugo za to imajo predvsem številne juvenilne diafize velikih dolgih kosti.

Za skupino *neonatus* je značilna najboljša zastopanost velikih dolgih kosti nog v primerjavi z zapestnimi, nartnimi, stopalnimi in prstnimi kostmi (*sl. 12.4.1c*).

*** Sedimentacijski nivo z ostanki ognjišča. Maloštevilni skeletni deli, najdeni v žganini, niso zajeti v tabeli, ker bodo obdelani v drugem delu monografije.

V tabeli tudi niso predstavljene relativno redke najdbe okostenelih rebrnih hrustancev, ki jih je težko taksonomsko opredeliti.

*** Sedimentation level with the remains of a hearth. The few bones found in the soil mixed with charcoal are not included in the table because they will be dealt with in second part of the monograph.

The relatively few finds of ossified rib bone cartilage which can be difficult to assign taxonomically, are also not shown in the table.

◁◁

Temeljna razlika med juvenilnimi in adultnimi skeletnimi deli je v ohranjenosti velikih kosti okončin.

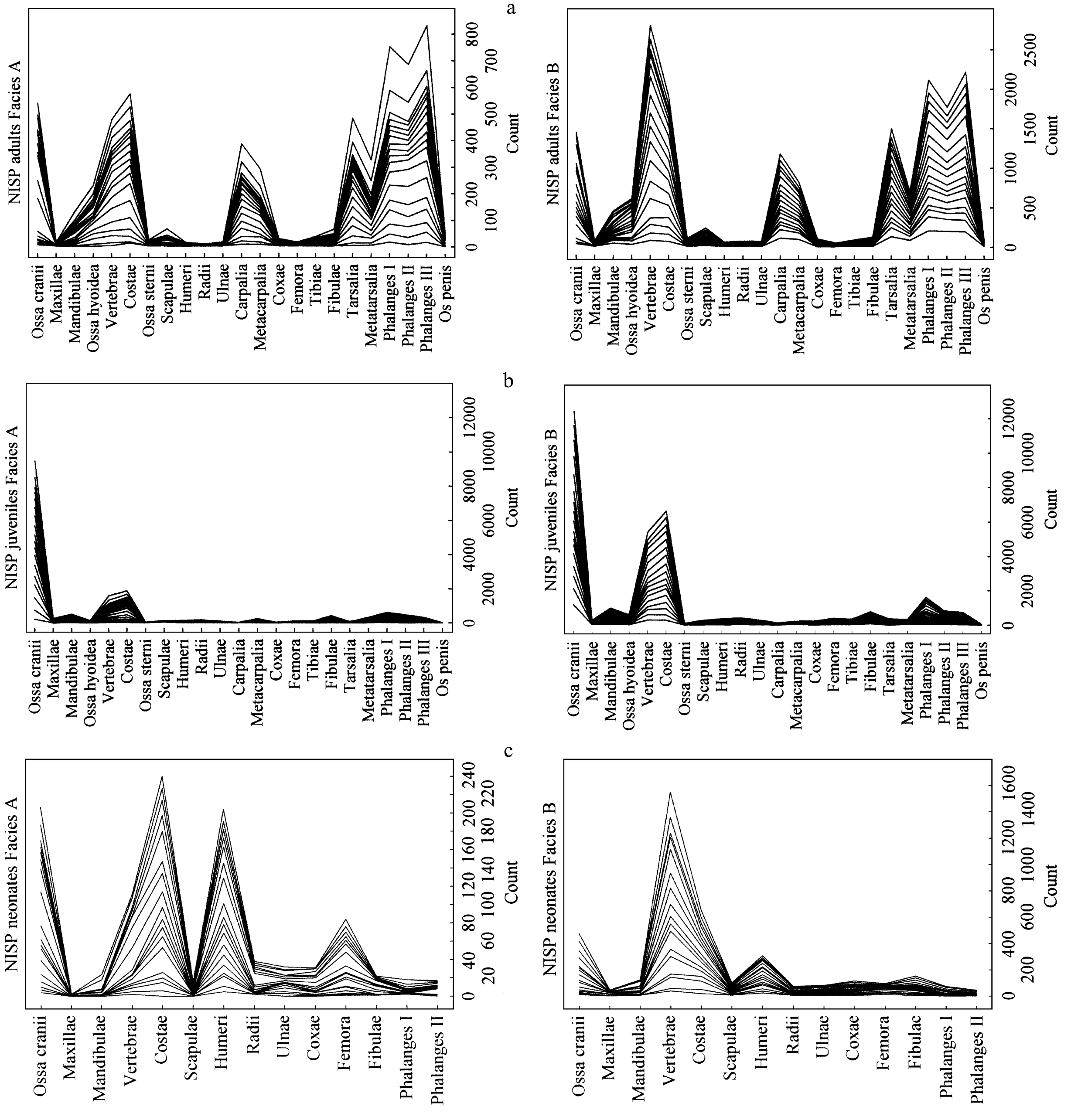
Velike dolge kosti adultnih medvedov so zastopane predvsem z epifizami, ki se jih drži del diafize. Fragmenti same diafize z ohranjenim medularnim kanalom, t. i. ”cilindri”, so bistveno redkejši, najredkejše pa so cele kosti (*tab. 12.4.5*).

Velike dolge kosti juvenilnih medvedov so zastopane predvsem z diafizami, izjemoma metafizami in nekoliko bolje s celimi epifizami.

V primerjavi z velikimi dolgimi kostmi so zapestne, nartne, dlančne, stopalne in prstne kosti adultnih medvedov boljše zastopane kot iste kosti juvenilnih medvedov.

Ena glavnih značilnosti stratigrafsko in kronološko razčlenjenega vzorca ZSD je, da veliko skeletnih delov sploh ni zastopanih v posameznih sedimentacijskih nivojih (*sl. 12.4.2*).

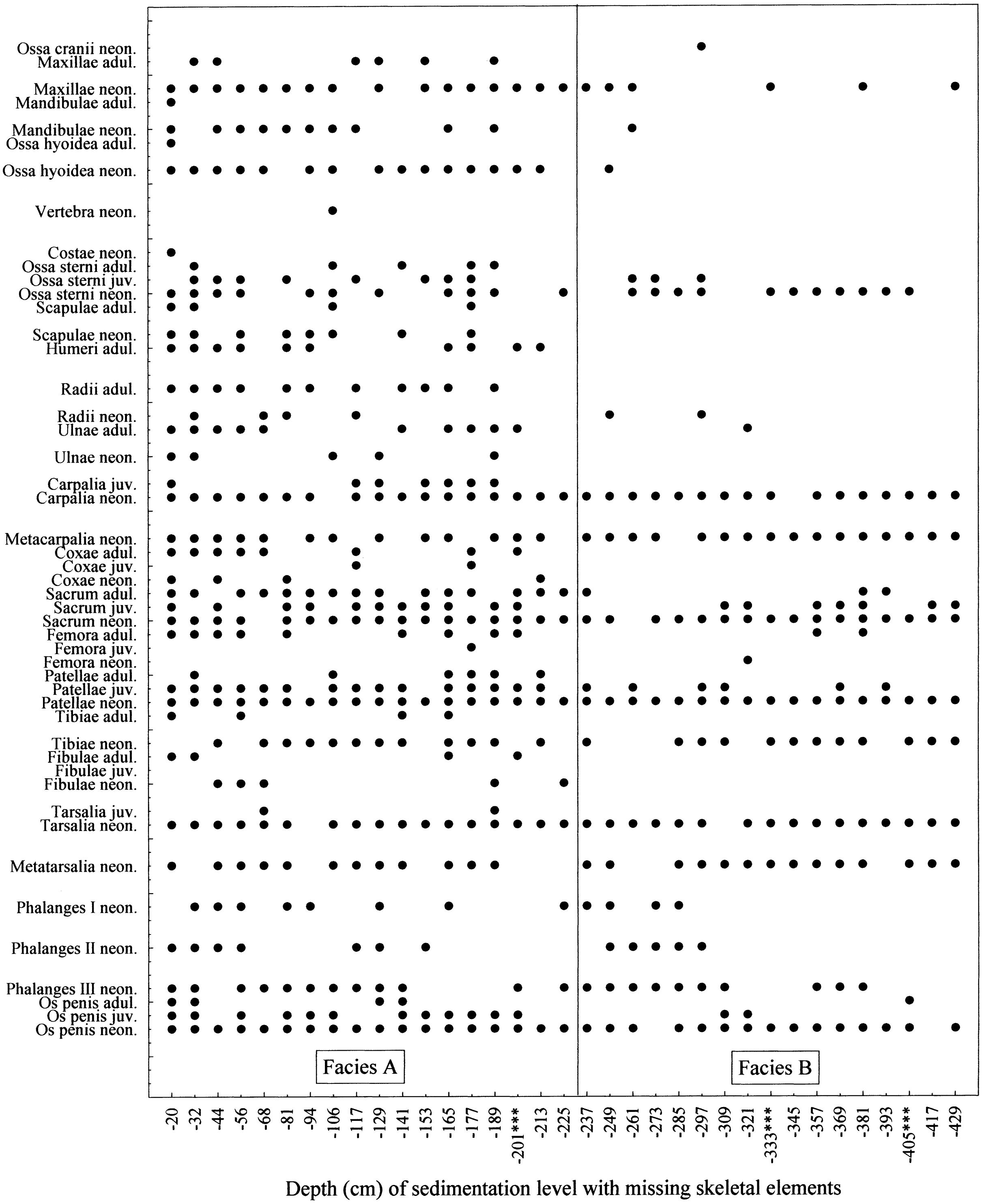
Najslabši ZSD ima skupina *neonatus*, srednjega skupina *adultus* in najboljšega skupina *juvenilis*. ZSD je slabši v faciji A, kjer je v splošnem manj kostnih ostan-



Sl.12.4.1a-c: Zastopanost skeletnih delov po starostnih skupinah (a: *adultus*, b: *juvenilis*, c: *neonatus*) v facijah A in B. Črte v grafih predstavljajo zastopanost skeletnih delov v 37 sedimentacijskih nivojih, tako da se vrednosti iz nivojev seštevajo, začenši z nivojem -20 cm. V grafu skupine *neonatus* so spuščeni skeletni deli z nično zastopanostjo.

Fig. 12.4.1a-c: Representation of skeletal parts by age groups (a: *adultus*, b: *juvenilis*, c: *neonatus*) in facies A and B. Lines on the graph are the representation of skeletel parts in 37 sedimentation levels in such a way that each level value is sum of previous level values, starting with level -20 cm. In the graph of *neonatus* group skeletel parts with nil representation are ommitted.

kov in izoliranih zob. Slednje bi kazalo na to, da je bolj ali manj popolen ZSD odvisen od števila anatomsko določljivih kostnih ostankov. To potrjujejo tudi tri starostne skupine, pri katerih je ZSD v premo sorazmernem odnosu s številom ostankov. Juvenilnih ostankov je namreč absolutno največ, neonatnih pa najmanj, medtem ko so adultni nekje vmes (glej podpoglavje 12.3 v tem zborniku: *tab. 12.3.1*). Vendar so tudi izjeme, ki temu nasprotujejo. V skupini *neonatus* je več skeletnih delov (*sternum, carpus, metacarpus, sacrum, femur, patel-*



Sl. 12.4.2: Manjkajoči skeletni deli v sedimentacijskih nivojih. Ognjiščni nivoji so označeni s tremi zvezdicami.
Fig. 12.4.2: Missing skeletel parts in sedimentation levels. Hearth levels are marked with three stars.

la, tibia, tarsus, metatarsus, phalanx III in *os penis*) približno enako slabo zastopanih v obeh facijah, kar je lahko dokaz za selektivno delovanje določenega dejavnika na skeletne dele. V faciji B so v skupini *neonatus* deli glave, prsnega koša in prednjih okončin brez prstnic bistveno bolje zastopani kot zadnje okončine brez prstnic. V faciji A te razlike ni (*sl. 12.4.2*). Do takšnega stanja je lahko prišlo zaradi različne opredelitve skeletnih delov prvega avtorja, ki je obdelal gradivo facije A, in drugega, ki je nadaljeval obdelavo gradiva facije B. Posebej morava poudariti, da trije nivoji z ostanki ognjišč v tem pogledu ne odstopajo od ostalih sedimentacijskih nivojev.

FRAGMENTACIJA

Fragmentacija skeletnih delov, ki sodi v sklop posebne fragmentacije, globalno ne vpliva na ZSD, ker med njima ni povezave, lahko pa vpliva na zastopanost posameznega skeletnega dela. V faciji A je splošna in posebna fragmentacija večja, ZSD pa slabši. Ker fragmentacija povečuje število določljivih skeletnih delov, bi pričakovala v faciji A boljši ZSD. Juvenilni in neonatni skeletni deli so destkrat bolj fragmentirani kot adultni. Zato je pričakovati boljši ZSD pri skupini *juvenilis* in *neonatus*. Pričakovani ZSD se pri treh starostnih skupinah samo delno ujema z dejanskim. Skupini *adultus* in *neonatus* se ne ravnata povsem po pričakovanem ZSD. Zato morava pri ZSD računati razen s fragmentacijo tudi s popolnim izginotjem skeletnih delov. Zanj sta dve možnosti, in sicer, da deli skeleta razpadejo na nerazpoznavne koščke ali da jih nekdo odstrani z najdišča. Kot odstranljitelji pridejo v poštev ljudje in zveri. To je obraten postopek kot v paleolitskih bivališčih, kjer so ljudje domnevno prinašali določene skeletne dele uplenjenih živali.

Delež fragmentov, nastalih pri izkopavanju, je zanemarljiv in ni bistveno vplival na rezultate analiz. To potrjuje večja fragmentacija v faciji A, in to kljub uporabi pnevmatičnega kladiva v cementiranem delu facije B, kar je nedvomno prispevalo največ “arheoloških fragmentov”.

VARIABILNOST IN TAFONOMSKI DEJAVNIKI

Za preučevanje variabilnosti zastopanosti skeletnih delov je najprimernejši ontogenetsko stratificiran vzorec. Variabilnost v ZSD med starostnimi skupinami je po najinem prepričanju pogojena predvsem s tafonomskimi dejavniki biotske in abiotske narave. Stratificiran in kronološko razčlenjen vzorec ZSD kaže, da skeletni deli vseh starostnih skupin variirajo tudi v času, kar pomeni, da variirajo tudi tafonomski vplivi. Vse skupaj ustvari zelo zapletene (pod)vzorce ZSD, ki jih je mogoče razložiti na veliko načinov, odvisno od tega, s katerim dejavnikom poveževa določeno stanje v ZSD. Glavna težava, ki nastopi pri tem je, da ne veva, kako zanesljivo je določeno stanje, ki ga želiva razložiti, povezano z določenim dejavnikom. Izhod iz labirinta domnev, povezav in razlag vidiva v zmanjšanju časovne ločljivosti. Zato si pobliže oglejmo ZSD v facijah A in B, ki ponuja manj zapleteno sliko kot ZSD v posameznih sedimentacijskih nivojih, ker sva z združitvijo teh v dve faciji močno poenostavila časovno pogojeno variabilnost.

Tako v facijah A kot B so zastopani vsi skeletni deli razen neonatne pogačice in spolovilne kosti (*tab. 12.4.1*), medtem ko v posameznem sedimentacijskem nivoju manjka veliko več skeletnih delov, predvsem neonatnih in adultnih (*sl. 12.4.2*).

Na ZSD vplivata številčnost skeletnih ostankov in fragmentacija skeletnih delov. V poglavju o splošni frag-

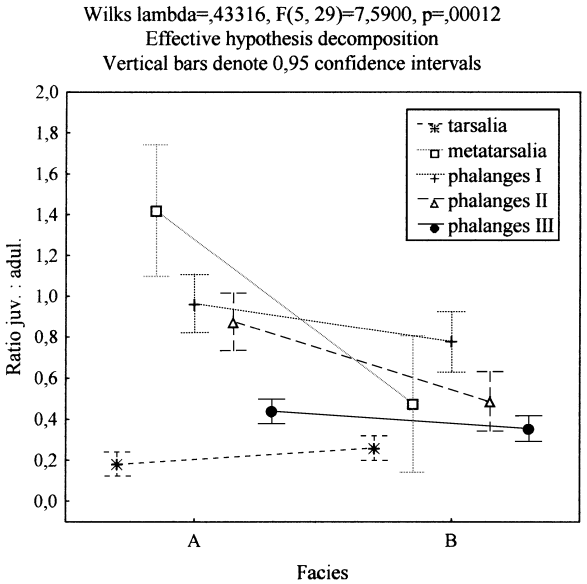
Tab. 12.4.2: Rezultati neparametrične analize variance razmerij med juvenilnimi in adultnimi skeletnimi deli v sedimentacijskih nivojih. Statistično značilne razlike med razmerji so podane v krepkem tisku.
Tab. 12.4.2: Results of non-parametric analysis of variance of ratios between juvenile and adult skeletal parts in sedimentation levels. Statistically significant differences between ratios are given in bold type.

	Kruskal-Wallis Test	Median Test	Juveniles in Facies A
Ossa cranii	**0.01**	**0.00**	**more**
Maxillae	**0.03**	**0.02**	**more**
Mandibukae	**0.00**	0.09	**more?**
Ossa hyoidea	0.09	0.09	no difference
Vertebrae	**0.01**	0.13	**more?**
Costae	0.32	0.24	no difference
Ossa sterni	0.48	0.71	no difference
Scapulae	0.12	0.11	no difference
Humeri	0.24	0.47	no difference
Radii	0.80	0.85	no difference
Ulnae	0.52	0.39	no difference
Carpalia	**0.01**	**0.01**	**less**
Metacarpalia	**0.00**	**0.00**	**more**
Coxae	**0.01**	**0.05**	**less**
Sacrum	0.10	0.07	no difference
Femora	**0.06**	**0.04**	**less**
Paltellae	0.12	**0.04**	**less?**
Tibiae	0.23	0.87	no difference
Fibulae	0.97	0.58	no difference
Tarsalia	**0.03**	**0.00**	**less**
Metatarsalia	**0.00**	**0.00**	**more**
Phalanges I	0.06	0.13	no difference
Phalanges II	**0.00**	**0.03**	**more**
Phalanges III	**0.03**	0.13	**more?**
Os penis	**0.03**	**0.03**	**less**

mentaciji sva ugotovila, da je lahko oboje povezano. ZSD je boljši, če je najdb več in če so skeletni deli bolj fragmentirani. V faciji A je ZSD slabši, čeprav je fragnentacija večja, je pa obenem manj najdb. Zato sklepava, da število najdb najbolj vpliva na ZSD.

Temeljna razlika med facijama A in B, ki jo poznamo že iz prejšnjih poglavij, je v količini določljivih skeletnih ostankov. Vendar to ni edina razlika. Med facijama A in B so tudi kakovostne razlike v ZSD vsake od starostnih skupin. Te razlike so najbolj vidne v skupini *neonatus* (*sl. 12.4.1c*) in slabše prepoznavne v skupini *juvenilis* in *adultus* (*sl. 12.4.1a, b*). Zato sva stanje v skupini *juvenilis* in *adultus* preverila s pomočjo parametrične analize variance (ANOVA) za normalno porazdeljena razmerja juvenilnih in adultnih skeletnih delov ter z neparametrično analizo variance teh istih razmerij za vse skeletne dele. Ugotovila sva, da so kakovostne razlike v ZSD med facijama A in B dejstvo, ki predstavlja poleg količinskih razlik zanesljivo izhodišče za razlago izsledkov analize ZSD. Pri tem je treba poudariti, da ni dokazov o povezanosti kakovostnih razlik v ZSD s krioturbacijo v faciji A.

Rezultat neparametrične analize variance kaže, da je razlika selektivna glede na skeletne dele (*tab.12.4.2*). V faciji A je več juvenilnih lobanj, vključno z zgornjimi čeljustnicami, dlančnic, stopalnic in drugih prstnic ter manj nartnic, medenic, stegnenic, nartnic in spolovilnih kosti. V zastopanosti drugih skeletnih delov ni bistvenih razlik med facijami, kar še posebno velja za velike dolge kosti okončin. Morebitne izjeme so spodnja čeljustnica, vretenca, pogačica in tretje prstnice.



Sl. 12.4.3: Razlika v razmerjih zastopanosti izbranih skeletnih delov v facijah A in B.
Fig. 12.4.3: Difference in ratios of representation of selected skeletel parts in facies A and B.

Rezultat parametrične analize variance kaže, da je določenih juvenilnih skeletnih delov več v faciji A (*sl. 12.4.3*). Pomembno je, da razlika ni pri vseh kosteh enaka. Največja je pri stopalnicah in drugih prstnicah. Pri nartnicah je ravno obratno: juvenilnih primerkov je več v faciji B, kar je lahko metodološko pogojeno.

KLASIFIKACIJA SEDIMENTACIJSKIH NIVOJEV NA PODLAGI SKELETNIH DELOV

Klasifikacijo sedimentacijskih nivojev na facije A in B na podlagi sedimentoloških podatkov (glej Turk 2006 in poglavje 5 v tem zborniku) sva kot običajno preverila z analizo glavnih komponent (PCCA) in diskriminantno funkcijsko analizo (DFA). Če so facije resnično del sistema, se mora rezultat na podlagi zastopanosti skeletnih delov skladati z rezultatom na podlagi sedimentnih značilnosti in pokazati razliko med facijami. Za analizo sva izbrala tiste skeletne dele, ki so brez dodatne transformacije normalno porazdeljeni v obeh facijah. Zaradi velikih razlik v standardnem odstopanju ZSD, sva analizo opravila na podlagi standardiziranih podatkov in korelacije (*tab. 12.4.3*). Standardizirani podatki imajo srednjo vrednost 0 in odstopanje ± 1.

Izbrani skeletni deli so različno fragmentirani. Največ fragmentov pripada lobanji in rebrom, najmanj prstnicam in vretencem. Koželjnica in golenica sta nekje vmes. Juvenilne kosti so bolj fragmentirane kot adultne. Ker v vzorcu prevladujejo juvenilni skeletni deli, ta ni najbolje uravnotežen. Vendar boljšega vzorca, ki bi izpolnjeval pogoje za PCCA, trenutno ni na voljo.

Na s*l. 12.4.4* je prikazana projekcija skeletnih delov na faktorsko ravnino prvih dveh faktorjev, ki največ prispevata k razlikovanju med facijami. Vsi skeletni deli so obratno sorazmerni s prvim faktorjem, ki bi lahko predstavljal hitrost sedimentacije. Adultna vretenca in rebra tvorijo izrazito skupino, ki je dobro ločena od skupine vseh juvenilnih skeletnih delov. Drugo izrazito skupino predstavljajo koželjnica, golenica in prve prstnice iz skupine juvenilnih skeletnih delov. Razlika med obema skupinama bi lahko bila pogojena z različno fragmentacijo skeletnih delov. Vendar temu nasprotuje umestitev juvenilnih reber in drugih prstnic. Poglavje zase so kosti glave. Kosti lobanje in zgornjih čeljustnic tvorijo ohlapno skupino, ki je dobro ločena od spodnjih čeljustnic. Ker gre za dva skeletna sklopa glave, ki ju je mogoče po smrti ločiti, lahko doživita različno usodo, kar ima za posledico razliko v ZSD. Zgornji čeljustnici sta za nameček skeletna dela, ki sta najslabše povezana s prvim faktorjem (glej tudi *tab. 12.4.3*), razen tega sta edini izenačeni v številu najdb v obeh facijah (p = 0,51). V vseh drugih primerih je najdb bistveno več v faciji B (p < 0,01). Vse anomalije, povezane s kostmi glave, imajo določeno ozadje, ki ga vsekakor velja raziskati. Vendar o tem v nadaljevanju.

Tab. 12.4.3: Korelacijska matrika za zastopanost izbranih skeletnih delov v sedimentacijskih nivojih. Prikazani so Pearsonovi korelacijski koeficienti.

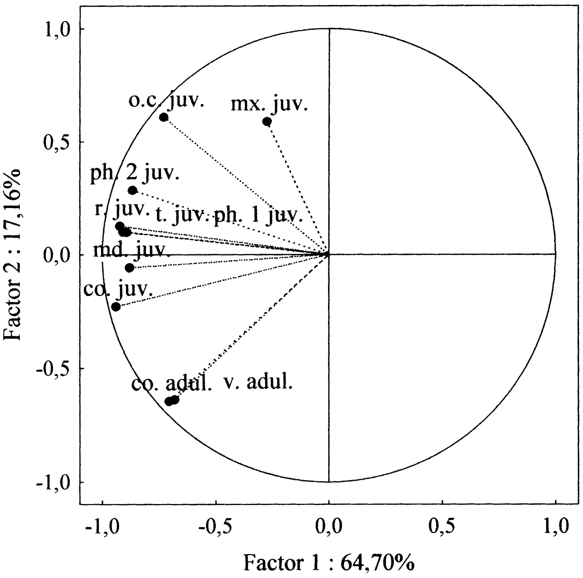
Tab. 12.4.3: Correlation matrix for the representation of selected skeletal parts in sedimentation levels. Pearson's correlation coefficients are shown.

	Ossa cranii juv.	Maxillae juv.	Mandibulae juv.	Vertebrae adul.	Costae adul.	Costae juv.	Radii juv.	Tibiae juv.	Phalanges I juv.
Ossa cranii juv.	1.00								
Maxillae juv.	0.50	1.00							
Mandibulae juv.	0.58	0.36	1.00						
Vertebrae adul.	0.13	-0.03	0.64	1.00					
Costae adul.	0.13	-0.03	0.68	0.91	1.00				
Costae juv.	0.54	0.13	0.84	0.76	0.81	1.00			
Radii juv.	0.75	0.18	0.73	0.49	0.55	0.82	1.00		
Tibiae juv.	0.74	0.32	0.79	0.54	0.59	0.82	0.85	1.00	
Phalanges I juv.	0.69	0.08	0.69	0.49	0.48	0.82	0.88	0.76	1.00
Phalanges II juv.	0.79	0.24	0.66	0.39	0.37	0.75	0.86	0.73	0.92

Sl. 12.4.5a, b prikazuje projekcijo sedimentacijskih nivojev s skeletnimi deli na ravnino prvih dveh faktorjev. Projekcija je hkrati klasifikacija sedimentacijskih nivojev in facijev. Trije sedimentacijski nivoji z ostanki ognjišč, ki so označeni s tremi zvezdicami, predstavljajo tri ločene skupine (*sl. 12.4.5a*). V primeru večjega vpliva ljudi na ZSD, bi ti sedimentacijski nivoji verjetno tvorili eno skupino. Večina sedimentacijskih nivojev se med seboj močno razlikuje, tudi če so si stratigrafsko blizu. To pomeni, da plasti, takšne kot so bile določene v terenskih profilih, niso homogene kar zadeva ZSD, marveč so v ZSD veliko bolj homogene facije. Faciji A in B tvorita dve ločeni skupini glede na prvi faktor (*sl. 12.4.5b*). Izjemi v faciji A sta sedimentacijska nivoja -81 cm in -225 cm, ki sta se glede na prvi faktor znašla v skupini facije B. Izjemnost sedimentacijskega nivoja -225 cm je prišla na dan tudi v analizi zastopanosti zob in splošne fragmentacije kostnih ostankov. Povezujeva jo z njegovo stratigrafsko lego na meji facijev A in B.

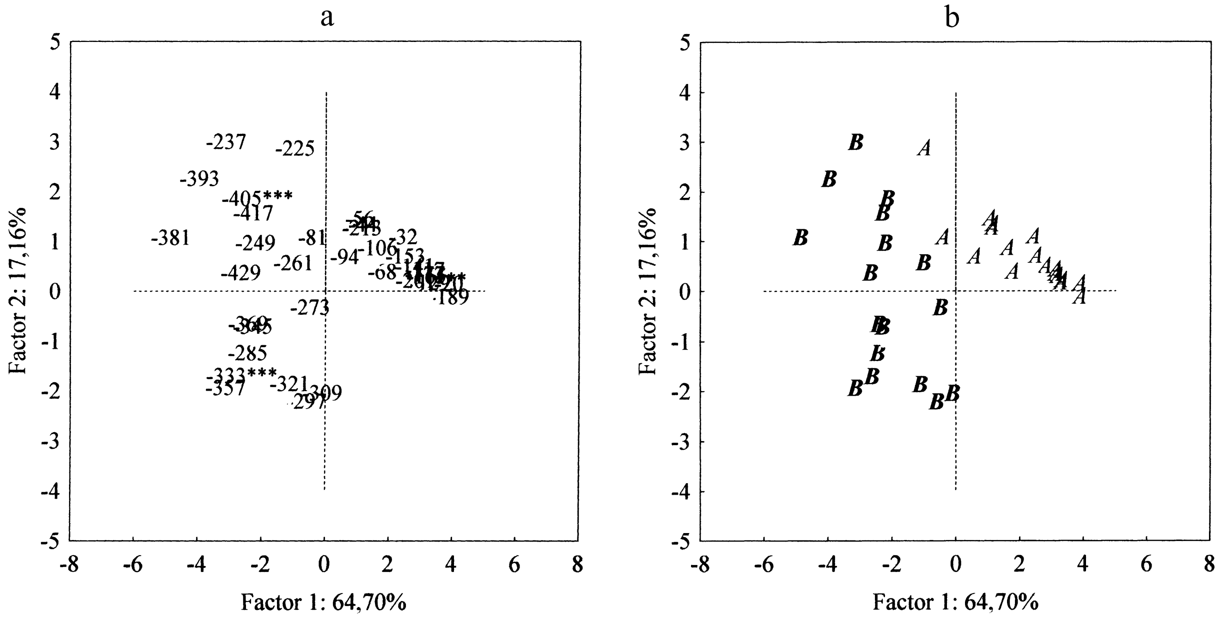
Skeletni deli so boljše povezani (več večjih in značilnih korelacijskih koeficientov) v sedimentacijskih nivojih facije A, in to kljub manjšemu številu skeletnih ostankov in slabši zastopanosti skeletnih delov. Rezultat tega je boljša grupiranost sedimentacijskih nivojev v faciji A in razpršenost v faciji B (*sl. 12.4.5a, b*). Zelo podoben ZSD imata npr. sedimentacijski nivo -129 cm in -201 cm ($r = 0,85$; $p < 0,05$), pri čemer je bil v slednjem najden ostanek ognjišča. Zelo različen ZSD imata npr. sedimentacijska nivoja -333 cm in -405 cm ($r = 0,63$; $p > 0,05$), oba z ostanki ognjišča.

Položaj facijev glede na prvi faktor je natančno tak kot pri izoliranih zobeh, kjer sva glavni faktor razložila z vplivom človeka in njegovim vedenjskim vzorcem, ki se ne razlikuje od vedenjskega vzorca zveri. Različen predznak korelacije med facijami in prvim faktorjem na *sl. 12.4.5b* lahko pojasniva s podobnim vedenjskim vzor-



Sl. 12.4.4: Projekcija izbranih skeletnih delov na faktorsko ravnino prvih dveh faktorjev. Kratice: o. c. (*ossa cranii*), mx. (*maxillae*), md. (*mandibulae*), v. (*vertebrae*), co. (*costae*), r. (*radii*), t. (*tibiae*), ph. (*phalanges*).

Fig. 12.4.4: Projection of selected skeletel parts on the factor plane of the first two factors. Abbreviations: o. c. (*ossa cranii*), mx. (*maxillae*), md. (*mandibulae*), v. (*vertebrae*), co. (*costae*), r. (*radii*), t. (*tibiae*), ph. (*phalanges*).



Sl. 12.4.5a, b: Projekcija sedimentacijskih nivojev (a) in facijev (b) na faktorsko ravnino prvih dveh faktorjev.
Fig. 12.4.5a, b: Projection of sedimentation levels (a) and facies (b) on the factor plane of the first two factors.

cem ljudi in zveri in s tekmovanjem, ki izhaja iz tega. Slabši ZSD v faciji A, kjer so skeletni deli maloštevilni, pomeni manjši poseg zveri, saj gre pretežno za juvenilne skeletne dele. Poseg je bil manjši zaradi večje prisotnosti ljudi, ki so bili dejavni predvsem pri adultnih skeletnih delih. Domnevna dejavnost ljudi je bila v faciji A večja kot v faciji B zaradi manjše izbire. Boljša zastopanost ZSD v faciji B, kjer so skeletni deli številnejši, pomeni manjši poseg zveri in ljudi zaradi večje izbire.

Na podlagi diskriminantne funkcijske analize (DFA) sva ugotovila, da k ločevanju med ZSD v facijah po prvi diskriminantni funkciji, katere delež pri ločevanju je 91 %, prispevajo skeletni deli po naslednjem vrstnem redu od največ (±1) do najmanj (0): juvenilna rebra (-0,92), golenica, koželjnica, adultna vretenca, zgornja čeljustnica, lobanjske kosti, spodnja čeljustnica, prve prstnice in adultna rebra (-0,05). Vprašanje je, koliko vpliva fragmentacija na standardni prispevek (od 0 do ±1) posameznih skeletnih delov pri ločevanju med ZSD v facije. Odgovor je negativen, saj ni korelacije med deleži fragmentov skeletnih delov in prispevki posameznih skeletnih delov pri ločevanju med ZSD v facije (R = -0,19, p = 0,76). Skeletni deli so glede na delež fragmentov razporejeni takole: lobanjske kosti (99,9 %), adultna rebra (98 %), zgornja čeljustnica in rebra (98 %), spodnja čeljustnica (96 %), golenica (91 %), adultna vretenca (89 %), koželjnica (86 %) in prve prstnice (41 %). Iz deležev fragmentov je razvidna velika fragmentacija večine skeletnih delov.

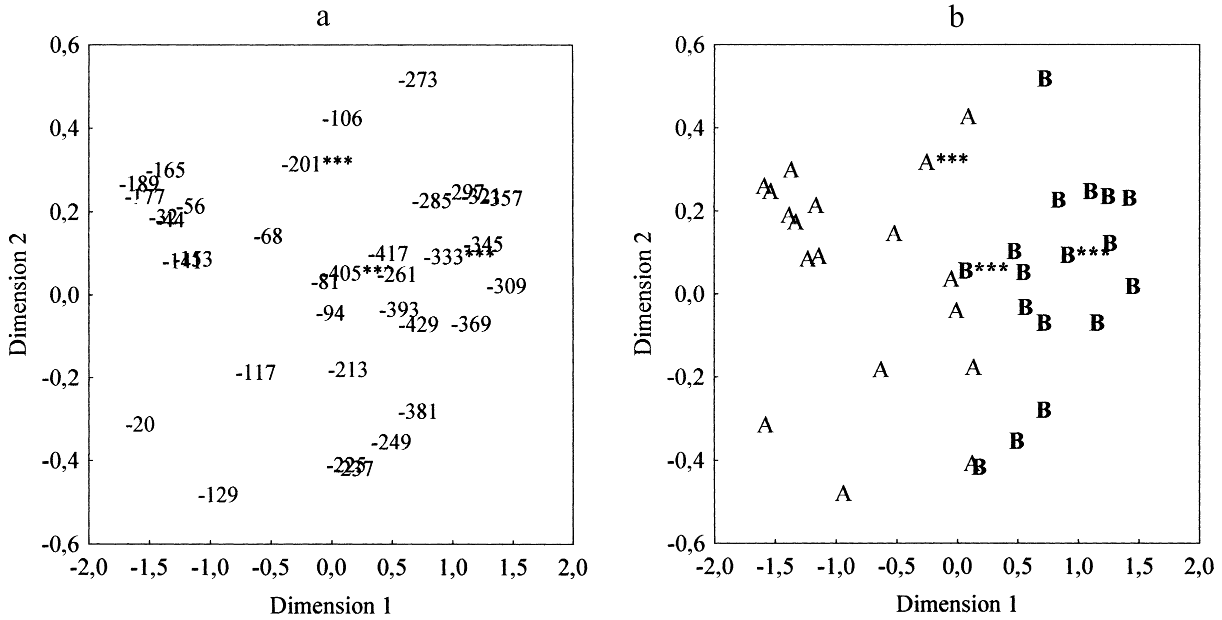
Rezultat multivariatne analize skeletnih delov, predvsem PCCA, potrjuje smotrnost delitve stratigrafskega stolpca na facije A in B, ne pa delitve na plasti. Skeletni deli so tako kot kostni fragmenti in izolirani zobje del sistema najdišča.

Trditev sva preverila tudi z dvo- in tridimenzionalnim skaliranjem (MDS, *multidimensional scaling*) evklidskih razdalj med zastopanostjo vseh skeletnih delov, podanih v *tab.12.4. 1*, razen sezamoidnih koščic. Ta tehnika ima v danem primeru dve prednosti pred PCCA in DFA. Prvič ne zahteva normalno porazdeljenih vhodnih podatkov, in drugič, kot rečeno, delno omili količinske razlike med sedimentacijskimi nivoji.

Sl. 12.4.6a, b kaže dobro ločevanje facije A in B na podlagi prvih dveh dimenzij. *Sl.12.4. 7* prikazuje gostitev točk na Shepardovem diagramu, ki skupaj z majhno vrednostjo *stress* (0,05), jamči, da dve dimenziji zadostujeta za ugotavljanje podobnosti oz. različnosti med sedimentacijskimi nivoji oz. facijami. Mimogrede naj omeniva, da sva manjši stres in večjo gostitev v Shepardovem diagramu dobila pri obravnavi vseh kostnih ostankov v predhodnem podpoglavju.

V facijah A in B je bilo na terenu ugotovljenih 10 geoloških plasti, ki so vse debelejše od 12 cm; zato bi pričakovala vsaj toliko skupin sedimentacijskih nivojev, teh pa je največ 7 (*sl.12.4.6a*). Razen tega nekatere skupine vsebujejo sedimentacijske nivoje, ki ne sledijo stratigrafskemu zaporedju (npr. -81 cm in -405 cm), kar nekaj nivojev pa predstavlja popolnoma ločene skupine (npr. -20 cm, -68 cm, -106 cm, -129 cm). Nivoji z ostanki ognjišč se ne grupirajo.

Sl. 12.4.8a, b kaže razlike in podobnosti med vsemi najdenimi skeletnimi deli v sedimentacijskih nivojih na podlagi prvih treh dimenzij. Med facijama A in B so se pokazale dodatne razlike. V faciji A tvorijo sedimentacijski nivoji 4 skupine, dve manjši (-81 cm, -94 cm in -177 cm, -189 cm) in dve večji (-32 cm do -68 cm in -141 cm do -165 cm) (*sl. 12.4.8a*). Skupine bi lahko predstavljale



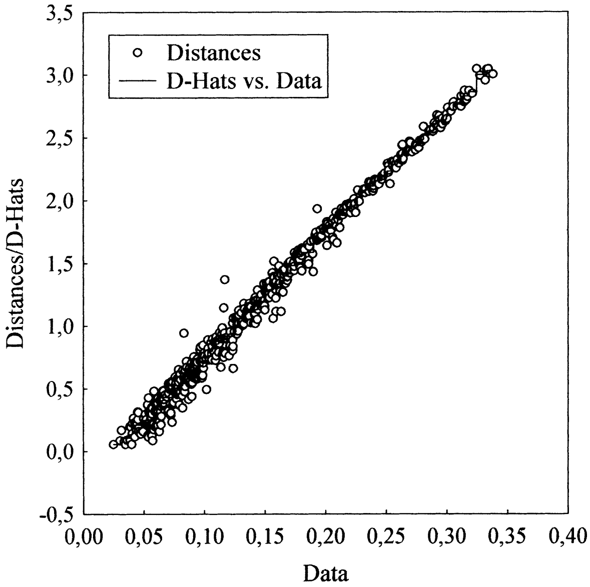
Sl. 12.4.6a, b: Grafični prikaz rezultata dvodimenzionalnega skaliranja na podlagi zastopanosti vseh neonatnih, juvenilnih in adultnih skeletnih delov ter evklidskih razdalj (stres = 0,05). Prikazana je razporeditev posameznih sedimentacijskih nivojev (a) in facijev (b). Ognjiščni nivoji so označeni s tremi zvezdicami. Podatki za 74 tako analiziranih skeletnih delov so navedeni v *tab. 12.4.1.*
Fig. 12.4.6a, b: Graphic presentation of the result of two-dimensional scaling on the basis of representation of all neonatal, juvenile and adult skeletal parts and Euclidian distances (stress = 0.05). The distribution of individual sedimentation levels (a) and facies (b) is shown. Hearth levels are marked with three stars. Data for 74 skeletel parts analysed in such a way are given in *Tab. 12.4.1.*

4 od 5 geoloških plasti. Osem sedimentacijskih nivojev tvori samostojne skupinice, ki jih ne moreva povezati s plastmi. V faciji B sta samo dve manjši skupini (-237 cm, -249 cm in -417 cm, - 429 cm) in ena večja (-333 cm do -357 cm) (*sl. 12.4.8b*), ki bi lahko ustrezale trem od petih geoloških plasti. Deset sedimentacijskih nivojev tvori samostojne skupinice, ki jih ne moreva povezati s plastmi. Sedimentacijski nivoji v faciji B so manj razpršeni kot v faciji A, vendar slabše grupirani. Slednje se je pokazalo tudi pri PCCA in ni skladno s pojavom krioturbacije v faciji A, ki bi lahko povzročil večje stratigrafske motnje. Ognjiščni nivoji ne tvorijo samostojne skupinice, temveč so vsak za sebe, kar sva ugotovila že s PCCA.

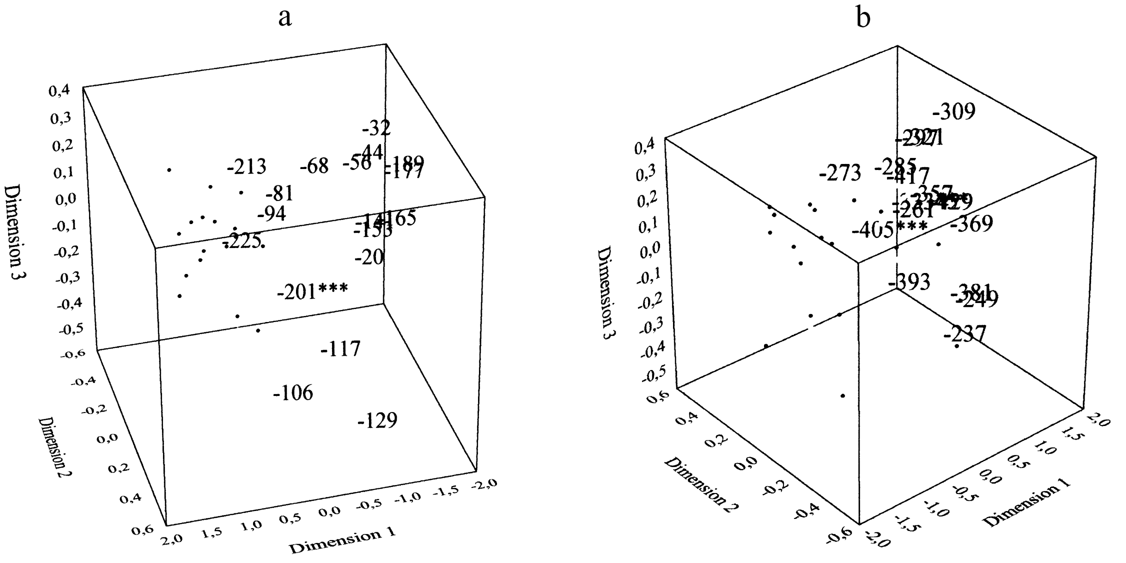
Multivariatne analize ZSD so odkrile razlike med facijami, kakor tudi med posameznimi stratigrafskimi nivoji. Prve so nesporno povezane s stratigrafijo in kronologijo najdišča, druge je zaradi številnih nepravilnosti težko povezati v sistem.

Če obstajajo časovno pogojene razlike na ravni celotnega starostno in drugače nestratificiranega skeleta, so razlike tudi na ravni posameznih skeletnih delov in stratificiranega ZSD.

Med skeletnimi deli zaslužijo posebno pozornost lobanje zaradi prehrambeno pomembnih možganov, velike dolge kosti okončin adultnih osebkov zaradi prehrambeno prav tako pomembnega mozga in kosti šap od narta oz. zapestja navzdol kot eventualna specialiteta. Ker je bil mozeg, vključno z možgani, v adultnih kosteh dosegljiv skoraj izključno ljudem, je to dober razlog za podrobnejšo analizo zastopanosti izbranih skeletnih delov, začenši pri kosteh glave, vključno s posamič najdenimi zobmi.



Sl. 12.4.7: Shepardov diagram za končno porazdelitev matrike, pridobljene z dvodimenzionalnim skaliranjem vseh neonatnih, juvenilnih in adultnih skeletnih delov.
Fig. 12.4.7: Shepard's diagram for the final distribution of the matrix obtained by two-dimensional scaling of all neonatal, juvenile and adult skeletel parts.



Sl. 12.4.8a, b: Grafični prikaz rezultata tridimenzionalnega skaliranja na podlagi zastopanosti vseh neonatnih, juvenilnih in adultnih skeletnih delov in evklidskih razdalj (stres = 0,02). Razporeditev sedimentacijskih nivojev v faciji A prikazuje graf (a), v faciji B pa graf (b).

Fig. 12.4.8a, b: Graphic presentation of the result of three-dimensional scaling on the basis of the representation of all neonatal, juvenile and adult skeletel parts and Euclidian distances (stress = 0.02). The distribution of sedimentation levels in facies A is shown in graph (a) and in facies B in graph (b).

KOSTI GLAVE

Kosti glave so sestavljene iz treh ločenih delov: 1.) lobanje z zgornjo čeljustnico, 2.) dvodelne spodnje čeljustnice in 3.) podjezičnih kosti.

Ti deli se po smrti zelo hitro ločijo, zaradi česar jih lahko doleti različna usoda. Podobno se dogaja z zgornjimi in spodnjimi zobmi, ki sčasoma izpadejo iz čeljustnic. S primerjanjem vseh adultnih in juvenilnih delov glave, vključno z izoliranimi stalnimi zobmi lahko naredite določene sklepe, ki temeljijo na križno preverjenih dejstvih in so zato zanesljivejši od drugih sklepov, temelječih samo na zastopanosti skletnih delov ali izoliranih zob.

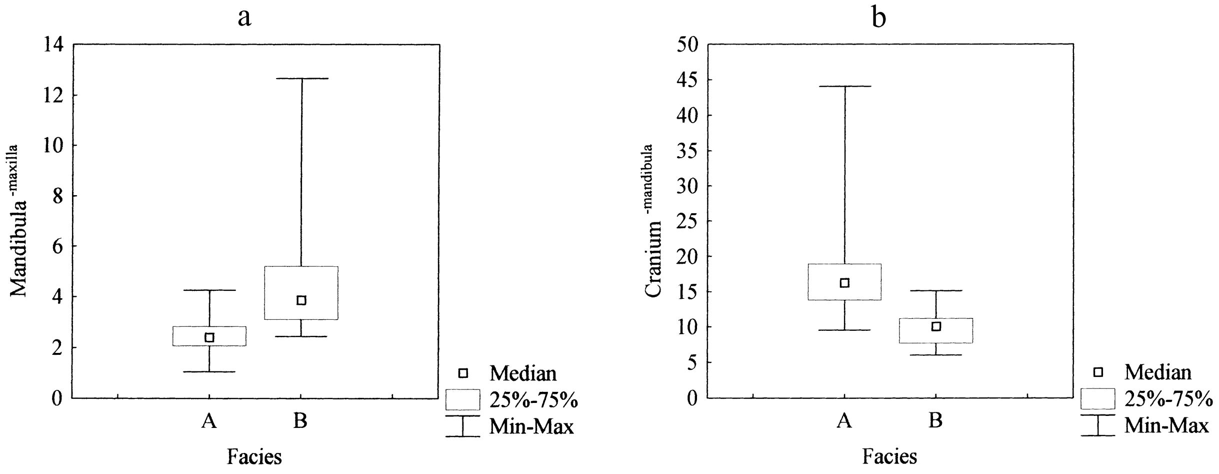
Splošno je znano, da je spodnjih zob in spodnjih čeljustnic v paleolitskih najdiščih, vključno z Divjimi babami I, veliko več kot zgornjih zob in zgornjih čeljustnic. Vprašanje je, kaj je temu vzrok.

Pri iskanju odgovora sva se osredotočila na vzorec vseh stalnih zob in združenih juvenilnih in adultnih kosti glave brez podjezičnih kosti. Vzorec sva preučila na podlagi razmerij med spodnjimi in zgornjimi zobmi, med spodnjima čeljustnicama in lobanjskimi kostmi, vključno z zgornjo čeljustnico in na podlagi razmerij naštetih zob in kosti v facijah. Ker podatki niso normalno porazdeljeni sva uporabila neparametrično analizo variance (ANOVA).

V faciji A je relativno več zgornjih čeljustnic in lobanjskih kosti kot v faciji B (*sl. 12.4.9a, b*).

Rezultat, ki je statistično zelo značilen (p < 0,001 pri Kruskalovem in Walisovem testu in testu mediane), je mogoče razložiti bodisi s povečanjem števila zgornjih čeljustnic in lobanjskih kosti bodisi z zmanjšanjem števila spodnjih čeljustnic. Ker je obenem tudi več spodnjih zob, je verjetnejša prva razlaga. Povečanje lahko pojasniva z delovanjem paleolitskega človeka in lahko pomeni večjo fragmentacijo lobanj, povezano z ekstrahiranjem možganov *in situ* (glej Turk, Kavur 1997). Fragmentacija lobanj bi bila v tem primeru bistveno večja kot izgube, ki bi nastale z odstranitvijo lobanj z najdišča, kar je tudi mogoče. Povečano fragmentacijo lahko razloživa z že omenjenim vedenjskim vzorcem ljudi, povezanim s številom lobanj. Teh je bilo v faciji A bistveno manj kot v faciji B (*tab. 12.4.4*). Zato so bile bolj izpostavljene fragmentaciji kot številčnejše lobanje v faciji B, kjer smo v plasti 8 našli večino maloštevilnih celih ali skoraj celih lobanj (glej poglavje 14 v tem zborniku). Veliko skoraj celih lobanj ima poškodovan možganski del. Vendar morava biti pri razlagi takšnih poškodb previdna, saj so nekatere lahko nastale med izkopavanjem postsedimentno natrtih lobanj. Zanesljivo stari so samo tisti prelomi, ki imajo korozijsko zaobljene robove.

V faciji A je več lobanjskih kosti in zgornjih čeljustnic, pa tudi več spodnjih zob (*sl. 12.4.10a, b*). Rezultat je statistično zelo značilen (p < 0,001 oz. 0,02 pri Kruskalovem in Walisovem testu in testu mediane) in ga je mogoče razložiti bodisi z večjim številom lobanjskih kosti, zgornjih čeljustnic in spodnjih zob bodisi z manjšim številom spodnjih čeljustnic in zgornjih zob. Ker je spodnjih čeljustnic v vseh sedimentacijskih nivojih (glej *tab. 12.4.1*) in najdiščih več kot zgornjih, je verjetnejša prva razlaga.



Sl. 12.4.9a, b: Razmerje spodnji čeljustnici: zgornja čeljustnica (a) in razmerje lobanjske kosti : spodnji čeljustnici (b) v facijah A in B.
Fig. 12.4.9a, b: Ratio of mandibles : maxillae (a) and ratio of skull bones : mandibles (b) in facies A and B.

Več lobanjskih kosti in zgornjih čeljustnic v faciji A zato pomeni večjo fragmentacijo lobanj, povezano z ekstrahiranjem možganov *in situ*. Ker je v faciji A hkrati več izoliranih spodnjih zob, sklepava, da je bil del lobanj odstranjen z najdišča. Namen takšnega početja ni znan.

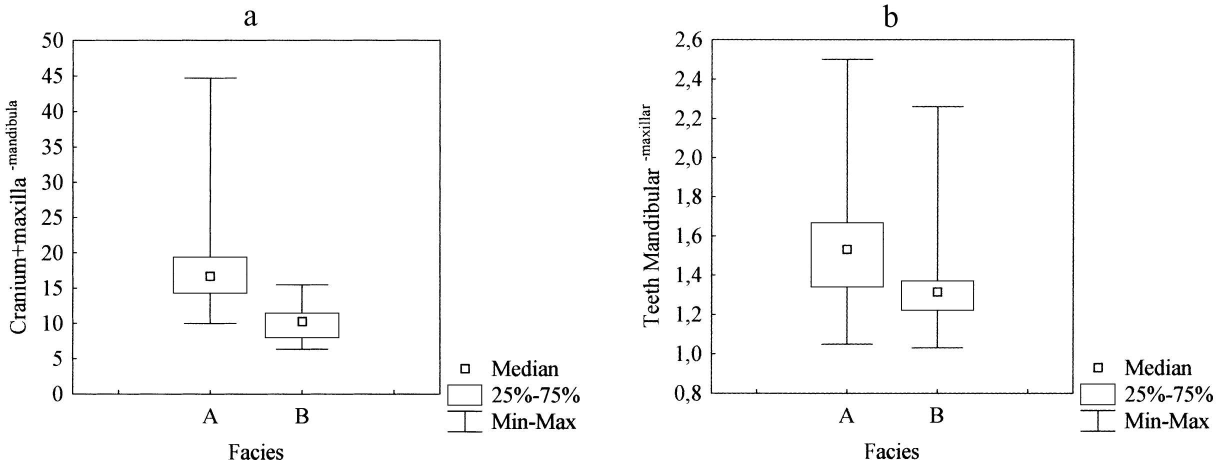
Bolj ali manj cele lobanje so v vzorčnem bloku sedimentov relativno slabo zastopane glede na dolgo časovno obdobje, v katerem so sedimenti nastali. Vse najdene lobanje so zbrane v *tab.12.4.4*, medtem ko so biometrični podatki podani v poglavju 14 tega zbornika.

Najdbe lobanj kažejo predvsem dvoje. Prvič, da se lobanje mladičev bistveno slabše ohranijo kot lobanje odraslih. To je razumljivo spričo dejstva, da lobanje mladičev nimajo zraščenih kosti in zato prej razpadejo. Drugič, da v določenih plasteh ni bolj ali manj celih lobanj. Brez njih sta predvsem zgornji in spodnji del facije A in prehod iz facije C v facijo B ter B v A.

Podobno kot lobanje, bi lahko kartirala vse cele skeletne dele. Vendar v preučevanju horizontalne razprostranjenosti ne vidiva pravega smisla, ker je tudi v tlorisu treba pri interpretaciji upoštevati časovni dejavnik. Primer lobanj kaže, da bi se morda splačalo preučiti prostorsko porazdelitev skeletnih delov v času, tj. profilu. Kombinacija prostora in časa je edina smiselna metoda, katere rezultate je mogoče kolikor toliko zanesljivo interpretatirati. Vse drugo je čisto špekuliranje.

V povezavi z lobanjami morava omeniti dve izjemni najdbi lobanj, ki sta lahko dokaz, da so paleolitski ljudje dejansko nekaj počeli z njimi.

Prva je lobanja odraslega jamskega medveda samca štev. 2349, najdena na dnu plasti 8 med podornimi bloki, kvadrat 39, reženj -333 cm (= sedimentacijski nivo -345 cm), 4 m vstran od ognjišča in 12 cm globlje. Lobanja ima simetrično preluknjana oba masivna odrastka



Sl. 12.4.10a, b: Razmerje lobanjske kosti z zgornjo čeljustnico : spodnje čeljustnice (a) in razmerje spodnji stalni zobje : zgornji stalni zobje (b) v facijah A in B.
Fig. 12.4.10a, b: Ratio of skull bones with maxillae : mandibles (a) and ratio of lower permanent teeth : upper permanent teeth (b) in facies A and B.

Tab. 12.4.4: Stratigrafski pregled lobanj.
Tab. 12.4.4: Stratigraphic review of skulls.

Sedimentation level (cm)	Facies	Age stage	No.	Quadrat	Exact depth (cm)
-20	A	-	-	-	-
-32	A	-	-	-	-
-44	A	-	-	-	-
-56	A	-	-	-	-
-68	A	-	-	-	-
-81	A	-	-	-	-
-94	A	-	-	-	-
-106	A	Adultus	s.n.	19	-106
-117	A	Adultus	1399	19	-117
-117	A	Adultus	1277	20	-117
-117	A	Adultus	s.n.	16	-129
-129	A	Adultus	1398	16	-141
-141	A	Adultus	1313	38	-141
-165	A	Adultus	s.n.	31	-153
-177	A	-	-	-	-
-189	A	-	-	-	-
-201***	A	-	-	-	-
-213	A	-	-	-	-
-225	A	-	-	-	-
-237	B	-	-	-	-
-249	B	-	-	-	-
-261	B	Adultus	1693	32-33	-249
-273	B	Adultus	s.n.	13	-285
-285	B	Adultus	2032	37	-285
-297	B	Adultus	1996	37	-297
-309	B	-	-	-	-
-321	B	-	-	-	-
-333***	B	Juvenilis	1992	29	-321
-333***	B	Adultus	2033	39	-321
-333***	B	Adultus	2124	31	-321
-333***	B	Adultus	s.n.	40	-321
-345	B	Adultus	2349	39	-333
-345	B	Adultus	2125	14	-357
-345	B	Adultus	s.n.	35	-357
-345	B	Adultus	s.n.	35	-357
-345	B	Adultus	s.n.	35	-357
-357	B	Juvenilis	s.n.	35	-369
-357	B	Adultus	s.n.	35	-369
-369	B	Adultus	2123	32	-357
-381	B	-	-	-	-
-393	B	Adultus	s.n.	25	-393
-405***	B	Adultus	s.n.	38	-405
-417	B	Juvenilis	s.n.	39	-405
-429	B	-	-	-	-
-441	C-1	-	-	-	-
-453	C-2	-	-	-	-

*** Sedimentacijski nivo z ostanki ognjišča.
*** Sedimentation level with the remains of a hearth.

za mandibularno sklepno vdolbino in poškodovano širšo okolico *foramen occipitale magnum* (*sl. 12.4.11*). Poškodba je lahko nastala postsedimentno ali pri odstranitvi možganov. Vsekakor so nekatere manjše poškodbe nastale tudi postsedimentno zaradi jedkanja. Simetrija parnih lukenj za mandibularno sklepno površino je neobičajna. Lega in velikost lukenj sta prav tako nenavadni. Zato ne izključujeva možnosti, da so bile luknje narejene z namenom, da se lobanja čvrsto pritrdi ali obesi. Za nameček je lobanja ležala na temenu, kar je neobičajno, podprta z dvema kamnoma. Z gobcem je bila obrnjena proti zahodu. Vzporedno z njo je 12 cm višje ležala enako obrnejna še ena lobanja odraslega jamskega medveda, tokrat samičja štev. 2033. Ta je bila nepoškodovana, z gobcem obrnjena proti vzhodu z rahlim odklonom proti jugu. Ker sta se lobanji dotikali, ni izključeno, da je do odklona lobanje štev. 2033 prišlo postsedimentno. V najdiščih jamskega medveda so cele lobanje v obrnjeni legi redkost (prim. Pacher, Miranelli 2004, sl. 2; Fosse, Philippe 2005). Primer obrnjenih lobanj štev. 2033 in 2349 bo podrobneje obravnavan v drugem delu monografije. Vsekakor lahko trdiva, da je vse našteto (lega, orientacija, spol, poškodbe) zelo težko razložiti s spletom naključij.

Istemu ognjišču lahko pripada tudi lobanja štev. 2125, najdena v kvadratu 14, reženj –357 cm (= sedimentacijski nivo –345 cm), ki ima razbit možganski del. Lobanja je ležala v ognjiščnem kvadratu, kar je lahko naključje, v eventualnem kontekstu z lobanjo štev. 2033 in 2349 pa tudi ne. V sedimentacijskem nivoju –345 cm so bili v kvadratu 35 ostanki še treh adultnih lobanj, v sedimentacijskem nivoju –333 cm, ki sva ga označila kot ognjiščnega, pa so bile še tri lobanje (*tab. 12.4.4*), in sicer dve odrasli (štev. 2124 in *s. n.* v kvadratu 40, reženj –321 cm) in ena juvenila (štev. 1992). Vse so bile bolj ali manj fragmentirane. Pri časovni ločljivosti približno 1000 let na stratigrafski nivo je seveda povezava med ognjiščem in lobanjami ali samo med lobanjami zgolj špekulativna.

VELIKE DOLGE KOSTI OKONČIN

Podobna usoda, kot je domnevno doletela lobanje v faciji A, bi morala domnevno doleteti tudi velike dolge kosti okončin, v katerih so večje količine mozga. Te kosti so adultne nadlahtnice, stegnenice in golenice. Druge adultne kosti kot podlahtnica, koželjnica in mečnica imajo bistveno manj mozga, zato domnevno niso bile zanimive za paleolitskega človeka. Ker je bil mozeg v teh zelo masivnih kosteh dostopen le njemu, sva jih primerjalno analizirala v facijah A in B. Pri tem sva najdene ostanke razdelila na epifize, diafize in cele kosti (*tab. 12.4.5*). Epifiz se običajno drži del diafize. Ločevanje na proksimalne in distalne diafize ni potrebno razen v izjemnih primerih. V skupini diafiz so samo cevasti ali cilindrični odlomki različnih dolžin brez maloštevilnih določljivih iveri.

Sl. 12.4.11: Domnevno umetne luknje na odrastkih za sklepno vdolbino lobanje štev. 2349. Fotografija M. Zaplatil.
Fig. 12.4.11: Suspected artificial holes on the spurs behind the mandibular articular depression (*fovea articularis mandibulae*) of skull no. 2349. Photograph M. Zaplatil.

Velike dolge kosti okončin sodijo v skupino najslabše zastopanih skeletnih delov, ker jih veliko manjka v sedimentacijskih nivojih (*sl. 12.4.12*). V faciji A, kjer je na splošno manj kosti in zob, je zastopanost slabša. Vendar to ne velja za cele nadlahtnice, stegnenice, golenice in mečnice, pri katerih je zastopanost v obeh facijah približno enaka. Za vse kosti razen mečnice je značilno, da vsebujejo največ mozga. Ker so cele koželjnice in podlahtnice v faciji B bolje zastopane, kar je za večji vzorec normalno, je relativno slabša zastopanost kosti z več mozga neobičajna. Považeva jo lahko bodisi z odnašanjem kosti bodisi z večjo fragmentacijo. Večji fragmentaciji v prid govori neobičajno veliko število odlomkov mečnice, ki se drži golenice. Takšno sliko bi dobili, če bi bili obe kosti fragmentirani sočasno. Vendar je lahko fragmentacija mečnice tudi ali predvsem postsedimentna.

Več o fragmentaciji povedo razmerja, navedena v *tab. 12.4.6*.

Temeljna ugotovitev je, da je v facijah A in B razmerje epifize : diafize pri nadlahtnici in golenici drugačno kot pri ostalih velikih dolgih kosteh. V faciji B je bistveno več fragmentov diafiz nadlahtnic in golenic, kot pri katerih koli drugih velikih dolgih kosteh (*tab. 12.4.5* in *12.4.6*). Kriterij za klasifikacijo fragmentov diafiz je bil takšen, da močnejša fragmentacija zmanjšuje število fragmentov diafiz. V faciji A je bila fragmentacija zato večja, kar je skladno z večino sklepov. Če to drži, je treba sprejeti tudi sklep, da so bile velike dolge kosti z veliko mozga delno odstranjene z najdišča. V plasti 8 facije B je bilo najdenih največ celih velikih dolgih kosti okončin, pogosto v kaotičnih skupkih skupaj z drugimi velikimi kostmi in relativno dobro ohranjenimi lobanjami. Vse skupaj je bilo na moč podobno fosilnim tlem s površinskimi kostnimi najdbami jamskega medveda v najdišču Chauvet v Franciji in Grotta degli Orsi na Krasu (Fosse, Philippe 2005; Boschian, Ota 2002).

Nadvse zanimiv rezultat je dalo testiranje razmerij epifize : diafize in diafize : cele kosti v facijah A in B pri nadlahtnici, podlahtnici, stegnenici, golenici in mečnici. Pri koželjnici testiranje ni bilo mogoče, zaradi ene nične vrednosti pri celih primerkih v faciji A. Rezultat testa hi-kvadrat kaže, da so zelo značilne razlike med facijami pri nadlahtnici (p < 0,001) in golenici (p < 0,001), medtem ko pri podlahtnici (p = 0,77), stegnenici (p = 0,93) in mečnici (p = 0,76) ni razlik. Rezultat testa za nadlahtnico in golenico je bil pričakovan, nepričakovan pa je rezultat za stegnenico, ki se tako uvršča v skupino kosti z malo mozga. Pri tem se ne moreva sklicevati na njeno robustnost, ker je golenica prav tako robustna, če ne celo bolj. Razen tega je testiranje razmerja epifize : diafize (p = 0,89) in diafize : cele kosti (p = 0,70) pri robustni stegnenici in krhki mečnici v facijah A in B pokazalo, da med stegnenico in mečnico v facijah zelo verjetno ni razlik. Enako velja za podlahtnico in mečnico. To pomeni, da robustnost oz. nerobustnost nimata pri vsej zadevi nič, ampak gre v tem primeru za namenski izbor nekega povzročitelja fragmentacije in/ali selektivno odstranitev kosti z veliko mozga z najdišča. Stegnenica se je lahko izognila usodi nadlahtnice in golenice, ker jo je ščitilo debelo mišično tkivo, katerega odstranitev je zahtevala več napora kot pri nadlahtnici in golenici. Razmerje epifize : diafize (p = 0,16) in diafize : cele kosti (p = 0,40) je v facijah A in B zelo verjetno enako pri nadlahtnici in golenici, je pa to razmerje različno pri nadlahtnici in drugih velikih dolgih kosteh na eni strani (p < 0,001) in golenici in drugih dolgih kosteh na drugi strani (p < 0,001).

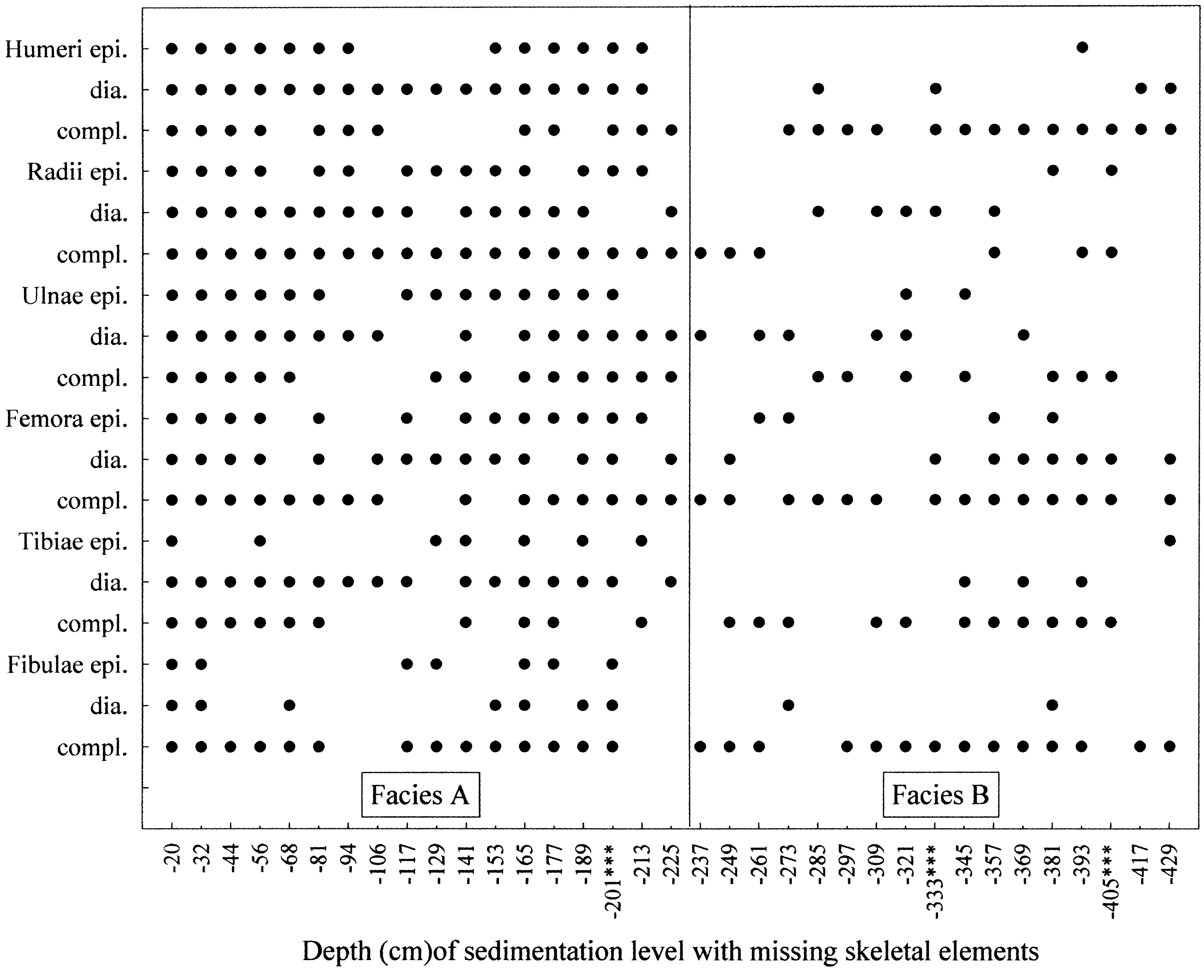
Nadlahtnica in golenica potrjujejta domnevo, ki sva jo postavila pri lobanjskih kosteh. Ta je povezana s posegom človeka in njegovo veliko potrebo po mozgu. Poseg je bil tem večji, čim manj je bilo na razpolago kosti z izdatnimi zalogami mozga. To je edini način, s katerim lahko razloživa paradoks, ki ga predstavlja slaba ohranjenost skeletnih delov in njihova velika fragmentacija v faciji A, ki vsebuje manj paleolitskih najdb kot facija B. Odnos med paleolitskimi najdbami in stanjem fosilnih ostankov jamskega medveda je obratno sorazmeren, ne pa premo sorazmeren kot bi pričakovala. Kar zadeva klimo, se ne ve, kako je vplivala na človekovo potrebo po mozgu. V faciji B, za katero je značilno zelo hladno podnebje, ni znakov o večji porabi mozga.

Tab. 12.4.5: Zastopanost adultnih celih velikih dolgih kosti okončin in njihovih delov v sedimentacijskih nivojih v facijah A in B. V sivo obarvanem stolpcu z izpisanim imenom skeletnega dela so prvi navedeni celi primerki, ki jim sledijo fragmenti epifiz in diafiz.
Tab. 12.4.5: Representation of adult whole large long bones of extremities and their parts in sedimentation levels in facies A and B. In the grey column, with the name of the skeletal part, are first given whole specimens, followed by fragments of epiphyses and diaphyses.

Sedimentation level (cm)	Facies	Humeri	epiphyses	diaphyses	Radii	epiphyses	diaphyses	Ulnae	epiphyses	diaphyses	Femora	epiphyses	diaphyses	Tibiae	epiphyses	diaphyses	Fibulae	epiphyses	diaphyses	SUM
-20	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
-32	A	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	*2*
-44	A	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	2	*6*
-56	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	*3*
-68	A	1	0	0	0	1	0	0	0	0	0	1	1	0	2	0	0	2	0	*8*
-81	A	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	2	1	*7*
-94	A	0	0	0	0	0	0	1	2	0	0	1	1	1	2	0	1	3	3	*15*
-106	A	0	1	0	0	2	0	2	1	0	0	4	0	1	1	0	1	3	3	*19*
-117	A	1	1	0	0	0	0	1	0	1	1	0	0	3	3	0	0	0	2	*13*
-129	A	2	2	0	0	0	1	0	0	2	1	1	0	2	0	1	0	0	2	*14*
-141	A	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	*4*
-153	A	1	0	0	0	0	0	1	0	1	1	0	0	1	2	0	0	2	0	*9*
-165	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
-177	A	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	3	*6*
-189	A	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	*4*
-201***	A	0	0	0	0	0	1	0	0	0	0	0	0	1	3	0	0	0	0	*5*
-213	A	0	0	0	0	0	1	0	1	0	0	0	1	0	0	1	1	3	3	*11*
-225	A	0	1	1	0	1	0	0	1	0	0	1	0	1	3	0	1	10	6	*26*
-237	B	1	3	1	0	3	5	1	2	0	0	3	1	2	4	4	0	6	2	*38*
-249	B	1	1	2	0	3	2	1	3	1	0	4	0	0	5	3	0	9	4	*39*
-261	B	2	1	3	0	2	3	1	5	0	3	0	1	0	1	1	0	5	3	*31*
-273	B	0	2	3	1	1	2	1	6	0	0	0	1	0	3	2	2	2	0	*26*
-285	B	0	3	0	1	2	0	0	1	1	0	1	1	1	4	2	1	4	2	*24*
-297	B	0	4	2	2	1	1	0	1	1	0	1	1	2	2	1	0	3	2	*24*
-309	B	0	1	1	1	1	0	2	1	0	0	3	1	0	2	1	0	1	2	*17*
-321	B	2	4	1	1	2	0	0	0	0	2	2	1	0	4	2	0	5	1	*27*
-333***	B	0	1	0	1	4	0	1	3	1	0	3	0	3	2	1	0	4	2	*26*
-345	B	0	1	1	1	1	2	0	0	1	0	2	2	0	1	0	0	3	2	*17*
-357	B	0	2	1	0	1	0	2	2	1	0	0	0	0	4	1	0	1	5	*20*
-369	B	0	1	2	1	4	1	1	2	0	0	2	0	0	3	0	0	2	3	*22*
-381	B	0	1	1	1	0	1	0	2	3	0	0	0	0	5	2	0	9	0	*25*
-393	B	0	0	1	0	1	1	0	2	1	0	4	0	0	5	0	0	5	3	*23*
-405***	B	0	1	1	0	0	2	0	2	3	0	3	0	0	2	1	1	6	3	*25*
-417	B	0	2	0	1	6	2	1	1	3	1	1	1	1	2	5	0	6	6	*39*
-429	B	0	2	0	1	1	5	2	4	1	0	3	0	2	0	2	0	7	2	*32*
-441	C-1	0	2	0	2	6	2	0	1	1	0	4	1	1	3	0	1	3	2	*29*
-453	C-1	0	1	0	0	1	0	0	1	0	0	2	1	0	0	1	0	0	1	*8*
SUM	*A*	*7*	*6*	*1*	*0*	*5*	*3*	*6*	*5*	*4*	*3*	*8*	*4*	*11*	*23*	*2*	*4*	*33*	*27*	*152*
SUM	*B*	*6*	*33*	*20*	*14*	*40*	*29*	*13*	*39*	*18*	*6*	*38*	*12*	*12*	*52*	*29*	*5*	*81*	*45*	*492*

Tab. 12.4.6: Razmerja epifize : diafize in diafize : cele kosti velikih dolgih kosti v facijah A in B.
Tab. 12.4.6: Ratios of epiphyses : diaphyses, and diaphyses : whole large long bones in facies A and B.

Facies	Humeri epi. : dia.	Humeri dia. : compl.	Femora epi. : dia.	Femora dia. : compl.	Tibiae epi. : dia.	Tibiae dia. : compl.		Radii epi. : dia.	Radii dia. : compl.	Ulnae epi. : dia.	Ulnae dia. : compl.	Fibulae epi. : dia.	Fibulae dia. : compl.
A	**6.0**	0.1	2.0	1.3	**11.5**	0.2		1.7		1.3	0.7	1.2	6.8
B	**1.7**	3.3	3.2	2.0	**1.8**	2.4		1.4	2.1	2.2	1.4	1.8	9.0



Sl. 12.4.12: Manjkajoči deli velikih dolgih kosti okončin odraslih medvedov v sedimentacijskih nivojih.
Fig. 12.4.12: Missing parts of large long bones of extremities of adult individuals in sedimentation levels.

Da so ljudje dejansko posegali po velikih dolgih kosteh jamskega medveda, kažejo številni ožgani in zogleneli kostni drobci ter posamezni značilni odlomki in znaki na teh kosteh, o čemer bo več govora v drugem, arheološkem delu monografije.

Do enakega sklepa kot pri adultnih velikih dolgih kosteh sva prišla pri analognih juvenilnih kosteh na podlagi analize razmerja med združenimi kostmi z veliko in

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*** Sedimentacijski nivo z ostanki ognjišča. Maloštevilni skeletni deli, najdeni v žganini, niso zajeti v tabeli, ker bodo obdelani v drugem delu monografije.

*** Sedimentation level with the remains of a hearth. The few bones found in the soil mixed with charcoal are not included in the table because they will be dealt with in second part of the monograph.

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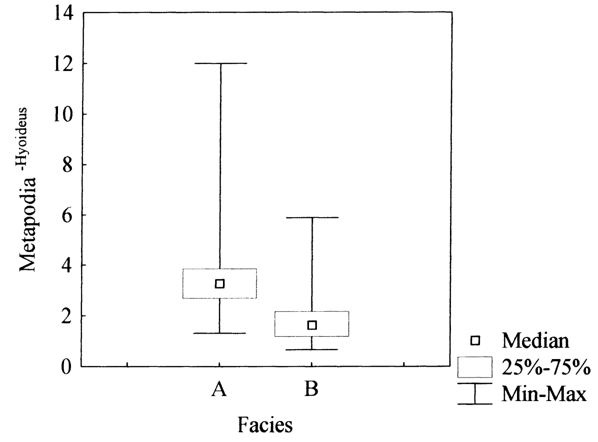
malo mozga, ki so naštete v *tab. 12.4.1.* V faciji B je v skupini *juvenilis* več kosti z veliko mozga (p < 0,01). Ker so juvenilne dolge kosti okončin zastopane predvsem z diafizami, lahko sklepava, da je v faciji B bodisi več juvenilnih diafiz nadlahtnic, stegnenic in golenic bodisi manj diafiz podlahtnic, koželjnic in mečnic. Pri podobnem razmerju v skupini *adultus* med facijami ni razlik (p = 0,71). Te so se pokazale šele ko sva analizirala razmerje epifize : diafize. Primerljiv rezultat pri adultnih in juvenilnih velikih dolgih kosteh pomeni, da gre bodisi za isti bodisi podobno delujoč tafonomski dejavnik, tj. ljudi ali zveri.

KOSTI ŠAP

Ker so medvedje šape lahko bile ljudem poslastica, podobno kot danes, sva posebej obdelala njihove skeletne dele. V ta namen sva združila zapestne in nartne kosti mladih in odraslih osebkov, dlančnice in stopalnice mladih in odraslih osebkov ter vse prstnice mladih in odraslih medvedov. Ločevanje na sprednje okončine in zadnje ter na skupino *juvenilis* in *adultus* nima smisla, ker so ljudje in/ali zveri verjetno uživali šape vse od kraja. Razen tega sva se tako izognila napakam pri anatomskem in ontogenetskem opredeljevanju poškodovanih skeletnih delov šap. Zastopanost skeletnih delov šap sva primerjala z zastopanostjo pogačic, grodnic in podjezičnic odraslih in mladih medvedov skupaj, tj. kosti, ki nekako ustrezajo po velikosti, obliki in trdnosti kostem šap, vendar imajo domnevno drugačno preteklost, kar zadeva človeške interese in dejavnost. Podatki, na podlagi katerih sva izračunala razmerja v facijah A in B, so prikazani v *tab. 12.4.7.*

Razmerja med posameznimi kostmi šap in izbranimi skeletnimi deli niso normalno porazdeljena zato sva morebitne razlike med facijami A in B poskušala ugotoviti z neparametrično analizo variance (ANOVA). Zelo značilne razlike med facijami sva ugotovila v razmerjih *metapodia* : *patellae* (p < 0,01 pri Kruskalovem in Walisovem testu in testu mediane), *metapodia* : *ossa sterni* (p < 0,01 in p = 0,02 glede na omenjeni vrsti testa) in *metapodia* : *ossa hyoidea* (p < 0,01 pri obeh omenjenih testih). Značilna razlika je tudi pri razmerju *phalanges* : *ossa sterni* (p = 0,04 in p = 0,02 glede na omenjeni vrsti testa) in *phalanges* : *ossa hyoidea* (p = 0,05 in p = 0,03 glede na omenjeni vrsti testa). Pri razmerjih *carpus+tarsus* : *patellae*, *carpus+tarsus* : *ossa sterni*, *carpus+tarsus* : *ossa hyoidea* in *phalanges* : *patellae* med facijami ni razlik.

Vse razlike med facijami so takšne, kot jih prikazuje *sl. 12.4.13*, in jih lahko razloživa takole: v faciji B je bodisi manj dlančnic, stopalnic in prstnic bodisi več pogačic, grodnic in podjezičnic oziroma v faciji A je bodisi več dlančnic, stopalnic in prstnic bodisi manj pogačic, grodnic in podjezičnic. Zapestnih in nartnih kosti je v obeh facijah enako. Ker ne vidiva nobenega pametnega razloga za spreminjanje številčnega stanja pogačic in grodnic v luči domnevnega posega ljudi, predpostavljava da se je dejansko spreminilo število dlančnic, stopalnic in prstnic ter morda podjezičnic. Zato si po vrsti poglejmo možne razlage za ugotovljene razlike.



Sl. 12.4.13: Prikaz razlike v razmerju *metapodia* : *ossa hyoidea* med faciji A in B.
Fig. 12.4.13: Presentation of difference in the ratio *metapodia* : *ossa hyoidea* between facies A and B.

Manj dlančnic, stopalnic in prstnic v faciji B lahko pomeni, da so bili ti skeletni deli odstranjeni z najdišča. To bi se zgodilo, če bi ljudje odnašali šape brez zapestja in narta. Razlaga je podprta z večjo gostoto paleolitskih najdb v faciji B, vendar ni skladna z ugotovitvami in razlagami, povezanimi s kostmi glave in velikimi dolgimi kostmi. Dodatne dokaze je treba iskati pri poškodbah zapestno-nartnih kosti in proksimalnih sklepov dlančnic in stopalnic, ki bi nastale pri dezartikulaciji šap. Druga možnost je, da so šape požrle zveri. Ker je predvsem na dlančnicah in stopalnicah veliko sledov grizenja, je to celo bolj verjetno kot prva razlaga. V tem primeru bi bil glavni dejavnik volk, katerega ostanki so v faciji B pogostnejši kot v faciji A. Tretja možnost je različno obravnavanje natančneje nedoločljivih metapodijev v facijah A in B. Ta možnost ni upoštevanja vredna, ker sva podobno razliko med facijami odkrila tudi pri prstnicah, ki so del šape.

Kar zadeva prstne členke in podjezične kosti, sta možni dve razlagi. Po prvi razlagi bi bili prstni členki v faciji B odstranjeni z najdišča skupaj z dlančnicami in stopalnicami. Po drugi razlagi bi bile odstranjene z najdišča podjezične kosti v faciji A. To bi bilo do neke mere skladno z ugotovitvami in razlagami, povezanimi s kostmi glave in velikimi dolgimi kostmi. Kaj se je dejansko zgodilo ni mogoče ugotoviti.

ANATOMSKE LEGE

Skeletni deli jamskega medveda se redko najdejo v anatomski legi. Večinoma gre za nekaj skeletnih delov, samo izjemoma za bolj ali manj cel skelet. Največ dobro dokumentiranih skeletnih delov, najdenih v anatom-

Sedimentation level (cm)	Facies	Patellae	Ossa sterni	Ossa hyoidea	Carpalia+Tarsalia	Metapodia	Phalanges
-20	A	1	10	2	9	24	68
-32	A	0	0	20	27	59	191
-44	A	1	1	30	50	93	224
-56	A	1	3	24	82	85	257
-68	A	3	2	27	63	74	205
-81	A	6	4	42	89	112	325
-94	A	2	9	18	75	86	294
-106	A	0	4	20	70	54	203
-117	A	2	1	11	51	39	132
-129	A	1	4	11	42	39	110
-141	A	2	1	14	41	54	146
-153	A	2	1	30	22	39	147
-165	A	0	1	12	24	23	121
-177	A	0	0	12	22	41	132
-189	A	0	1	7	15	18	95
-201***	A	3	4	16	28	43	106
-213	A	0	2	25	101	112	295
-225	A	7	4	46	165	205	643
-237	B	5	10	50	254	294	766
-249	B	10	20	63	237	203	626
-261	B	7	5	46	147	113	384
-273	B	8	6	39	122	109	282
-285	B	10	9	108	175	127	438
-297	B	8	13	64	163	123	405
-309	B	7	7	80	139	52	319
-321	B	10	8	64	160	100	411
-333***	B	12	5	67	188	105	567
-345	B	6	12	100	206	90	543
-357	B	13	8	104	176	109	551
-369	B	4	13	96	197	115	663
-381	B	9	37	61	257	129	908
-393	B	8	11	56	206	112	697
-405***	B	5	10	38	140	82	549
-417	B	5	5	97	170	94	512
-429	B	11	21	70	238	113	681
-441	C-1	10	13	50	227	92	607
-453	C-1	3	10	35	59	36	236
SUM	*A*	*31*	*52*	*367*	*976*	*1200*	*3694*
SUM	*B*	*138*	*200*	*1203*	*3175*	*2070*	*9302*

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Tab. 12.4.7: Vse pogačice, grodnice in podjezičnice ter kosti šap mladih in odraslih medvedov v sedimentacijskih nivojih in facijah. Pri dlančnicah in stopalnicah so v faciji A izjemoma zajeti tudi neopredeljivi primerki glede na sprednjo ali zadnjo nogo, ki smo jih uvrstili polovico med *metacarpalia* in polovico med *metatarsalia*.

Tab. 12.4.7: All patellae, sterna and hyoidea and paw bones of young and adult individuals in sedimentation levels and facies. With metacarpals and metatarsals, exceptionally in facies A are also included specimens indistinguishable between front and rear, half of which we assigned to *metacarpalia* and half to *metatarsalia*.

*** Sedimentacijski nivo z ostanki ognjišča. Maloštevilni skeletni deli, najdeni v žganini, niso zajeti v tabeli, ker bodo obdelani v drugem delu monografije.

*** Sedimentation level with the remains of a hearth. The few bones found in the soil mixed with charcoal are not included in the table because they will be dealt with in second part of the monograph.

ski legi, poznamo v Sloveniji predvsem po zaslugi novih izkopavanj v Potočki zijalki (Pacher 2004, 103–104).

V Divjih babah I je bilo najdenih največ skeletnih delov v anatomski legi v plasti 8 (*sl. 12.4.14*), kjer je bilo tudi veliko celih kosti. Gledano v celoti so anatomske lege kosti v Divjih babah I redke, zaradi česar se z njimi ni smiselno posebej ukvarjati. Pač pa morava opozoriti na izjemno najdbo precej popolnega skeleta odrasle jamske medvedke v polovički kvadrata 163, skupaj s posameznimi skeletnimi deli drugih medvedov. Skelet je ležal tik pod previsno steno 5 m za vhodom v plasteh 10–14, ki pripadajo najbogatejšemu paleolitskemu horizontu E. Odkrit je bil leta 1984 v nenormalnih okoliščinah, kar ima za posledico pomanjkljivo dokumentacijo[9]. Vretenca so bila nesporno v anatomski legi, ob njih pa vse druge kosti v bolj ali manj anatomskem položaju.

Najdeni skelet so sestavljali naslednji deli (inv. štev. 381–390):

1. Lobanja in zgornji čeljustnici, vse postsedimentno fragmentirano zaradi pritiska blokov.
2. Mandibuli, dva fragmenta.
3. Podjezičnice, ena fragmentirana, **ostale manjkajo**.
4. Vretenca, prvo in drugo vretence, 4 vratna vretenca, 5 prsnih, 6 ledvenih in fragmenti različnih vretenc.
5. Rebra, fragmenti.
6. **Grodnične kosti, manjkajo**.
7. Lopatici, en sklepni del in drugi fragmenti.
8. Nadlahtnici, leva postsedimentno fragmentirana, **desna manjka**.
9. Podlahtnici, leva postsedimentno fragmentirana, desna cela.
10. Koželjnici, leva postsedimentno fragmentirana, desna cela.
11. Zapestnice, štiri cele, **ostale manjkajo**.
12. Dlančnice, vseh pet levih celih, **desne manjkajo**.

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[9] V steni ob skeletu je bila več 1.000 kg težka skalna luska, ki je grozila, da se zaradi spodkopavanja odlušči in pade na skelet in tistega, ki bi skelet odkopal.

Sl. 12.4.14: Anatomska lega dolgih kosti (femur + tibia in ulna + radius) jamskega medveda v plasti 8. Fotografija I. Turk.
Fig. Sl. 12.4.14: Anatomic position of long bones (femur + tibia and ulna + radius) of cave bear in Layer 8. Photograph I. Turk.

13. Sprednje prstnice, vse prve leve in desne cele, **druge in tretje manjkajo**.
14. **Kolčnici, manjkata**.
15. **Križnica, manjka**.
16. Stegnenici, desna cela, **leva manjka**.
17. Pogačici, par, celi.
18. Golenici, par, celi.
19. Mečnici, par, fragmentirani.
20. Nartnice, leve in desne, cele. **Manjkajo tri manjše nartnice**.
21. Stopalnice, vse leve in desne, cele.
22. Zadnje prstnice, leve in desne, cele. **Manjkata dve prstnici**.

Skupno je bilo ob steni v kvadratu 163 najdenih 312 skeletnih delov, od tega 21 juvenilnih in en neonaten, ki zanesljivo ne pripadajo skeletu medvedke. Skeletu medvedke ni pripadalo tudi vsaj 36 določljivih adultnih kosti, tako da ji lahko pripiševa največ 115, večinoma bolj ali manj celih skeletnih delov od 234 možnih brez sezamoidnih koščic.

Manjkajoče skeletne dele lahko razloživa tako s pomanjkljivo terensko tehniko, za katero je bila značilna velika prepustnost drobnih najdb, kot so podjezičnice, grodnične kosti, nekatere zapestnice in nartnice ter prstnice, kot z možnostjo, da smo dele skeleta nehote odstranili v letih 1982 in 1983, ko smo pustili dele sedimenta pod lusko, ki se je ločila od previsne stene in ogrožala delavce, zaradi varnosti nedotaknjene. Vendar med nadlahtnicami in stegnenicami, inventariziranimi v letih 1982–1984, ni celih primerkov, ki bi lahko pripadali skeletu medvdke. Zato bi najdeni skelet, če bi bil pravilno dokumentiran, lahko potrdil najino domnevo, da so ljudje odnašali in/ali močneje fragmentirali tiste velike dolge kosti okončin, ki so vsebovale več mozga.

Za tako dobro ohranjenost individualnega skeleta predlagava dve razlagi. Po prvi se je na ostanke poginule medvedke zrušil del stene in jih zaščitil pred razsipom. Po drugi je večino ostankov, ki evidentno niso bili dezartikulirani, nekdo zakopal.

PRIMERJAVA S POTOČKO ZIJALKO

Nova izkopavanja v Potočki zijalki so dala nekaj gradiva za preučevanje fosilnih ostankov jamskega medveda, med drugim tudi zastopanosti skeletnih delov (Pacher 2004b, tab. 2), ki jo lahko neposredna primerjava z ZSD v vzorcu Divjih bab I. Primerjavo lahko narediva bodisi v kronološko nerazčlenjenih vzorcih bodisi razčlenjenih. Ker vzorec Potočke zijalke ni kronološko razčlenjen, zadnja možnost odpade. Gradivo Divjih bab I in Potočke zijalke ni bilo pridobljeno na enak način, kar je vsekakor vplivalo na ZSD in drugo. Na izsledke primerjave je poleg metode lahko vplival tudi velik časovni odmik najdišč, hitrost sedimentacije oz. časovni razpon, ki ga zaobjemajo vzorci, delež površine vzorčenih sedimentov glede na celotno jamsko površino, stopnja fragmentacije skeletnih delov, struktura žive najdiščne populacije in nenazadnje naravno okolje. To je samo nekaj dejavnikov, ki sva se jih domislila in ki konkurirajo vplivom ljudi in zveri na ZSD. Zato bova pri interpretaciji rezultatov zelo previdna.

V Divjih babah I so bili vsi sedimenti pregledani s pomočjo spiranja na treh sitih z različnim premerom luknjic. V Potočki zijalki se sedimenti niso spirali zaradi objektivnih okoliščin. V vzorcu Divje babe I je zato povprečno 2,1 sezamoidne koščice na določljive dlančnice in stopalnice, v vzorcu Potočke zijalke pa le 0,8, kar kaže na slabšo pobranost majhnih skeletnih delov in fragmentov. Najdbe iz Divjih bab I so do dva in polkrat starejše, odvisno od facije (za datacije najdišč glej poglavje 6 v tem zborniku in Rabeder, Pohar 2004). Facija A je odmaknjna od Potočke zijalke približno 10–20 tisoč let, facija B pa 21–50 tisoč let. Delež površine vzorčenih sedimentov je v Divjih babah I približno 8,5 %, v Potočki zijalki pa le okoli 0,5 %. Stopnja reprezentativnosti ZSD za najdišče kot sistem je premo sorazmerna z velikostjo deleža površine vzorčenih sedimentov (glej Turk 2004). Fragmentacija je v Divjih babah I bistveno večja kot v vzorcu Potočke zijalke (prim. Pacher 2004b, tab. 2 in podpoglavje 12.3 v tem zborniku), čeprav je delež dejavnosti zveri v obliki sledov grizenja v vzorcu Potočke zijalke zijalke precej večji kot v Divjih babah I (prim. *tab. 12.4.1* in Pacher 2004b, tab. 5). Podobno velja za sledove delovanja človeka na kosteh. Struktura žive populacije je bila v Potočki zijalki drugačna kot v Divjih babah I. Hitrost sedimentacije v primerjanih najdiščih ni enaka, se pa da oblikovati vzorec Divjih bab I, ki v tem pogledu približno ustreza vzorcu Potočke zijalke. Naravno okolje je v Potočki zijalki alpinsko, v Divjih babah I, hribovsko, sedimentno okolje pa je v obeh najdiščih podobno. Razen tega gre za podoben tip najdišča, tj. kombinacijo paleolitskega zavetišča in medvedjega brloga.

Glede na naštete razlike je pričakovati razlike tudi v ZSD, ki je podana v *tab. 12.4.1, 12.4.8* in *12.4.9*. *Sl. 12.4.15a, b* kaže, da so te razlike v ZSD in to kljub temu, da sva izenačila število najdb skeletnih delov in časovni razpon, ki ga obsegata vzorca, tako da v obeh primerih znaša približno 2.000 let. Te razlike, ki so najizrazitejše pri starostnih skupinah in velikih dolgih kosteh okončin, so celo večje kot razlike med facijama A in B (*sl. 16a, b*). To po najinem mnenju dokazuje, da je veliko laže ugotoviti razlike med najdišči kot znotraj njih, čeprav gre v obeh primerih za velik časovni odmik med vzorci. Zato domnevava, da so izrazite razlike med najdiščema bodisi metodološke narave bodisi tafonomske. Na slednje nedvomno vpliva razmerje med starostnimi skupinami, ki je bilo zelo verjetno različno pri živi populaciji, prisotni v prvem in drugem najdišču.

Kako zanesljive so razlike med najdiščema, temelječe na starostni strukturi ZSD, sva ugotovila s testiranjem razmerja adultni : juvenilni skeletni deli s testom "hi kvadrat". Vrednost "p" v *tab. 12.4.8* označuje verjetnost od 0 (0 %) do 1 (100 %), da je razmerje v Divjih babah I enako razmerju v Potočki zijalki. Vrednosti, ki so manjše od 0,05, pomenijo, da ni enakosti z verjetnostjo, večjo od 95 %. Isti postopek sva ponovila pri razmerju juvenilni : neonatni skeletni deli.

V razmerju adultni : juvenilni skeletni deli ni zanesljive razlike med najdiščema samo pri sedmih skeletnih delih od skupno 25. Razlike največkrat ni pri vzorcu facije B in vzorcu Potočke zijalke (*tab. 12.4.8*). Za facijo B je značilno relativno manj ostankov mladičev in posledično povečanje števila samcev, kar je tudi značilnost vzorca Potočke zijalke (Debeljak 2004, 179). Rezultati testa "hi kvadrat" so skladni s pričakovanji in kažejo na različne naravne in umetne okoliščine, ki so vplivale na oblikovanje analiziranih vzorcev. Med naravnimi okoliščinami je treba vsekakor omeniti starostno strukturo žive populacije, ki se lahko odslikava v fosilni populaciji.

Razmerja adultni : juvenilni skeletni deli so v obeh najdiščih zelo verjetno različna ($p < 0{,}01$). V vzorcu Potočke zijalke je več skeletnih delov skupine *adultus* kot v časovno nestratificiranem vzorcu Divjih bab I, kjer je zato več skeletnih delov skupine *juvenilis.*

V razmerju juvenilni : neonatni skeletni deli ni zanesljive razlike med najdiščema kar pri 16 skeletnih delih od skupno 24 (*tab. 12.4.9*). Faciji A in B sta skoraj izenačeni po številu skeletnih delov, katerih razmerja niso drugačna od razmerij v vzorcu Potočke zijalke. Kaj je vzrok za to, je težko odgovoriti zaradi metodoloških pomanjkljivosti, povezanih z natančnostjo pobiranja skeletnih delov skupine *neonatus* in z arbitrarnim razlikovanjem med skupino *juvenilis* in *neonatus* pri določenih skeletnih delih.

Razmerja juvenilni : neonatni skeletni deli so v obeh najdiščih verjetno podobna ($p = 0{,}08$), čeprav kaže, da je v časovno nestratificiranemu vzorcu Divjih bab I več juvenilnih skeletnih delov kot v vzorcu Potočke zijalke.

PRIMERJAVA Z JAMO CHAUVET

V francoski jami Chauvet so se podobno kot v Grotta degli Orsi na slovensko-italijanski meji ohranila fosilna tla s skeletnimi ostanki jamskega medveda (Fosse, Philippe 2005). Doslej so na tleh več kot 200 m dolge jame zabeležili 3.703 skeletne dele jamskega medveda, od tega 190 bolj ali manj celih lobanj brez spodnjih čeljustnic. Časovni razpon vseh skeletnih najdb je bil z metodo ^{14}C določen na največ 18.000 radiokarbonskih let. To nedvomno kaže na daljši zastoj v sedimentaciji. Najdišče, ki je sicer bolj poznano po najstarejših poslikavah, nama lahko služi za primerjavo skeletnih ostankov jamskega medveda, najdenih v jamah brlogih. Jama Chauvet je bila poleg svetišča namreč nedvomno tudi brlog jamskega medveda.

Med Divjimi babami I in jamo Chauvet je več razlik kot podobnosti. Razlike so v fragmentaciji, starostni in spolni sestavi ter zastopanosti skeletnih delov. Podobnosti so v kaotičnih grupacijah skeletnih delov, ki se le izjemoma nahajajo v anatomski legi, v položaju lobanj in nekaterih večjih kosti ter v nesorazmerju med zgornjimi in spodnjimi čeljustnicami.

Površinski ostanki v jami Chauvet so večinoma celi. Za Divje babe I je značilna ekstremna fragmentacija vseh večjih skeletnih delov v vseh stratigrafskih nivojih, ki jih lahko enačiva z nekdanjim površjem. Čeprav kaže, da hitrost sedimentacije ne vpliva na stopnjo fragmentacije, je treba biti previden, ker so bili v jami Chauvet možni občasni vdori vode, ki je lahko odplavila manjše fragmente in skeletne dele.

Večina ostankov iz jame Chauvet pripada odraslim živalim, v Divjih babah I pa mladičem. V jami Chauvet so to predvsem velike dolge kosti okončin, v Divjih babah I majhne kosti šap.

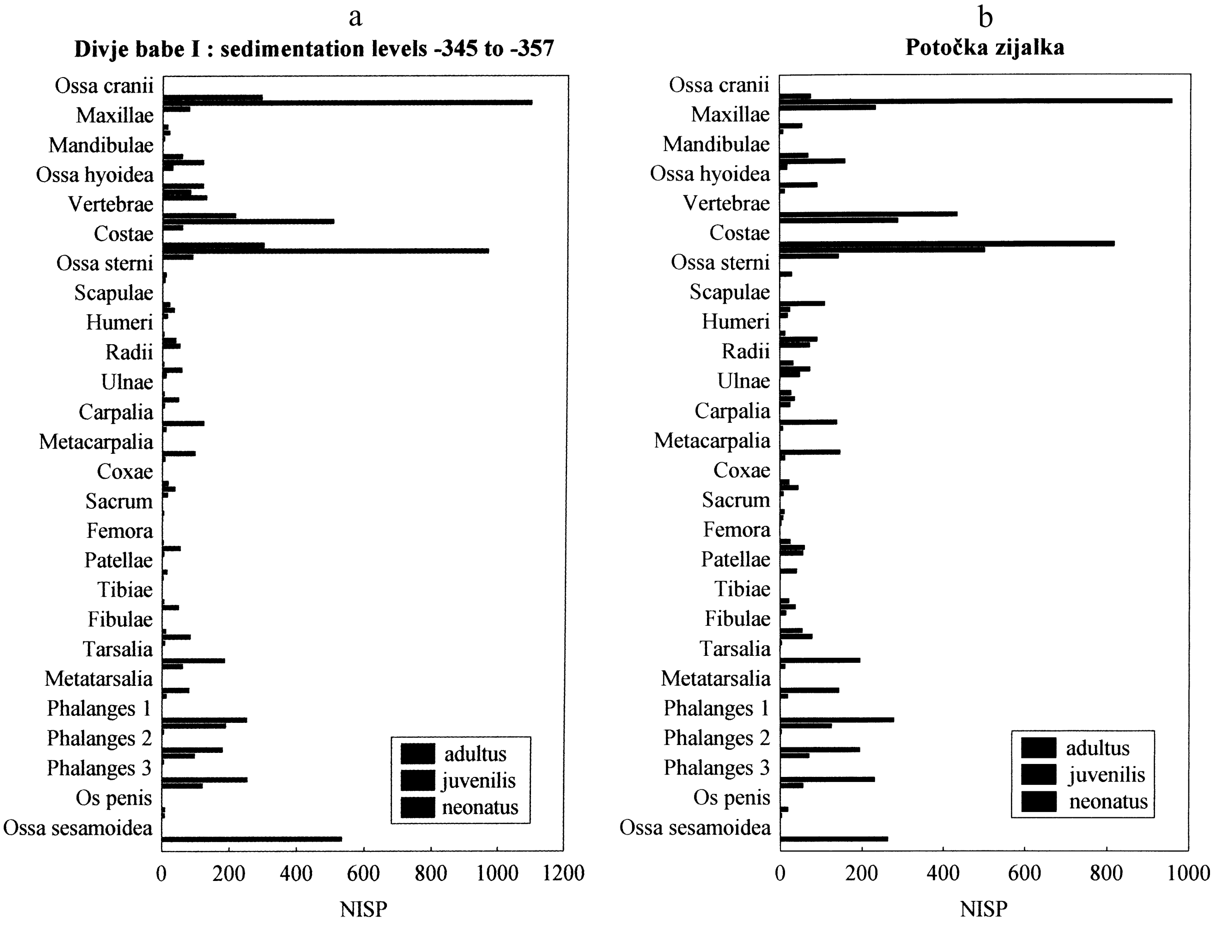
V Divjih babah I lahko na veliko več skeletnih delov oceniva manj medvedov kot je to mogoče v jami Chauvet, kjer jih je na podlagi lobanj najmanj 190. V posameznem sedimentacijskem nivoju facije B v bloku sedimentov, kjer je število določljivih skeletnih delov približno enako kot v jami Chauvet, je ocena največ 44 osebkov s stalnim zobovjem.

Tab. 12.4.8: Primerjava adultnih in juvenilnih skeletnih delov v Divjih babah I in Potočki zijalki.
Tab. 12.4.8: Comparison of adult and juvenile skeletal parts in Divje babe I and Potočka zijalka.

Bone	Divje babe I (Facies)	Potočka zijalka	"p" Chi2 Terst
Ossa cranii adul.	538 (A)	76	0.00
juv.	9447 (A)	955	
adul.	1443 (B)	76	0.00
juv.	12434 (B)	955	
Maxillae adul.	14 (A)	55	0.00
juv.	267 (A)	10	
adul.	68 (B)	55	0.00
juv.	281 (B)	10	
Mandibulae adul.	130 (A)	70	0.00
juv.	517 (A)	160	
adul.	445 (B)	70	0.00
juv.	981 (B)	160	
Ossa hyoidea adul.	229 (A)	92	0.00
juv.	138 (A)	13	
adul.	604 (B)	92	0.00
juv.	599 (B)	13	
Vertebrae adul.	476 (A)	433	0.00
juv.	1592 (A)	289	
adul.	1668 (B)	433	0.00
juv.	4142 (B)	289	
Costae adul.	574 (A)	816	0.00
juv.	1895 (A)	501	
adul.	1893 (B)	816	0.00
juv.	6624 (B)	501	
Ossa sterni adul.	23 (A)	30	0.00
juv.	29 (A)	2	
adul.	102 (B)	30	0.00
juv.	98 (B)	2	
Scapulae adul.	66 (A)	110	0.00
juv.	131 (A)	25	
adul.	235 (B)	110	0.00
juv.	278 (B)	25	
Humeri adul.	14 (A)	14	0.29
juv.	139 (A)	91	
adul.	56 (B)	14	1.00
juv.	364 (B)	91	
Radii adul.	8 (A)	33	0.00
juv.	178 (A)	74	
adul.	72 (B)	33	0.00
juv.	421 (B)	74	
Ulnae adul.	15 (A)	28	0.00
juv.	101 (A)	36	
adul.	67 (B)	28	0.00
juv.	299 (B)	36	
Carpalia adul.	388 (A)	139	0.47
juv.	30 (A)	8	
adul.	1175 (B)	139	0.08
juv.	130 (B)	8	
Metacarpalia adul.	294 (A)	147	0.00
juv.	250 (A)	13	
adul.	820 (B)	147	0.00
juv.	229 (B)	13	
Coxae adul.	27 (A)	23	0.74
juv.	47 (A)	45	
adul.	99 (B)	23	0.39
juv.	247 (B)	45	
Sacrum adul.	3 (A)	11	0.03
juv.	12 (A)	8	
adul.	26 (B)	11	0.68
juv.	15 (B)	8	
Femora adul.	15 (A)	25	0.00
juv.	102 (A)	60	
adul.	48 (B)	25	0.00
juv.	400 (B)	60	
Patellae adul.	28 (A)	41	0.39
juv.	3 (A)	2	
adul.	114 (B)	41	0.04
juv.	24 (B)	2	
Tibiae adul.	36 (A)	22	0.05
juv.	118 (A)	38	
adul.	88 (B)	22	0.00
juv.	354 (B)	38	
Fibulae adul.	64 (A)	54	0.00
juv.	423 (A)	79	
adul.	124 (B)	54	0.00
juv.	785 (B)	79	
Tarsalia adul.	484 (A)	196	0.00
juv.	74 (A)	13	
adul.	1496 (B)	196	0.00
juv.	374 (B)	13	
Metatarsalia adul.	327 (A)	144	0.00
juv.	329 (A)	19	
adul.	692 (B)	144	0.00
juv.	329 (B)	19	
Phalanges I adul.	753 (A)	279	0.00
juv.	624 (A)	126	
adul.	2114 (B)	279	0.00
juv.	1622 (B)	126	
Phalanges II adul.	686 (A)	195	0.00
juv.	475 (A)	71	
adul.	1771 (B)	195	0.07
juv.	834 (B)	71	
Phalanges III adul.	832 (A)	232	0.00
juv.	324 (A)	56	
adul.	2214 (B)	232	0.03
juv.	747 (B)	56	
Os penis adul.	52 (A)	19	0.69
juv.	14 (A)	4	
adul.	101 (B)	19	0.05
juv.	62 (B)	4	
Ossa sesamoidea	6534	266	

Tab. 12.4.9: Primerjava juvenilnih in neonatnih skeletnih delov v Divjih babah I in Potočki zijalki.
Tab. 12.4.9: Comparison of juvenile and neonatal skeletal parts in Divje babe I and Potočka zijalka.

Bone	Divje babe I (Facies)	Potocka zijalka	"p" Chi2 Terst
Ossa cranii neon.	206 (A)	235	0.00
juv.	9447 (A)	955	
neon.	475 (B)	235	0.00
juv.	12434 (B)	955	
Maxillae neon.	2 (A)	0	0.78
juv.	267 (A)	10	
neon.	44 (B)	0	0.21
juv.	281 (B)	10	
Mandibulae neon.	24 (A)	19	0.00
juv.	517 (A)	160	
neon.	121 (B)	19	0.88
juv.	981 (B)	160	
Ossa hyoidea neon.	7 (A)	0	0.42
juv.	138 (A)	13	
neon.	382 (B)	0	0.00
juv.	599 (B)	13	
Vertebrae neon.	111 (A)	0	0.00
juv.	1592 (A)	289	
neon.	361 (B)	0	0.00
juv.	4142 (B)	289	
Costae neon.	240 (A)	144	0.00
juv.	1895 (A)	501	
neon.	650 (B)	144	0.00
juv.	6624 (B)	501	
Ossa sterni neon.	7 (A)	2	0.16
juv.	29 (A)	2	
neon.	8 (B)	2	0.00
juv.	98 (B)	2	
Scapulae neon.	15 (A)	20	0.00
juv.	131 (A)	25	
neon.	98 (B)	20	0.00
juv.	278 (B)	25	
Humeri neon.	204 (A)	73	0.00
juv.	139 (A)	91	
neon.	303 (B)	73	0.83
juv.	364 (B)	91	
Radii neon.	38 (A)	49	0.00
juv.	178 (A)	74	
neon.	71 (B)	49	0.00
juv.	421 (B)	74	
Ulnae neon.	32 (A)	25	0.02
juv.	101 (A)	36	
neon.	78 (B)	25	0.00
juv.	299 (B)	36	
Carpalia neon.	1 (A)	0	0.61
juv.	30 (A)	8	
neon.	1 (B)	0	0.80
juv.	130 (B)	8	
Metacarpalia neon.	6 (A)	0	0.58
juv.	250 (A)	13	
neon.	3 (B)	0	0.68
juv.	229 (B)	13	
Coxae neon.	31 (A)	9	0.00
juv.	47 (A)	45	
neon.	112 (B)	9	0.03
juv.	247 (B)	45	
Sacrum neon.	2 (A)	4	0.25
juv.	12 (A)	8	
neon.	2 (B)	4	0.16
juv.	15 (B)	8	
Femora neon.	84 (A)	56	0.60
juv.	102 (A)	60	
neon.	92 (B)	56	0.00
juv.	400 (B)	60	
Patellae neon.	0 (A)	0	
juv.	3 (A)	2	
neon.	0 (B)	0	
juv.	24 (B)	2	
Tibiae neon.	8 (A)	15	0.00
juv.	118 (A)	38	
neon.	7 (B)	15	0.00
juv.	354 (B)	38	
Fibulae neon.	22 (A)	4	0.96
juv.	423 (A)	79	
neon.	150 (B)	4	0.00
juv.	785 (B)	79	
Tarsalia neon.	2 (A)	1	0.39
juv.	74 (A)	13	
neon.	2 (B)	1	0.00
juv.	374 (B)	13	
Metatarsalia neon.	10 (A)	0	0.45
juv.	329 (A)	19	
neon.	4 (B)	0	0.63
juv.	329 (B)	19	
Phalanges I neon.	18 (A)	3	0.76
juv.	624 (A)	126	
neon.	72 (B)	3	0.29
juv.	1622 (B)	126	
Phalanges II neon.	17 (A)	0	0.11
juv.	475 (A)	71	
neon.	45 (B)	0	0.05
juv.	834 (B)	71	
Phalanges III neon.	8 (A)	0	0.24
juv.	324 (A)	56	
neon.	20 (B)	0	0.22
juv.	747 (B)	56	
Os penis neon.	0 (A)	0	
juv.	14 (A)	4	
neon.	4 (B)	0	0.61
juv.	62 (B)	4	



Sl. 12.4.15a, b: Primerjava zastopanosti skeletnih delov (ZSD) v dveh sedimentacijskih nivojih Divjih bab I, katerih skeletni deli so se nabrali v dva do tri tisoč letih (a), in Potočki zijalki, kjer so se kosti nabirale približno enako dolgo (b). Vsaka skupina treh paličic v grafu predstavlja tri ontogenetske starostne skupine (adultni, juvenilni, neonati) v zastopanosti določenega skeletnega dela.
Fig. Sl. 12.4.15a, b: Comparison of representation of skeletal parts (RSP) in two sedimentation levels of Divje babe I, in which skeletel parts accumulated over two to three thousand years (a) and Potočka zijalka with approximately the same time period of accumulation (b). Each group of three bars in the graph represents three ontogenetic age groups (adult, juvenile, new born) in the representation of a specific skeletel part.

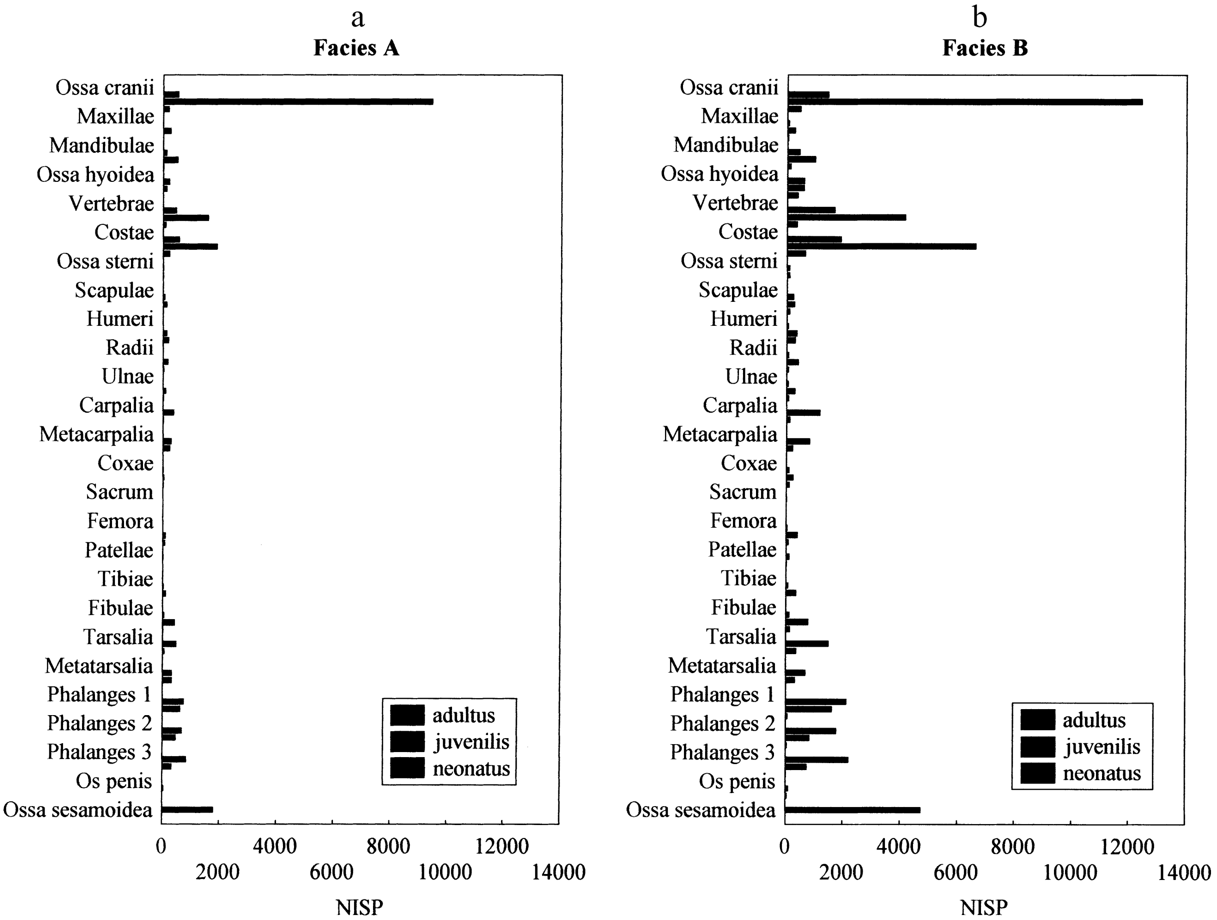
Večina celih lobanj v obeh najdiščih je ležala z bazo navzdol. Vsaj ena lobanja v Chauvetu in dve v Divjih babah I sta bili obrnjeni, tako da sta ležali s temenom navzdol. Skupaj z lobanjami jamskega medveda je bila v obeh najdiščih odkrita ena cela lobanja rjavega medveda. Cele lobanje so v Divjih babah I redkost. Nekatere večje kosti so bile v obeh najdiščih navpično ali poševno zasajene. Večino takšnih primerov lahko vsaj v Divjih babah I razloživa s krioturbacijo. Vendar tega ne gre posploševati, ker so lahko prisotne tudi izjeme. V obeh najdiščih je bistveno več spodnjih čeljustnic kot zgornjih oz. lobanj (Fosse, Philippe 2005, sl. 5). Za jamo Chauvet se domneva, da so del lobanj v dvorano z lobanjami prinesli ljudje, ki so jamo poslikali.

Podrobnejša kvantitativna primerjava med najdiščema žal ni mogoča zaradi pomanjkanja primerljivih podatkov, vendar se iz povedanega da slutiti, da so ljudje od nekdaj na različne načine ravnali s skeletnimi ostanki jamskega medveda v jamah brlogih. Vprašanje odnosa človek – jamski medved (Turk 2003b), ki ga je mogoče preučevati samo na podlagi materialnih ostankov, je še vedno daleč od rešitev, ki bi bile bistveno boljše od starih, toliko kritiziranih razlag.

12.5. SKLEP

V predhodnih podpoglavjih sva opozorila na posamezne nepravilnosti v vzorcu fosilnih ostankov, ki se kažejo med facijama A in B. Te nepravilnosti, ki bi jih lahko smiselno razložila tudi z delovanjem človeka, so:

1. Primanjklaj kaninov adultnih medvedov.
2. Fragmentacija lobanj adultnih medvedov oz. njihov primanjkljaj, ki se odslikava tudi v nesorazmerni zastopanosti zgornih in spodnjih stalnih izoliranih zob.
3. Fragmentacija nadlahtnice.
4. Fragmentacija golenice.



Sl. 12.4.16a, b: Primerjava ZSD v facijah A (a) in B (b) vzorca iz Divjih bab I. Vsaka skupina treh paličic v grafu predstavlja tri ontogenetske starostne skupine v zastopanosti določenega skeletnega dela.

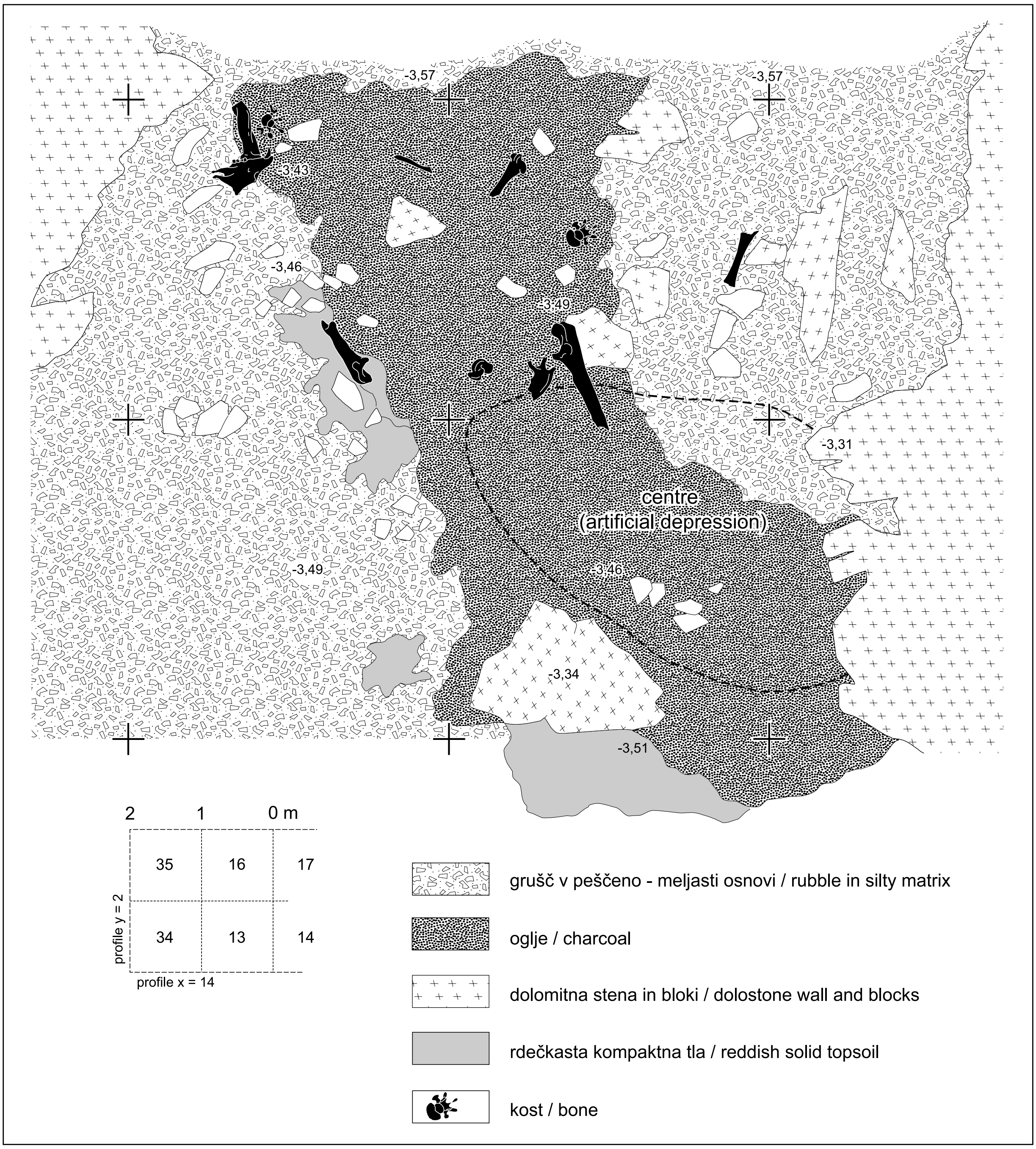
Fig. 12.4.16a, b: Comparison of RSP in facies A (a) and B (b) of a sample from Divje babe I. Each group of three bars in the graph represents three ontogenetic age groups in the representation of a specific skeletel part.

V sedimentacijskih nivojih analiziranega bloka so bili najdeni ostanki treh ognjišč, ki so med drugim opredeljeni z majhnimi odlomki zažganih kosti (glej podpoglavje 12.2 v tem zborniku, *tab. 12.2.1*). Ostanki najbolje ohranjenega in največjega ognjišča pripadajo sedimentacijskemu nivoju -333 cm (*sl. 12.5.1*). V bližini tega ognjišča sta bili najdeni tudi narobe obrnjeni lobanji medveda (inv. štev. 2349, biometrični podatki so podani poglavje 14 v tem zborniku, *tab. A*) in medvedke (inv. štev. 2033, glej prav tam), orientirani zahod-vzhod in vzhod-zahod. Lobanja medvedjega samca, ki je imela pogled usmerjen na zahod, je imela štiri umetne luknje in posmrtno povečan *foramen occipitale magnum.* To ognjišče je dalo tudi največ zažganih kostnih odlomkov in velike količine drevesnega oglja (glej poglavje 8 v tem zborniku). Manjše, slabše ohranjeno ognjišče je bilo v sedimentacijskem nivoju -213 cm, najmanjše in najslabše ohranjeno pa v sedimentacijskem nivoju -405 cm. Slednje je dalo tudi najmanj zažganih kostnih odlomkov. Prvi dve ognjišči sta delovali v obdobju najbolj mrzle klime, tretje pa v zmerni klimi. Več o ognjiščih bo podano v drugem delu monografije.

Primerjava lobanjskih, maksilarnih in mandibularnih fragmentov ter kaninov, humerusov in tibij v ognjiščnih nivojih z ostalimi sedimentacijskimi nivoji z uporabo tehnike dvodimenzionalnega skaliranja (MDS) je dala rezultat, ki neodvoumno podpira tezo o udejstvovanju paleolitskega človeka vsaj na naštetih delih jamskega medveda.

Za analizo MDS sva vse podatke najprej standardizirala, in sicer ločeno po sedimentacijskih nivojih. Nato sva izdelala matrike nestandardiziranih evklidskih razdalj, v katerih ima vsak sedimentacijski nivo srednjo vrednost 0 in standardno odstopanje 1. Matrike so bile izdelane posebej za juvenilne in adultne primerke, enkrat z zažganimi kostnimi fragmenti, drugič brez njih. Shepardovi diagrami in majhne vrednosti *stresa* (0,009-0,09), jamčijo, da dve dimenziji zadostujeta za ugotavljanje podobnosti oz. različnosti med ognjiščnimi in sedimentacijskimi nivoji.

Sl. 12.5.2a, v kateri smo med drugim upoštevali tudi zažgane kosti, kaže, da vsi sedimentacijski nivoji in ognjiščni nivo -405 cm tvorijo eno homogeno skupino. Preostala dva ognjiščna nivoja in nekateri sedimentacijski

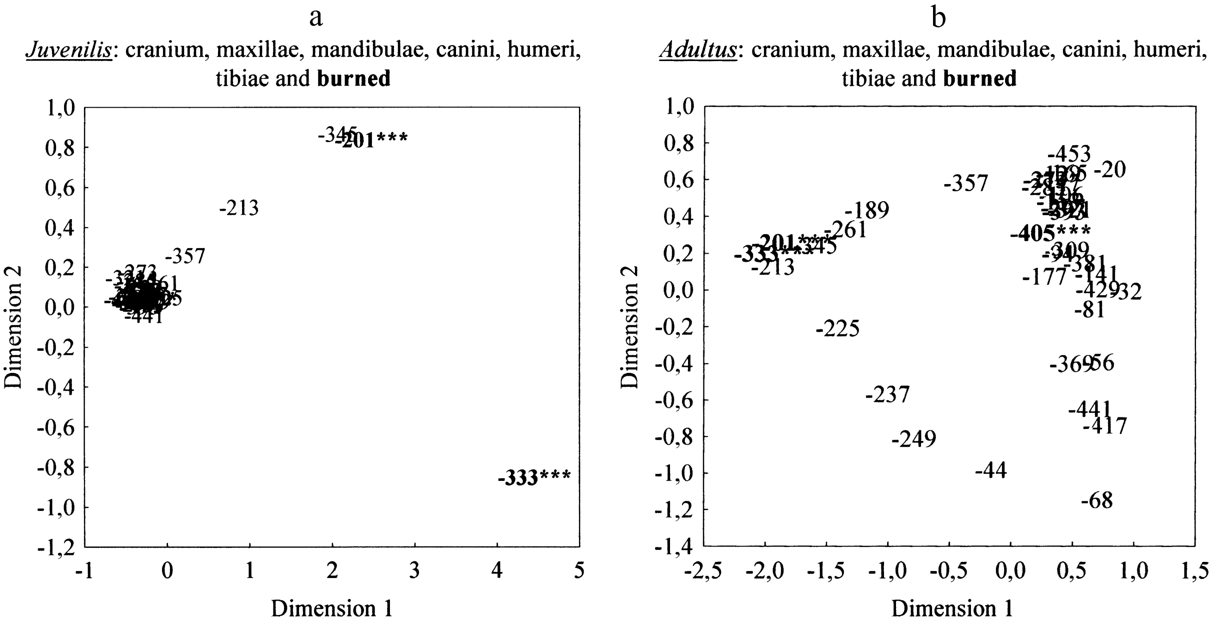


Sl. 12.5.1: Tloris ognjišča v sedimentacijskem nivoju –333 cm (plasti 8). Risba I. Turk (svinčnik) in D. Knific Lunder (tuš).
Fig. 12.5.1: Groundplan of the hearth in sedimentation level –333 cm (Layer 8). Drawing I. Turk (pencil) and D. Knific Lunder (ink).

nivoji, ki so jima stratigrafsko najbližje, pa tvorijo ločene skupine tako po prvi kot po drugi dimenziji. Na podlagi takšne razporeditve ognjiščnih nivojev sklepava, da ljudje niso imeli opraviti z analiziranimi juvenilnimi ostanki jamskega medveda.

Drugače je z adultnimi ostanki, če vse ostalo ostane nespremenjeno (*sl. 12.5.2b*). Glavna ognjiščna nivoja –201 cm in –333 cm sta tesno skupaj. Sedimentacijski nivoji, ki so jima stratigrafsko najbližji, tvorijo z njima ohlapno skupino, ki pa ima svojo notranjo logiko glede na evklidsko razdaljo med nivoji. Stranski ognjiščni nivo –405 cm tvori s preostalimi sedimentacijskimi nivoji veliko skupino, ki jo od prve loči druga dimenzija. Takšna razporeditev dveh glavnih ognjiščnih in nekaterih drugih sedimentacijskih nivojev naju privede do sklepa, da so ljudje vplivali na adultne ostanke jamskega medveda.

Ker vplivajo na združevanje ognjiščnih in njim stra-



a

Juvenilis: cranium, maxillae, mandibulae, canini, humeri, tibiae and **burned**

b

Adultus: cranium, maxillae, mandibulae, canini, humeri, tibiae and **burned**

Sl 12.5.2a, b: Grafični prikaz rezultata dvodimenzionalnega skaliranja na podlagi lobanjskih, maksilarnih in mandibularnih fragmentov, kaninov, humerusov in tibij za juvenilne (a) in adultne primerke (b), zažganih kostnih odlomkov in evklidskih razdalj (stres = 0,009 in 0,05). Pri humerusih in tibijah so zajete tako cele kosti kot odlomljene diafize in epifize. Zažgane kostne odlomke ni bilo mogoče deliti na juvenilne in adultne. Vsi podatki so zbrani v *tab. 12.2.1, 12.3.1* in *12.4.1* oz. *12.4.5.*

Fig. 12.5.2a, b: Graphic presentation of the result of two-dimensional scaling on the basis of skull, maxillary and mandibular fragments, canines, humeruses and tibiae for juvenile (a) and adult specimens (b), burned bone fragments and Euclidian distances (stress = 0.009 and 0.05). With humeruses and tibiae, both whole bones and broken diaphyses and epiphyses are included. Burned bone fragments could not be divided into juvenile and adult. All data are collected in *Tab. 12.2.1, 12.3.1* and *12.4.1* or *12.4.5.*

tigrafsko bližnjih nivojev pri adultnih ostankih predvsem zažgane kosti, sva v nadaljevanju analitskega postopka te izločila (*sl. 12.5.3a,b*). Tako sva dobila popolnoma nepristransko sliko domnevnega posega človeka v ostanke jamskega medveda.

Pri juvenilnih ostankih ognjiščni in sedimentacijski nivoji ne tvorijo skupin po nobeni dimenziji (*sl. 12.5.3a*). Trije ognjiščni nivoji so močno oddaljeni drug od drugega, kar pomeni, da se ljudje niso ukvarjali z juvenilnimi ostanki ali vsaj ne na enak način.

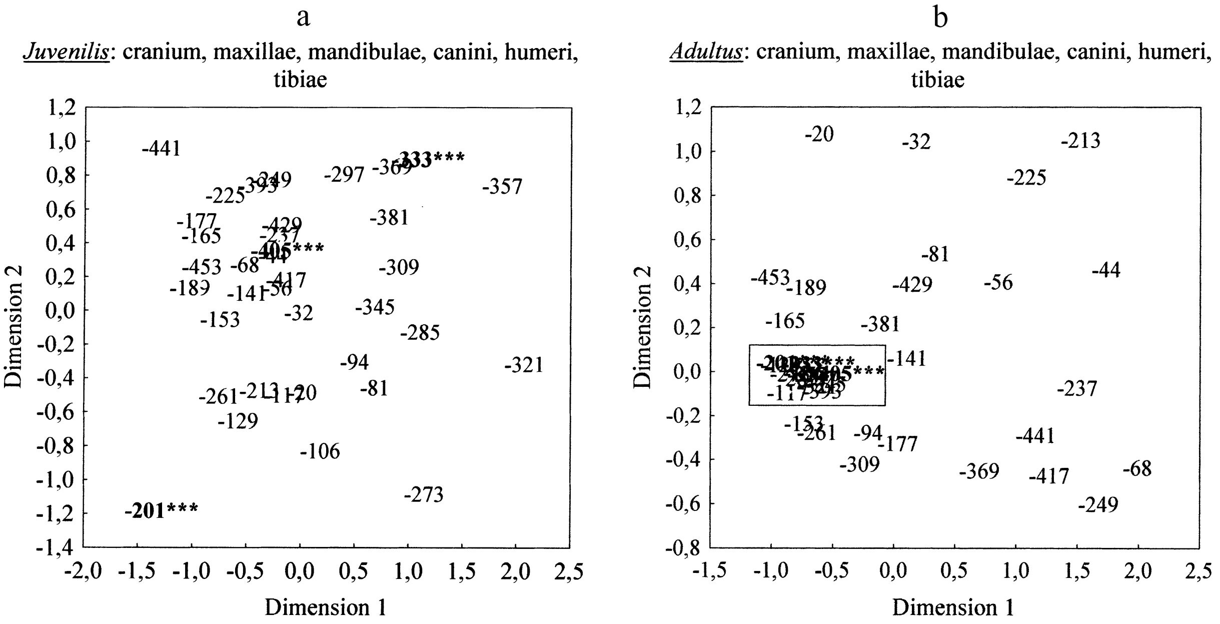
Drugače je zopet z adultnimi ostanki, če vse ostalo ostane nespremenjeno (*sl. 12.5.3b*). Vsi ognjiščni nivoji tvorijo z desetimi drugimi nivoji homogeno skupino, ki se loči od oblaka z ostalimi sedimentacijskimi nivoji. Homogeno ognjiščno skupino predstavljajo pri najpomembnejšem ognjiščnem nivoju -333 cm glede na prvo dimenzijo tudi trije sedimentacijski nivoji (-321 cm, -345 cm in -357 cm), ki so mu stratigrafsko najbližji (*sl. 12.5.4).* Ker sva tokrat skalirala ostanke brez zažganih kosti, predstavlja homogena ognjiščna skupina zanesljivo vzorec ostankov jamskega medveda, ki ga je preoblikoval človek. In kaj je značilno za ta vzorec:

Prvič odnašanje (premeščanje) in/ali razbijanje lobanj odraslih medvedov. Namen ni znan. Lahko gre za čisto ekonomski interes, lahko tudi za karkoli drugega. Nenavadna lega lobanj štev. 2033 in 2349, ki je nabita s simboliko, namiguje na neko obliko čaščenja medvedjega para.

Drugič odnašanje (premeščanje) kaninov popolnoma odraslih medvedov. Namen ni znan. Lahko bi šlo za zbiranje trofej, lahko da so imeli kanini uporabno vrednost.

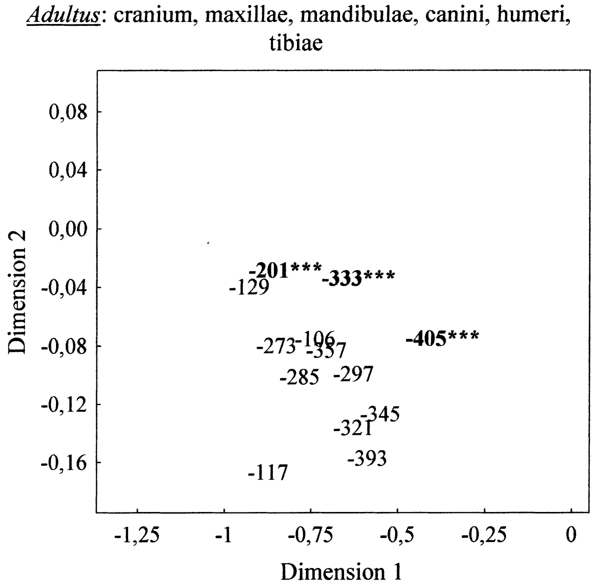
Tretjič odnašanje (premeščanje) in/ali razbijanje nadlahtnic in golenic. V tem primeru je verjetno šlo izključno za ekonomski interes, tj. pridobivanje mozga in maščob.

Seveda je lahko bilo posegov človeka v ostanke jamskega medveda bistveno več, vendar se ne dajo izslediti in še manj dokazati. Ker so zareze in druge poškodbe, ki nastanejo pri odiranju in razteleševanju skrajno redke (glej podpoglavje 12.2 v tem zborniku, *tab. 12.2.1*), lahko trdiva, da jamskega medveda v Divjih babah I zanesljivo niso lovili. O lovu in obdelavi plena pa bomo povedali več v drugem, arheološkem delu monografije.



Sl. 12.5.3a, b: Grafični prikaz rezultata dvodimenzionalnega skaliranja na podlagi lobanjskih, maksilarnih in mandibularnih fragmentov, kaninov, humerusov in tibij za juvenilne (a) in adultne primerke (b) in evklidskih razdalj (stres = 0,09 in 0,03). Pri humerusih in tibijah so zajete tako cele kosti kot odlomljene diafize in epifize. Vsi podatki so zbrani v *tab. 12.2.1, 12.3.1* in *12.4.1* oz. *12.4.5.*

Fig. 12.5.3a, b: Graphic presentation of the result of two-dimensional scaling on the basis of skull, maxillary and mandibular fragments, canines, humeruses and tibiae for juvenile (a) and adult specimens (b) and Euclidian distances (stress = 0.09 and 0.03). With humeruses and tibiae, both whole bones and broken diaphyses and epiphyses are included. All data are collected in *Tab. 12.2.1, 12.3.1* and *12.4.1* or *12.4.5.*



Sl. 12.5.4: Grafični prikaz rezultata dvodimenzionalnega skaliranja na podlagi lobanjskih, maksilarnih in mandibularnih fragmentov, kaninov, humerusov in tibij za adultne primerke in evklidskih razdalj (stres = 0,03) za uokvirjeno skupino na *sl. 12.5.3b.* Pri humerusih in tibijah so zajete tako cele kosti kot odlomljene diafize in epifize. Vsi podatki so zbrani v *tab. 12.2.1, 12.3.1* in *12.4.1* oz. *12.4.5.*

Fig. 12.5.4: Graphic presentation of the result of two-dimensional scaling on the basis of skull, maxillary and mandibular fragments, canines, humeruses and tibiae for adult specimens and Euclidian distances (stress = 0.03) for the outlined group in *Fig. 12.5.3b.* With humeruses and tibiae, both whole bones and broken diaphyses and epiphyses are included. All data are collected in *Tab. 12.2.1, 12.3.1* and *12.4.1* or *12.4.5.*

12. CAVE BEAR AT THE DIVJE BABE I SITE: TAPHONOMIC-STRATIGRAPHIC ANALYSIS

IVAN TURK and JANEZ DIRJEC

12.1. INTRODUCTION TO TAPHONOMIC ANALYSIS

Abstract

All remains of cave bear obtained by wet sieving on sieves of gauge 0.5 mm, 3 mm and 10 mm, from a block of stratified sediments with a volume of 95 m^3 from area B and part of area A of the excavation field (*Fig. 1.3*), were systematically processed quantitatively and qualitatively. Since the sediments of all stratigraphic units, i.e., sedimentation levels, in the block have the same volume (see Chapter 1 in this volume), in processing the finds it was not necessary to operate with their shares or to weight the finds. The block of sediments represents only 5% of all available volume in the stratigraphic series of the site, but is sufficiently representative in cases when it contains large numbers of finds and analytical data, which is normal for a block (see *Tab. 12.2.1, 12.3.1* and *12.4.1*). An additional experiment showed that only data collected in sedimentation levels with an area greater than 15 m^2 are entirely reliable (see *Fig. 1.4a, b; 1.5a, b; Tab. 1.2; 1.3*). The area of each sedimentation level in the block was 21 m^2.

12.2 ISOLATED TEETH

Abstract

The authors analysed isolated teeth quantitatively and qualitatively in a block of sediments divided into two parts (Facies A and B), which together cover 35 stratigraphic units, i.e., sedimentation levels. They found that there are more milk teeth in Facies A (*Fig. 12.2.1*), but fewer milk canines, including canines with resorbed roots (*Fig. 12.2.9a,b*). There are also more lower teeth (*Fig. 12.2.3*) and adult canines (*Fig. 12.2.7a,b*), as well as tooth fragments (*Fig. 12.2.2*). They explain the differences by changes in the structure of the bear population present in the cave, which was influenced by climate, mainly precipitation and the activities of palaeolithic man, who presumable carried off skulls and canines. The differences in the facies are in accordance with differences that are based exclusively on sedimentological data. It is not possible to distinguish between layers on the basis of individual finds of teeth.

12.3. FRAGMENTATION OF ANATOMICALLY DEFINABLE BONES AND OTHER CHARACTERISTICS OF BONE REMAINS

Abstract

The authors analysed bone remains quantitatively and qualitatively in a block of sediments divided into two parts (Facies A and B), which together cover 35 stratigraphic units, i.e., sedimentation levels. They found that the bones of juvenile and neonatal individuals are more fragmented than the bones of adult individuals in both facies. In the group of *juvenilis* and *neonatus* there is an average of ten times more fragments per whole bones than in the group *adultus*. There are on average fifteen times more juvenile than adult diaphyses (see *Tab. 12.3.1*). All bone fragments in Facies A are smaller and more numerous (*Fig. 12.3.4a, b; Fig. 12.3.5*). There are more bones with traces of biting in Facies A (*Fig. 12.3.7*), and juvenile and neonatal bones are more fragmented (*Fig. 12.3.8a, b; Fig. 12.3.9a, b*). In Facies A, there are more bones of juvenile individuals in the upper part (*Fig. 12.3.10*). The authors explain the differences between facies by the activity of carnivores and humans, and the difference within Facies A by changes in the structure of the bear population present in the cave. The differences between facies are in accordance with differences that are based exclusively on sedimentological data. Differentiation between individual layers is not possible on the basis of bone finds.

In connection with the heading »gnawed bones« in *Tab. 12.3.1* the authors stress that there are no pierced bones among them. There are only those with the impressions of teeth on juvenile metaphyses, and exceptionally on adult epiphyses (see *Tab. 12.3.1*). There is only one "pierced" bone in the entire sample, on the proximal metaphysis of a juvenile femur, with a etched hole, found in quadrat 23 at a depth of -273 cm. They stress this in particular because of the bitter polemics about the find of a suspected bone flute in quadrat 17 at a depth of -285 cm, which some experts try to explain as the product of carnivore activity, referring to the general phenomenon of pierced bones at sites with cave bear (d'Errico *et al.* 2003, 35pp). Among 89,811 identifiable bones examined, there is only one bone pierced more than once, which is interpreted as a suspected flute (Turk *et al.* 1995b; 2005b) and one bone pierced a single time, which, in view of the position of the hole close to the epiphysis, may possibly be explained as a carnivore product. The first author and M. Brodar have already reported several times on the relatively small

number of other pierced bones from the site (Brodar 1999, Tab. 6: 8,9; Turk 1984–1986, 10; Turk *et al.* 2001b, Tab. 5, Fig. 19). Pierced bones in Divje babe I are in no sense a general phenomenon, but at most an exceptional phenomenon.

12.4. REPRESENTATION OF SKELETAL PARTS

Abstract

The authors quantitatively and qualitatively study the representation of skeletal parts among ontogenetic groups in the block of sediments from 35 stratigraphic units and two facies (A and B). They found differences in ontogenetic groups of skeletal parts such as *neonatus*, *juvenilis* and *adultus*. Juvenile skeletal parts are best represented, neonatal worst (*Fig. 12.4.1a–c*). Representation is worse with all groups in the upper part of the profile, where there are fewer skeletal parts (*Fig. 12.4.1a–c; Fig. 12.4.2*). The number of finds has a major impact on the representation of skeletal parts. The degree of fragmentation also has a certain influence. There are both quantitative and qualitative differences with some skeletal parts between the upper and lower parts of the profile (Facies A and B). In Facies A, there are more skull fragments, despite the smaller number of skulls (*Fig. 12.4.9a, b; Fig. 12.4.10a, b*) and there is also greater fragmentation of adult humeri and tibias (*Tab. 12.4.6*). The results of analysis and the exceptional find of a fairly complete adult skeleton of a cave bear female in Facies B, which lacks one each humerus and femur show that some large marrowbones could have been removed from the site, and skulls intentionally smashed.

In connection with skulls, the authors mention two exceptional finds of skulls, which may be evidence that palaeolithic people actually did something with them.

The first is the skull of an adult cave bear male no. 2349, found at the bottom of Layer 8 among rockfall blocks in quadrat 39, cut –333 cm (=sedimentation level –345 cm), 4 m away from a hearth. The skull has symmetrical holes in both massive spurs behind the mandibular articular depression (*fovea articularis mandibulae*) and the wider vicinity of the *foramen occipitale magnum* has been damaged after deposition or during removal of the brains. (*Fig. 12.4.11*). Certainly some minor damage occurred post-sedimentarily because of etching. The symmetry of the pair of holes behind the mandibular artcular depression is unusual. The position and size of the holes is similar unusual. The authors do not therefore exclude the possibility that the holes were made for the purpose of strongly attaching or hanging the skull. In addition, the skull lay on the vertex, which is also unusual, supported by two stones. The mouth was turned towards the west. In parallel with it, 12 cm higher lay on the vertex an additional skull of an adult cave bear, this time female no. 2033. This was undamaged, with the mouth turned towards the east with a slight deflection towards the south. Since the skulls were touching, it is not excluded that the deviation of skull no. 2033 occurred post-sedimentarily. Certainly all the aforementioned (position, orientation, sex, damage) is very difficult to explain by pure coincidence.

Finally, the authors compared the representation of skeletal parts in Divje babe I and two Aurignatian cave sites: Potočka zijalka in Slovenia (*Tab. 12.4.8, 12.4.9; Fig. 12.4.15a*) and Chauvet cave in France where a unique fossil floor was preserved. They found considerable differences, despite the similar types of site. They ascribe them to the different structures of cave bear population that visited these caves in more or less different time periods.

12.5. CONCLUSION

In the previous sub-chapters, we drew attention to individual anomalies in the sample of fossil remains, which show anomalies between Facies A and B. These anomalies, which could also be reasonably explained by human activity, are:

1. a lack of canines of adult individuals,
2. fragmentation of the skulls of adult individuals or their lack, which is also illustrated in the disproportionate representation of upper and lower permanent isolated teeth,
3. fragmentation of humeri,
4. fragmentation of tibias.

The remains of three hearths were found in the sedimentation levels of the analysed block, which were defined by, among other things, small fragments of charred bones (see sub-chapter 12.2 in this volume, *Tab. 12.2.1*). The remains of best preserved and biggest hearth belong to sedimentation level –333 cm (*Fig. 12.5.1*). Two inversely turned skulls of a male bear (inv. no. 2349, biometric data are given in Chapter 14 in this volume, *Tab. A*) and a female bear (inv. no. 2033, *ibid*) were found in the vicinity of this hearth, oriented west-east and east–west. The male skull, the gaze of which was directed to the west, had four artificial holes and enlarged *foramen occipitale magnum.* This hearth also provided the most charred bones fragments and a large amount of wood charcoal (see Chapter 8 in this volume). There was a smaller, poorly preserved hearth in sedimentation level –213 cm, and the smallest and least well preserved one in sedimentation level –405 cm. The latter also gave the fewest charred bone fragments. The first two hearths functioned in the period of the coldest climate, and the third in a moderate climate. More about the hearths will be given in the second part of the monograph.

Comparison of the skull, maxillary and mandibular fragments and canines, humeri and tibias in the hearth levels with other sedimentation levels using the technique of multi-dimensional scaling (MDS) gave a result that undoubtedly supports the thesis of activity of palaeolithic man at least in the enumerated parts of cave bear.

For the purposes of MDS analysis, all data was first standardised, i.e., separated into sedimentation levels. We then produced a matrix of non-standardised Euclidian distances in which each sedimentation level has a median value of 0 and standard deviation of 1. The matrices were produced individually for juvenile and adult specimens, once with charred bone fragments and a second time without them. Shepard diagrams and small values of *stress* (0.09–0.9), guarantee that the two dimensions are sufficient for establishing similarities or differences between the hearth and sedimentation levels.

Fig. 12.5.2a, in which among other things we also took into account charred bones, shows that all sedimentation levels and hearth level -405 cm form a homogeneous group. The other two hearth levels and some sedimentation levels that are stratigraphically closest to them form a separate group according to both the first and second dimension. On the basis of such a distribution of hearth levels, we conclude that people did not have anything to do with the analysed juvenile remains of cave bear.

It is otherwise with adult remains, if everything else remains unchanged (*Fig. 12.5.2b*). The main hearth levels -201 cm and -333 cm are close together. Sedimentation levels that are closest to them stratigraphically form a loose group with them, which has an internal logic in relation to Euclidian distances between levels. The unexpressive hearth level -405 cm forms a large group with other sedimentation levels, which the second dimension distinguishes from the first. Such a position (clustering) of the two main hearth and some other sedimentation levels leads us to the conclusion that people affected adult remains of cave bear.

Since charred bones have the main influence in the case of adult remains on the association of hearth levels and the sedimentation levels closest to them, we excluded these in the further analytical procedure (*Fig. 12.5.3a,b*). We thus obtained a completely impartial picture of the suspected influence of humans on the remains of cave bear.

In the case of juvenile remains, hearth and sedimentation levels form no group according to either dimension (*Fig. 12.5.3a*). The three hearth levels are greatly distant from each other, which means that people did not affect juvenile remains, or at least not in the same way.

It is again different with adult remains if everything else remains unchanged *(Fig. 12.5.3b)*. All hearth levels form a homogenous group with ten other levels, which is separated from cluster of other sedimentation levels. The three sedimentation levels (-321 cm, -345 cm and -357 cm) that are closest stratigraphically (*Fig. 12.5.4)* also form a homogenous hearth group with the most important hearth level -333 cm, in relation to the first dimension. Because this time we scaled the remains without charred bones, the homogenous hearth group represents a reliable sample of remains of cave bear which man reformed. The following is characteristic of this sample:

Firstly, removal (transferral) and/or smashing of the skulls of adult individuals. The purpose is not known. It could be for purely practical (economic) reasons, but could be something else. The unusual position of skulls no. 2033 and 2349, which is charged with symbolism, hints at some form of honouring of the bear couple.

Secondly, removal (transferral) of canines of completely adult individuals. The purpose is not known. It could have been collecting trophies, or the canines could have had some use value.

Thirdly, removal (transferral) and/or smashing of humeri and tibiae. In this case it was probably exclusively for economic reasons, i.e., getting at the marrow and fat.

There could of course have been essentially more human interference in the remains of cave bear, but this cannot be traced ,far less proved. Because incisions and other damage that occurs in skinning and dismembering are extremely rare (see sub-chapter 12.2 in this volume, *Tab. 12.2.1*), we can claim that cave bear in Divje babe I were reliably not hunted. We will say more about hunting and the processing of prey in the second, archaeological part of the monograph.

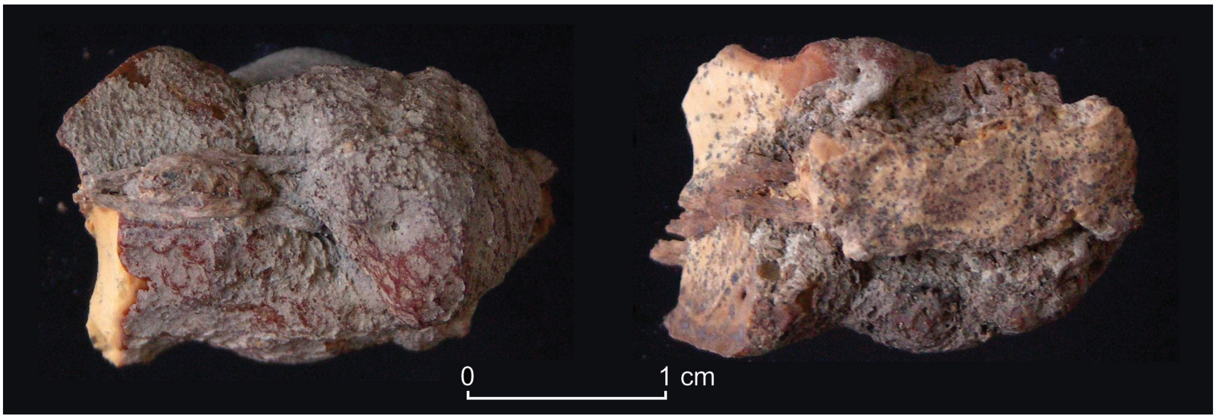
13. FOSILNE DLAKE JAMSKEGA MEDVEDA V NAJDIŠČU DIVJE BABE I

IVAN TURK in GREGOR KAPUN

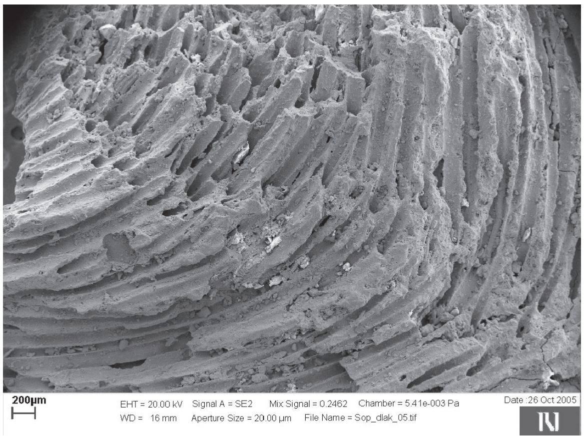
Mojemu zvestemu sopotniku na obiskih gora v spomin
(I. T.)

Med zanimivejša in redka odkritja v najdišču Divje babe I nedvomno sodijo najdbe fosiliziranih dlak (Turk *et al.* 1995a).

Za najdišče so značilni zelo številni ostanki skeleta in zobovja jamskega medveda (glej poglavje 12 v tem zborniku). Ti ostanki, ki pripadajo t. i. mrtvi oz. fosilni populaciji, ocenjeni na nekaj deset tisoč primerkov živali, predstavljajo samo majhen delež vseh jamskih medvedov, ki so se zadrževali v jami. Vsi mrtvi in živi medvedi so po jami natrosili milijone, če ne milijarde dlak. Zato je zelo verjetno, da so se nekatere dlake v posebnem sedimentnem okolju ohranile, bodisi v obliki odtiskov bodisi kot psevdomorfne oblike oz. fosili. To je bilo mogoče zaradi izrazito fosfatnega okolja, ki je idealno za ohranjanje najdb organskega izvora. Tako so se fosilizirali tudi koščki lesa (glej Paunović *et al.* 2002 in poglavje 8 v tem zborniku), ki prav tako sodijo med izjemne in redke najdbe. Medtem ko je bil fosiliziran les v paleolitskih jamskih najdiščih že večkrat omenjen (Pacher *et al.* 2004; Kaminská *et al.* 2005), za dlake to ne velja. Dlake pleistocenskih sesalcev (mamuta in dlakavega nosoroga) so bile izjemoma odkrite v drugačnih sedimentnih okoljih, predvsem v permafrostu in anaerobnem okolju (Kubiak, Dziurdzik 1973).

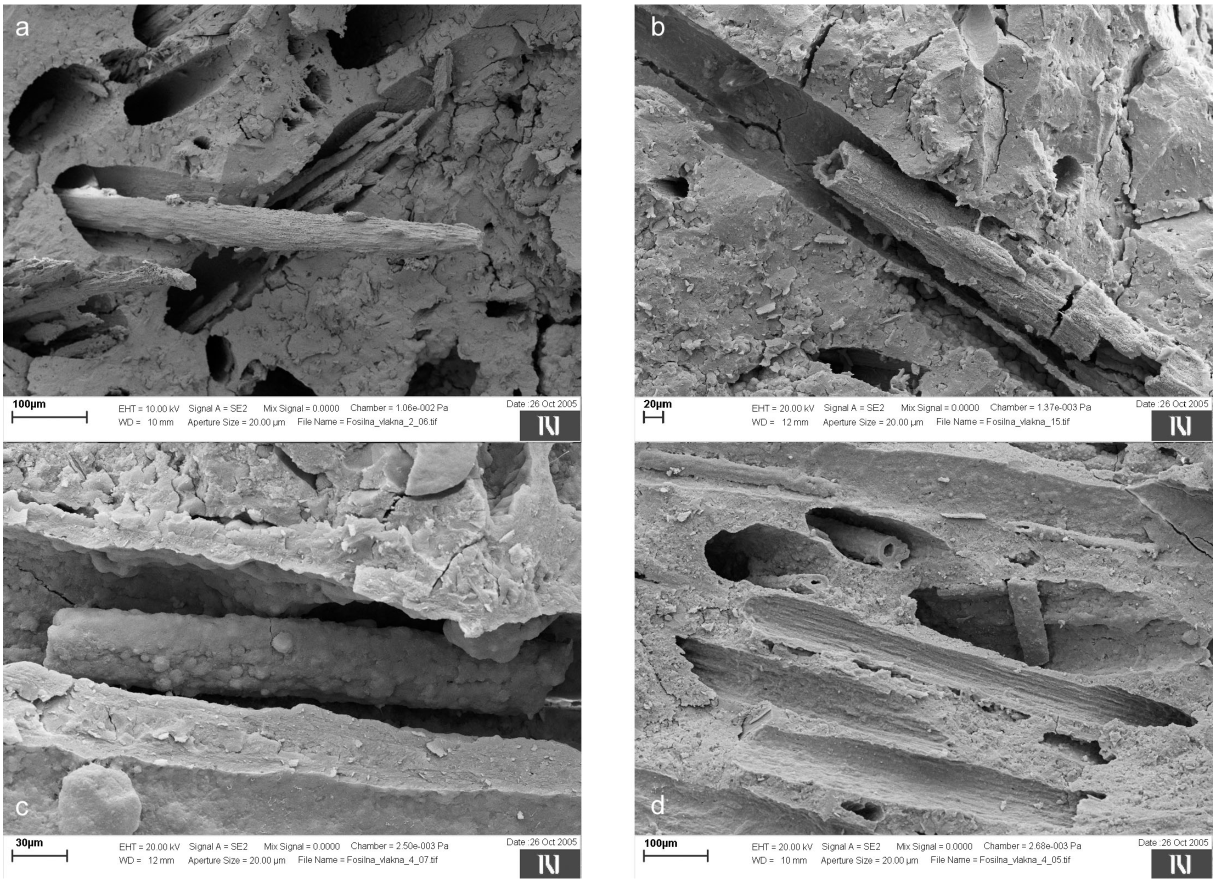


Sl. 13.1: Želatinast »agregat« s koščkom kosti. Fotografija I. Turk.
Fig. 13.1: Gelatinous »aggregate« with piece of bone. Photograph I. Turk.



Sl. 13.2: Elektronska slika odtisa domnevnega šopa dlak jamskega medveda. Največji premer posameznega odtisa je 0,16 mm. Skeniral G. Kapun.
Fig. 13.2: Electron image of the impression of a suspected tuft of cave bear fur. The maximum diameter of an individual impression is 0.16 mm. Scanned by G. Kapun.

Odtise dlak in psevdomorfne oblike dlak smo našli v zrnih strjene fosfatne želatine, ki vsebuje tudi redka dolomitna zrnca in kostne drobce. Želatina je v določenih primerih dobesedno zalila večje klaste in kosti (*sl. 13.1*). Na podoben način so se vanjo odtisnile posamezne dlake ali celi šopi dlak (*sl. 13.2*). Domnevne odtise dlak je prvi



Sl. 13.3a-d: Elektronska slika različnih vlaken, ki domnevno predstavljajo fosilizirane dlake jamskega medveda. Skeniral G. Kapun.
Fig. 13.3a-d: Electron image of various fibres thought to be fossilised cave bear fur. Scanned by G. Kapun.

avtor našel na površini nekaterih fosfatnih zrn, predvsem pa v njihovi notranjosti, ko je zrna prelomil. Zrn z odtisi dlak je bilo toliko kot je bilo agregatov z določenim kemijskim sestavom (*tab. 13.1*) in mineralno zgradbo v drobno gruščnati frakciji sedimenta (Turk 2006, sl. 8).

Dlake, ki jih je obdala želatina, so večinoma razpadle, ostali pa so njihovi odtisi v obliki kanalčkov. Prečni preseki kanalčkov so okrogli in ovalni, redkeje ledvičasti. Premer kanalčkov je od 0,02 mm do 0,22 mm. Površina kanalčkov je gladka ali vlaknasto ali bradavičasto strukturirana (*sl. 13.3a-d*). Pri vzdolžnih presekih daljših kanalčkov lahko vidimo, da se proti enemu delu zožujejo, kar je ena od značilnosti dlak (Turk 2003b, sl. 2).

V posameznih primerih so dlake v kanalčkih nadomestila anorganska vlakna, ki so dosti zvesto posnela obliko in zgradbo dlake, vključno s sredico ali medulo in luskasto povrhnjico ali kutikulo (*sl. 13.3a-d, 13.5a, b*) (Turk *et al.* 1995a, sl. 7a2). Večje odstopanje je samo v premeru kanalčkov in vlaken, ki domnevno predstavljajo dlake. Premer vlaken je običajno manjši od premera kanalčka in znaša 0,02-0,12 mm.

Pri rjavem medvedu so dlake podlanke praviloma okroglega do rahlo ledvičastega preseka in premera 0,05-0,09 mm. Dlake nadlanke so v preseku običajno okrogle do eliptične in redkeje ledvičaste oz. vbočeno-izbočene, premer pa se giblje od 0,11 mm do 0,20 mm (Kubiak, Dziurdzik 1973).

Zgradbo skorje in sredice domnevne fosilizirane dlake prikazuje *sl. 13.4a, b*. Podobnost s skorjo prave dlake, ki je pretežno sestavljena iz drobnih nitk keratina, in sredico je velika. Fosilizirano povrhnjico prikazuje *sl. 13.5a, b*.

Kemijski sestav zrn z odtisi dlak je lahko različen. Zrno na *sl. 13.3a* ima npr. na mikro lokaciji 400 mikro m^2 podobno sestavo, kot jo prikazuje *tab. 13.2*. Sicer so zrna sestavljena pretežno iz kalcija in fosforja (*tab. 13.1*). To je potrdila tudi geokemijska analiza peščeno-meljaste frakcije, ki vsebuje veliko agregatov (glej poglavje 5 v tem zborniku, *tab. 5.3.2*).

Kemijski sestav vlaken se malenkostno razlikuje od ene mikro lokacije do druge[1] in od vlakna do vlakna. Glavne sestavine so v vseh primerih Ca, P in Cu. Notranjost skorje vlakna na *sl. 13.4a* ima na dveh različnih mikrolokacijah podobno sestavo, kot je podana v *tab. 13.2*. Notranjost skorje vlakna na *sl. 13.4b* je sestavljena samo

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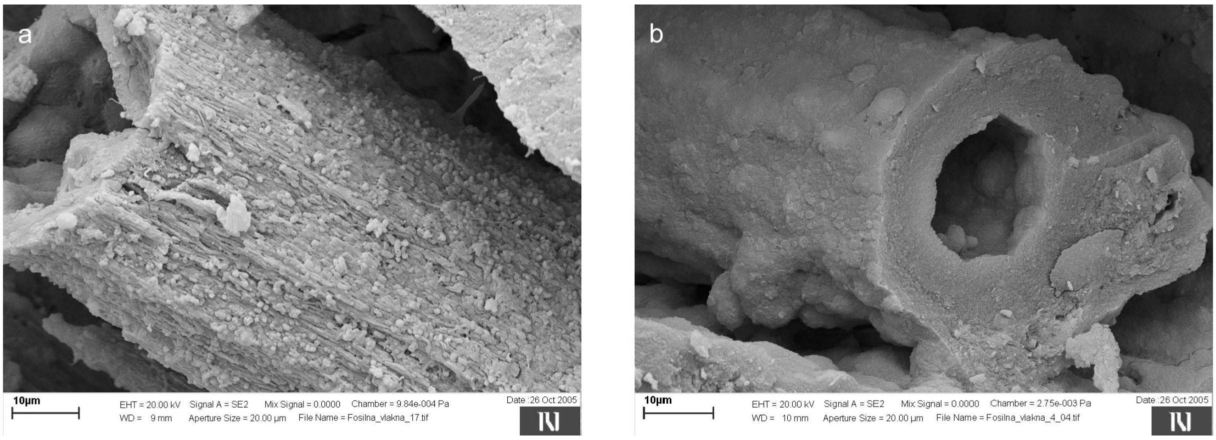
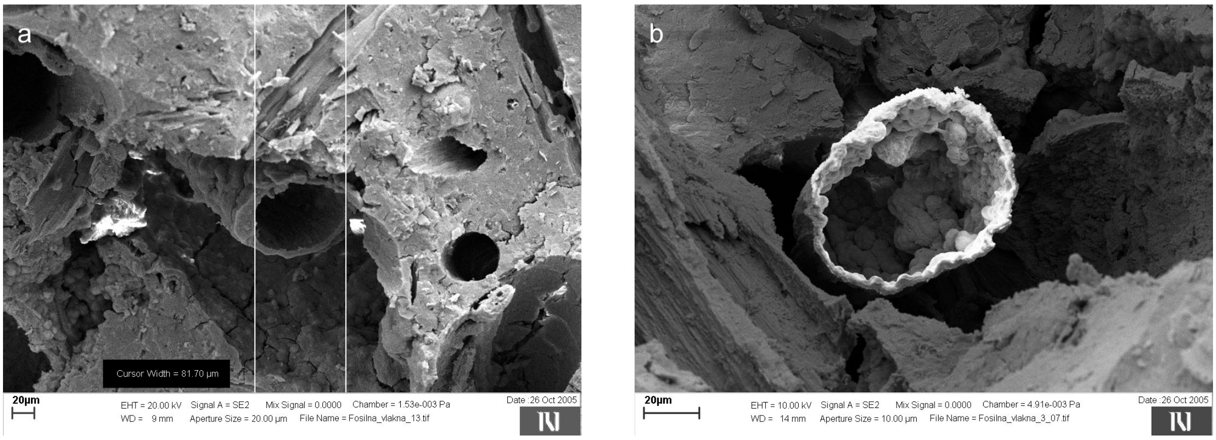
[1] Mišljena je mikrolokacija na vlaknu, na kateri je bila narejena kemijska analiza.



Sl. 13.4a, b: Elektronska slika skorje in sredice dveh različnih vlaken, ki domnevno predstavljata fosilizirano dlako jamskega medveda. Skeniral G. Kapun.
Fig. 13.4a, b: Electron image of cortex and medula of two different fibres thought to be fossilised cave bear fur. Scanned by G. Kapun.



Sl. 13.5a, b: Elektronska slika, ki domnevno predstavlja fosilizirano ovojnico dlake jamekage medveda. Skeniral G. Kapun.
Fig. 13.5a, b: Electron image considered to represent the fossilised wrapping (cuticula) of a cave bear hair. Scanned by G. Kapun.

iz P in Ca v razmerju 1 : 2 ter C in O. Notranjost skorje nekega drugega vlakna je na mikrolokaciji popolnoma brez fosforja.

Značilno za zrna in vlakna je, da vsebujejo relativno veliko bakra in da se med seboj kemijsko bistveno ne razlikujejo.

Tab. 13.1: Kemijski sestav sredice želatinaste mase na *sl. 13.1,* določen s spektrometrijo rentgenskih žarkov (EDS).
Tab. 13.1: Chemical composition of the interior of gelatinous mass in *Fig. 13.1,* analysed by energy dispersive spectrometry (EDS).

Element	Weight %	Atomic %
C K	19.97	21.37
O K	54.16	62.18
Mg K	0.34	0.26
Al K	0.39	0.26
Si K	0.51	0.33
P K	10.21	6.05
Ca K	20.83	9.55
Totals	100	

Tab. 13.2: Kemijski sestav vlakna na *sl. 13.3a* na mikrolokaciji 400 mikro m^2, določen s spektrometrijo rentgenskih žarkov (EDS).
Tab. 13.2: Chemical composition of fiber in *Fig. 13.3a* at micro-location of 400 micro m^2, analysed by energy dispersive spectrometry (EDS).

Element	Weight %	Atomic %
C K	21.19	44.20
O K	11.40	17.86
P K	13.51	10.93
Ca K	27.51	17.20
Cu K	22.71	8.96
Ag L	3.68	0.85
Totals	100	

13. FOSSIL HAIRS OF CAVE BEAR AT THE DIVJE BABE I SITE

IVAN TURK and GREGOR KAPUN

Finds of fossilised hairs are undoubtedly among the more interesting and rare discoveries at the Divje babe I site (Turk *et al.* 1995a).

Very numerous skeletal remains and isolated teeth of cave bear are characteristic of the site (see Chapter 12 in this volume). These remains, which belong to so-called dead or fossil population, considered to be of some ten thousand individuals, represent only a small proportion of all the cave bears that dwelt in the cave. All the dead and living bears scattered millions, if not billions, of hairs throughout the cave. It is therefore very probable that some of the hairs were preserved in the special sedimentary environment, either in the form of impressions or as pseudomorphic forms or fossils. This was possible because of the explicitly phosphate environment, which is ideal for preserving finds of organic origin. Pieces of wood were thus also fossilised (see Paunović *et al.* 2002 and Chapter 8 in this volume), which similarly belong among exceptional and rare finds. While fossilised wood has already been mentioned several times in palaeolithic cave sites (Pacher *et al.* 2004; Kaminská *et al.* 2005), this does not apply for hairs. Hairs of pleistocene mammals (mammoth and hairy rhinoceros) have been exceptionally discovered in other sedimentary environments, mainly in permafrost and anaerobic environments (Kubiak, Dziurdzik 1973).

We found impressions of hair and pseudomorphic forms of hair in grains of hardened phosphate gelatine, which contain occasional inclusions of dolomite clasts and bone fragments. Larger clasts and bones were simply cemented in the gelatine (*Fig. 13.1*). In a similar way, individual hairs or even tufts of hair were impressed in it (*Fig. 13.2*). The first author found suspected impressions of hair on the surface of particular grains, but mainly within them when the grain was broken. There were as many grains with the impression of hair as there were aggregates with specific chemical composition (*tab. 13.1*) and mineral structure in the fine gravel fraction of the sediment (Turk 2006, Fig. 8).

Hairs that were cemented in gelatine for the most part disintegrated, but they left their impression in the form of small channels. The transverse cross sections of the channels are circular and oval, more rarely kidney shaped. The diameter of the channels is from 0.02 mm to 0.22 mm. The surface of the channels is smooth or fibrillar or warty structured (*Fig. 13.3a–d*). The longitudinal cross-sections of the longer channels narrow towards one part, which is one of the characteristics of hair (Turk 2003b, Fig. 2).

In individual cases, hairs in the channels have been replaced by anorganic fibres, which sufficiently faithfully copied the form and structure of hair, including with a core or *medulla* and scaly epidermis or cuticle (*Fig. 13.3a–d; 13.5a, b*) (Turk *et al.* 1995a, Fig. 7a2). There is only greater deviation in the diameter of the channels and fibres that presumably represent hairs. The diameter of the fibre is normally smaller than the diameter of the channel and amounts to 0.02–0.12 mm.

With brown bears, hairs of the underfur are generally circular to slightly kidney-shaped in cross section, with a diameter of 0.05-0.09 mm. The hairs of the outer guard fur are normally circular to elliptical in cross-section, more rarely kidney-shaped or concave-convex, and the diameter ranges from 0.11 mm to 0.20 mm (Kubiak, Dziurdzik 1973).

The structure of the epidermis and core of presumed fossilised hair is shown in *Fig. 13.4a, b*. The similarity with the cuticle of real hair, which is predominantly composed of tiny threads of keratin, and the core is great. Fossilised cuticle is shown in *Fig. 13.5a, b*.

The chemical composition of grains with impressions of hair can be various. The grain in *Fig. 13.3a*, e.g., has a composition at a micro-location (400 micro m^2), as shown in *Tab. 13.2*. Otherwise, the grains are usually composed predominantly of calcium and phosphorus (*Tab. 13.1*). This was also confirmed by geochemical analysis of the sand-silt fraction, which contains a lot of aggregates (see Chapter 5 in this volume, *Tab. 5.3.2*).

The chemical composition of the fibres slightly differs from one micro-location to another[1] and from one fibre to another. The main components in all cases

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[1] The micro-location on the fibre at which the chemical analysis was made is meant.

are Ca, P and Cu. The interior of the cortex of the fibre in *Fig. 13.4a* has a similar composition at two different micro-locations, as given in *Tab. 13.2*. The interior of the cortex of the fibre in *Fig. 13.4b* consists only of P and Ca (P : Ca ratio is 1 : 2) and C and O. The interior of the cortex of another fibre is completely without phosphorus at the micro-location.

It is characteristic of grains and fibres that they contain relatively a lot of copper and that they do not differ essentially chemically among themselves.

14. STABILNI IZOTOPI IN METABOLIZEM JAMSKEGA MEDVEDA IZ NAJDIŠČA DIVJE BABE I*

ERLE NELSON, ANDERS ANGERBJÖRN, KERSTIN LIDÉN in IVAN TURK

Izvleček

Izotopske analize fosilnih kosti izumrlega evropskega jamskega medveda kažejo na to, da je bila ta žival hibernator z enakimi nenavadnimi procesi metabolizma kot nekatere današnje vrste medvedov. To odkritje ponuja uporabne biološke in arheološke podatke o izumrlih vrstah, same metode pa se lahko izkažejo kot splošno uporabne pri preučevanju metabolizma današnjih medvedov, drugih hibernatorjev in morda tudi stradajočih živali.

Arheološko najdišče Divje babe I v zahodni Sloveniji vsebuje izjemno količino fosilnih kosti izumrlega evropskega jamskega medveda (*Ursus spelaeus*), hkrati pa tudi materialne dokaze o občasni prisotnosti človeka v srednjem in zgodnjem mlajšem paleolitiku (Turk, Kavur 1997; Brodar 1999, Bastiani *et al.* 2000; Turk, Bastiani 2000, Turk *et al.* 2001b). Radiokarbonsko datiranje medvedjih kosti je potrdilo, da so medvedi to jamo uporabljali v obdobju pred vsaj 50.000 leti (meja metode ^{14}C) pa do približno 30.000 leti (Nelson 1997). Kosti, ki so bile datirane (*tab. 14.1*, številke vzorcev serije A), so bile za vzorce te starosti zelo dobro ohranjene. Zato nas je mikalo, da bi na tem starodavnem materialu testirali metodo ogljikovih izotopov za rekonstrukcijo prehrane, pa čeprav iz takšne raziskave ni bilo pričakovati kakšnega novega podatka o prehrani jamskega medveda. Vrednosti razmerij stabilnih ogljikovih izotopov kostnih proteinov ponujajo podatke o prehrani v okoliščinah, pri katerih jedec lahko izbira med morskimi in kopenskimi prehranjevalnimi verigami ali med verigami, ki bazirajo na rastlinah »tipa« C_3 ali C_4. Ambrose (1993) navaja za to pregled in izčrpno bibliografijo. Ker se za jamske medvede predvideva, da so bili predvsem rastlinojedi (Kurtén 1976), in ker ne moremo pričakovati, da bi bile rastline tipa C_4 ali morski proteini del prehrane pleistocenskega medveda v slovenskih gorah, lahko metoda ogljikovih izotopov v najboljšem primeru le potrdi te predpostavke. Zadnja izotopska merjenja fosilnih kosti jamskega medveda iz podobnih najdišč v Franciji (Bocherens *et al.* 1990, 1994) so dejansko pokazala, da so ti medvedi jedli kopensko hrano, osnovano na tipu C_3. Vendar pa je izotopska raziskava (Bocherens *et al.* 1994) zob jamskega medveda pokazala izotopsko sestavo, ki namigujejo na nenavadne okoliščine v zgodnjem obdobju življenja te živali.

VZORCI IN METODA

Da bi navedeno podrobneje raziskali, smo iz razpoložljivih vzorcev izbrali drugo serijo kosti (vzorci serije B, *tab. 14.1*) jamskih medvedov v razvojnih stopnjah od novorojenega pa vse do popolnoma razvitega odraslega. Z malo izjemami so bili ti vzorci B golenice iz določene stratigrafske plasti v jami (^{14}C datirani v približno 48.000 let pred sedanjostjo)[1], da bi lahko pridobili izotopske podatke za različne posamezne živali različnih starosti iz približno istega časovnega obdobja. Vzorci so bili razdeljeni v šest starostnih skupin v razponu od zarodka/novorojenega do odraslega (kot je navedeno v *tab. 14.1*), in sicer na podlagi velikosti kosti in stopnje zrastlosti epifiz z metafizami.

Vzorci z veliko molekularno težo iz ostanka kolagenskih molekul so bili odvzeti z uporabo metode Brown *et al.* (1988). Koncentracije proteinskega materiala v kosteh so bile razpete med 3 in 11%, z znatnimi frakcijami (1/3 do 1/2) vsakega izvlečka z molekularno težo >30 kD. Ta opažanja in pa izmerjeni deleži koncentracije ogljika/vodika od 2,8 do 2,9 težnega % dajo slutititi (prim. DeNiro 1985), da je izvlečeni material omogočal zanesljive izotopske meritve. Vsak izv-

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* Poglavje je ponatis članka: Nelson, D. E., A. Angerbjörn, K Lidén in I Turk 1998: Stable isotopes and the metabolism of the European cave bear. – *Oecologia* 116, 177–181. © Springer-Verlag 1998. Ponatisnjeno z dovoljenjem *Springer Science* in *Business Media*

[1] To je bila plast 13, katere starost smo določili pozneje z metodo ESR na okoli 80.000 let (glej poglavje 6 v tem zborniku).

Tab. 14.1: Opisi vzorcev in izotopski rezultati za fosilne kosti jamskega medveda iz jame Divje babe I. Vsi vzorci so iz plasti 13 oz. facij B/C-1.
Table 14.1: Sample descriptions and isotopic results for fossil cave bear bones from Divje babe I Cave. All samples are from Layer 13 (Facies B/C-1).

Age group	Developmental stage	Sample number	Bone identification	δ^{13}C (‰ PDB)	δ ^{15}N (‰AIR)
I	Neonate / fetus	B1:193	Tibia	22.5	
	" "	B1:188	Tibia	22.8	
	" "	B1:171	Femur	23.4	6.8
	" "	B1:173	Ulna	22.1	6.6
	" "	B1:163	Unknown	23.2	7.7
II	Cub	B2:173-1	Tibia	21.3	3.9
	"	B2:173-3	Tibia	22.8	7.2
	"	B2:182	Tibia	22.0	4.0
	"	B2:188	Tibia	21.5	4.7
III	Yearling	B3:188-1	Tibia	21.6	2.3
	"	B3:181-2	Tibia	20.4	3.0
	"	B4:188-1	Tibia	21.0	3.3
	"	B4:188-2	Tibia	21.1	3.2
	"	B4:188-3	Tibia	21.2	2.1
IV	Juvenile	A1	Cranium	21.5	4.4
	"	A3	Femur	21.3	4.0
	"	A9	Humerus	20.1	
V	Sub-adult	B5:188-1	Tibia	20.2	1.1
	"	B5:188-2	Tibia	20.1	2.3
	"	B6:182	Tibia	20.7	4.1
	"	A7	Femur	19.9	2.5
VI	Adult	B7:183	Tibia	21.0	1.4
	"	B8:181	Tibia	20.4	1.6
	"	B9:173	Tibia	20.2	1.9
	"	B10:192	Tibia	20.1	1.6
	"	B11:173	Tibia	20.6	2.2
	"	A2	Radius	20.3	2.6
	"	A4	Fibula	20.4	2.4
	"	A5	Cranium	21.0	3.3
	"	A6	Radius	21.0	1.7
	"	A8	Metacarpus	20.1	-
	"	A10	Metatarsal	20.5	0.6
	"	A11	Metacarpus	19.9	1.9

leček smo nato žarili s CuO pri 900 °C približno 5 ur v zataljeni evakuirani ampuli iz kvarca. δ^{13}C vrednosti končnega CO_2 smo izmerili z masnim spektrometrom (*VG Prism mass spectrometer*) in so podane v običajnem formatu δ^{13}C = 1000 (Ru/Rs -1)‰, kjer sta Ru in Rs posamezni razmerji ^{13}C/^{12}C za neznan ter izotopski standard PDB. Kot je opisano spodaj, smo pozneje potrebovali tudi stabilna dušikova izotopska razmerja (δ^{15}N vrednosti). Ta imajo analogno razlago, t.j. δ^{15}N = 1000 (Ru/Rs -1)‰, kjer sta Ru in Rs posamezni razmerji ^{15}N/^{14}N za neznan vzorec ter izotopski standard AIR. Ti postopki dajejo merilno točnost < 0,1‰ za ogljik in $\leq$ 0,3‰ za dušik, oboje pa je zanemarljivo majhno v primerjavi z razlikami, ki nas tukaj zanimajo.

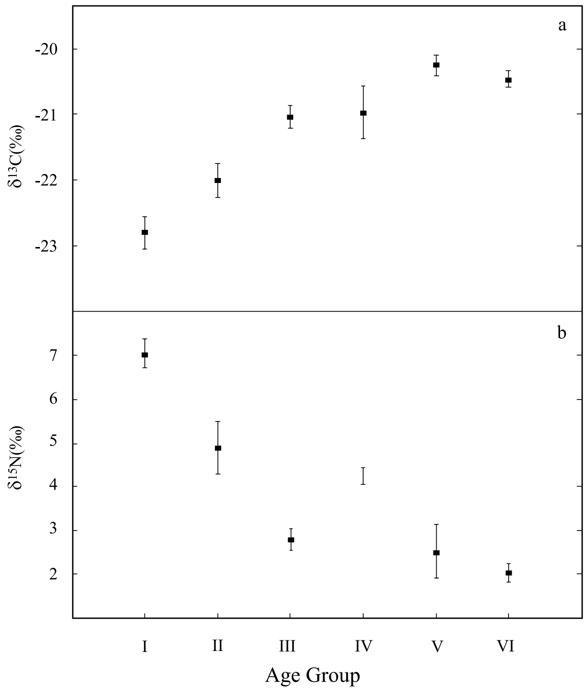
REZULTATI IN RAZPRAVA

Pridobljeni podatki so podani v *tab. 14.1.* Vrednosti δ^{13}C za odrasle medvede so pričakovane pri živalih, ki dobivajo proteine iz prehranjevalnih verig na osnovi rastlin tipa C$_3$, in se ujemajo z rezultati kosti jamskih medvedov iz francoskih najdišč (Bocherens *et al.* 1990, 1994). Variacija srednjih vrednosti za odrasle (0,37‰ pri enem standardnem odstopanju) je tudi zelo podobna tisti pri francoskih medvedih (*ibid.*), drugih živalih (t.j. Angerbjörn *et al.* 1994) in pri ljudeh (Lovell *et al.* 1986a). Vendar pa je zelo jasna korelacija (*sl. 14.1a*) med δ^{13}C-vrednostjo živali in njeno starostjo; novorojenčki imajo zelo majhno izotopsko vrednost, ki se postopoma, ko žival raste, spreminja na odraslo vrednost. Takšne starostne razlike niso bile opažene še pri nobeni drugi živalski vrsti. Raziskave ogljikovih izotopov prazgodovinske človeške populacije (Lovell *et al.* 1986), današnjih in prazgodovinskih človeških parov mati-novorojenček (Fogel *et al.* 1989), ter modernih arktičnih lisic (Angerbjörn *et al.* 1994) na primer niso pokazale nobenih pomembnih razlik za posamezne osebke in primerke živali različnih starosti. Vendar se ti sedanji rezultati na splošno ujemajo s tistimi za zobe odraslih jamskih medvedov (Bocherens *et al.* 1994), saj se zobje oblikujejo pred odstavitvijo od prsi in tako ohranijo izotopski zapis mlade živali.

Ker se medvedi skotijo z nenavadno izotopsko vrednostjo ogljika, moramo predvidevati izotopski učinek *in utero*, ki je drugačen za medvede kot za preostale živali. So imele medvedke med brejostjo neobičajne prehranjevalne navade ali pa je bil njihov metabolizem drugačen od tistega pri ljudeh ali lisicah? Prehranjevalna razlaga je malo verjetna, prav tako pa si je tudi težko zamisliti prehrano, ki je bila na voljo in bi lahko pojasnila tak preskok. Vendar pa je razlaga metabolizma v popolnem skladu s sedanjim razumevanjem izjemnih procesov metabolizma današnjega črnega medveda (*Ursus americanus*) in grizlija (*Ursus arctos*) med hibernacijo.

Metabolizem današnjih medvedov je med hibernacijo neobičajen, in sicer zato, ker medvedi ohranjajo svojo telesno temperaturo, ne opravljajo pa velike potrebe in ne urinirajo (Nelson 1973, 1980, 1989; Nelson *et al.* 1983; Lundberg *et al.* 1976). Da jim to uspe, imajo mehanizme metabolizma, ki izrabljajo predelane proteine in zalogo nakopičene maščobe za ustvarjanje aminokislin za vzdržno stopnjo proteinske sinteze (*ibid.*). Ker se brejost in rojstvo odvijata med zimsko hibernacijo, ko mati ne uživa hrane, mora kostni protein zarodka, ki se šele oblikuje, črpati tudi ogljik iz te maščobe in iz predelanih proteinov.

Medtem ko ti hibernacijski procesi metabolizma še niso bili izotopsko preučeni pri današnjih medvedih, pa vendar ponujajo prepričljivo razlago za opažene izotopsko nizke vrednosti pri mladih jamskih medvedih.



Sl. 14.1a, b: Povprečna ogljikova (a) in dušikova (b) izotopska razmerja za različne starostne razrede medvedov. Navpična črtica pri vsaki točki predstavlja izmerjeno standardno napako za določen razred, z izjemo dušikovega rezultata za starostni razred IV, ki navaja razpon za dve opravljeni meritvi.
Fig. 14.1a, b: The average carbon (a) and nitrogen (b) isotope ratios for the different age classes of the bears. The bar on each point gives the measured standard error for that class, with the exception of the nitrogen result for age-class IV, which gives the range for the two measures made.

Maščoba ima δ^{13}C-zapis, ki je približno 6‰ bolj negativen kot tisti pri kolagenu (prim. Tieszen, Boutton 1989), predelava proteinov pa lahko vključuje tudi frakcioniranje proti bolj negativnim vrednostim. Tako bo zarodkov kolagen, pridobljen iz nakopičene maščobe ter proteinske predelave hibernirajoče matere izotopsko negativen v primerjavi z njenim lastnim kolagenom. To pa ni podobno stanju zarodkovega kolagena pri ljudeh ali lisicah, o katerih smo govorili zgoraj, kjer so razmerja ogljikovih izotopov enaka materinim in so posledica njene prehrane.

To hipotezo lahko preizkušamo še naprej. Glede na to, da današnji medvedi med hibernacijo ne urinirajo, morajo imeti mehanizem za izogibanje strupenim koncentracijam sečnine, ki nastajajo pri proteinskem katabolizmu. To jim uspe s popolno predelavo dušika (Nelson *et al.* 1975), potemtakem torej lahko pričakujemo, da se bo ta nenavadni proces odražal v stabilnih dušikovih izotopskih (δ^{15}N) vrednostih kolagena, nastalega med hibernacijo.

Predelava dušika pri ne-hibernirajočih živalih se kaže v vrednosti δ^{15}N za kostne proteine, ki je približno +3‰ višja od tiste, ki jo ima zaužita hrana (Wada *et al.*

1980; Minagawa, Wada 1984; Schoeninger, DeNiro 1984; Ambrose 1993), izotopski „učinek trofičnega nivoja". Ti frakcinacijski procesi pa vplivajo tudi na druge proteine. Na primer, δ^{15}N-vrednost nohtov človeške matere in njenega novorojenega otroka je ista, vendar pa otrokov noht postane približno 3‰ bolj pozitiven med dojenjem, a se po njem vrne na odraslo vrednost (Fogel *et al.* 1989). Če ti frakcinacijski procesi delujejo pri ne-hibernirajočih vrstah, lahko pričakujemo, da bodo še posebej očitni v tkivu novorojenih medvedov, katerih hibernirajoče matere metabolično reciklirajo svoj urin med oblikovanjem zarodka.

Vrednosti δ^{15}N (*tab. 14.1; sl. 14.1b*), naknadno ugotovljene za vzorce jamskega medveda, popolnoma potrjujejo to predvidevanje, tako po pomenu kot tudi razsežnostih tega učinka. Za razliko od ljudi se jamski medved ne skoti z isto vrednostjo δ^{15}N, kot jo ima njegova mati, ampak s 5‰ višjo vrednostjo (približno dva „trofična nivoja"), kar je gotovo posledica metabolične predelave materinega proteinskega tkiva. Ta vrednost pade na en „trofični nivo", ko mladič raste, ter tako odraža izotopske razlike med materino prehrano in njenim mlekom, končno pa doseže odraslo vrednost v času po odstavitvi. Podobno kot pri podatkih δ^{13}C, je ta ugotovitev v skladu z rezultati δ^{15}N za zobe odraslega medveda (Bocherens *et al.* 1994).

Stopnja izotopske spremembe mora izražati tako postopno spremembo mladičeve prehrane po skotitvi kot tudi njegovo stopnjo rasti. Ker nimamo nobenih podrobnih podatkov o starosti, ko mladič ne sesa več, ali rasti te izumrle živali, ne moremo kvantitativno primerjati opažene izotopske spremembe s predvideno spremembo v krivulji za mešano prehrano. Če pa je naša splošna razlaga pravilna, lahko izotopski podatki sami ponudijo natančno meritev medvedovega procesa odraščanja. Na primer, vrednost δ^{15}N za vzorec B2:173-3 se zdi zunaj predvidenega za ocenjeno starost živali. Čeprav nimamo zadostnih podatkov o velikosti kosti za ta komplet vzorcev, ki bi omogočali podrobno kvantitativno primerjavo z izotopskimi rezultati, je bilo vendar dovolj preostalega gradiva za primerjavo najmanjših premerov diafiz tibij iz starostnih skupin 1 in 2. Ugotovili smo, da je bila kost, ki predstavlja vzorec B2:173-3, dejansko majhna za skupino 2, in bi po tem kriteriju morda res morala že biti na začetku uvrščena v skupino „novorojeni", tako kot predvidevajo izotopski podatki.

SKLEPI IN PREDLOGI ZA NADALJNJE RAZISKOVANJE

Podatki, pridobljeni iz obojih izotopov, ogljikovih in dušikovih, kažejo, da so novorojeni jamski medvedi v primerjavi z drugimi vrstami, za katere imamo podatke, začeli življenje z anomalnimi izotopskimi razmerji in da so postopoma spreminjali ta razmerja proti pričakovanim za živali, ki se hranijo s kopensko hrano. Odstopajoče vrednosti so v skladu s sedanjim vedenjem o metabolizmu današnjih hibernirajočih medvedjih vrst, kar nas privede do sklepa, da je bila tudi ta izumrla vrsta hibernator s podobnim metabolizmom.

Ta sklep odpira možnosti za nadaljnje raziskovanje na številnih področjih. Predvidevamo, da bodo imeli današnji hibernirajoči medvedi podobne izotopske zapise. Če se odkrije, da je to točno, bo to potrdilo naše sklepe glede jamskih medvedov. Menimo tudi, da je lahko izotopski zapis točen pripomoček za določitev odraslosti za hibernirajoče medvedje vrste, tako sedanje kot izumrle.

Če so ti sklepi pravilni, bi se morala izotopska metoda pokazati za koristno pri testiranju hibernatorskega metabolizma drugih živalskih vrst in pri kemični raziskavi teh neobičajnih procesov presnavljanja. Možnosti se raztezajo preko kostnega kolagena na druge proteine in tkiva (npr. zobni, kostni karbonat), ki imajo drugačne mehanizme nastajanja, časovno drugače dozorevajo in se spreminjajo. Tudi različne aminokisline v proteinih imajo različne izotopske zapise, kot jih imajo tudi različni ogljikovi atomi v aminokislinah (Hare *et al.* 1991; Abelson, Hoering 1961; Keeling 1997). Ali lahko raziskujemo podrobnosti metabolizma po izotopskih zapisih teh spojin?

Takšne raziskave se lahko izkažejo za uporabne tudi zunaj metabolizma hibernacije. Na primer, zdi se, da stradanje izzove odzive metabolizma pri ne-hibernirajočih živalih (tudi npr. pri anoreksičnih ljudeh), ki so podobni medvedjemu hibernirajočemu metabolizmu (Nelson 1989; Nedergaard, Cannon 1990). Ali lahko te izotopske vrednosti ponudijo uporabne informacije pri preučevanju stradanja, tako za sedanje kot tudi pretekle populacije? Izotopske posledice stradanja bi se morale razlikovati od tistih pri hibernaciji, saj stradajoči posamezniki nimajo nakopičene izotopsko lahke maščobe, iz katere bi lahko črpali. Ampak ali stradanje izzove frakcinacijo iz predelave proteinov? Ostaja še veliko neraziskanega.

Sklep, da so bili jamski medvedi hibernatorji z metabolizmom, podobnim presnovi današnjih medvedov, ponuja zelo uporabne podatke biologom, ki preučujejo vedenje teh izumrlih živali, in arheologom, ki jih zanima interakcija teh medvedov z ljudmi v prazgodovini. Omogoča tudi razložiti kopičenje kosti medvedov vseh starosti v jamskih najdiščih, saj je znano, da današnji medvedi včasih ne dosežejo primernega stanja hibernacije in zato umrejo od lakote (Lundberg *et al.* 1976). Kot zadnje pa si lahko tudi predstavljamo, da je kakršnokoli zimsko srečanje ljudi z jamskimi medvedi moralo biti zelo občutljive narave, saj so današnji hibernirajoči medvedi lahko razdražljivi, zelo hitro se začnejo braniti (*ibid*) in so hitro „godrnjavi kot medved", če jih grobo prebudimo.

ZAHVALA

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14. STABLE ISOTOPES AND THE METABOLISM OF CAVE BEAR FROM DIVJE BABE I*

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Abstract

Isotopic analyses of fossil bones of the extinct cave bear indicate that this animal was a hibernator with the same unusual metabolic processes as some modern bear species. This finding provides useful biological and archaeological information on an extinct species, and the methods themselves may prove generally useful in studies of the metabolisms of modern bears, other hibernators and perhaps of starving animals.

INTRODUCTION

The Divje Babe archaeological site in western Slovenia contains a remarkable quantity of fossil bones of the extinct European cave bear (*Ursus spelaeus*) as well as artifactual evidence for occasional human presence during the Middle and Early Upper Palaeolithic periods (Turk, Kavur 1997; Brodar 1999, Bastiani *et al.* 2000; Turk, Bastiani 2000, Turk *et al.* 2001b;). A radiocarbon dating study of these bear bones confirmed that the cave was used by bears over a period starting at least 50,000 years ago (the limit of the 14C method) until about 30,000 years ago (Nelson 1997). The bones dated in this study (*Table 1*, A-series sample numbers) were very well preserved for samples of this age, and we were tempted to use this ancient material to test the carbon isotope method for dietary reconstruction, even though there was no reason to anticipate new information on cave bear diet from such a study. Measures of the stable carbon isotope ratios of bone protein provide dietary information in those circumstances in which the consumer can choose between marine and terrestrial food chains or between food chains based on C3 or C4 plants. (Ambrose (1993) gives a review and extensive bibliography.) Since cave bears are thought to have been primarily herbivorous (Kurtén 1976), and since one would not expect either C4 plants or marine protein to have been part of the diet of Pleistocene bears in the Slovenian mountains, the carbon isotope method can at best only confirm these suppositions. In fact, recent isotopic measures on fossil cave bear bones from similar sites in France (Bocherens *et al.* 1990, 1994) do indeed indicate that these bears were eating a C3-based terrestrial diet. However, an isotopic study (Bocherens *et al.* 1994) of bear teeth shows isotopic signatures which hint at unusual circumstances during the early part of the bear's life.

SAMPLES AND METHOD

To explore this in detail, we selected from the available samples a second set of bones (B-series samples, *Table 1*) of bears ranging in development from newborn to fully developed adults. With few exceptions, these B samples were tibia from a specific stratigraphic layer in the cave (^{14}C dated at about 48,000 BP)[1] so that we would obtain measures of different individuals of varying ages from the same approximate time period. The samples were divided into six age classes ranging from fetal/newborn to adult (as given in *Table 1*) on the basis of their bone size and epiphyseal fusion.

High molecular-weight portions of the remnant collagen molecules were extracted using the method of Brown *et al.* (1988). The concentrations of proteinaceous material in the bones ranged from 3–11%, with substantial fractions (1/3 to 1/2) of each extract having molecular weight >30 kD. These observations, and measured carbon / nitrogen concentration ratios of 2.8 to 2.9 wt % strongly indicate (cf. DeNiro1985) that the extracted material provided reliable isotopic measures. Each extract was then combusted by heating it with CuO at 900 °C for 5 hours in a sealed, evacuated quartz tube. The $\delta^{13}C$ values of the resulting CO2 were measured using a VG Prism mass spectrometer and are given in the usual format $\delta^{13}C = 1000\,(Ru/Rs - 1)$ ‰ where Ru and Rs are the respective 13C/12C ratios for the unknown and the PDB

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[1] This layer was Layer 13 which was later ESR dated to about 80,000 (see Chapter 7 in this volume).

isotopic standard. As discussed below, we later required stable nitrogen isotope ratios (δ ^{15}N values) as well. These have an analogous definition, ie δ ^{15}N = 1000 (Ru/ Rs -1) ‰ where Ru and Rs are the respective ^{15}N/^{14}N ratios for the unknown and the AIR isotopic standard. These procedures give a measurement accuracy of $\leq$ 0.1‰ for carbon and $\leq$ 0.3 ‰ for nitrogen, both of which are negligibly small compared to the differences of interest here.

RESULTS AND DISCUSSION

The data obtained are given in *Table 1*. The δ ^{13}C values for the adult bears are as expected for animals obtaining their protein from a food chain based on C3 plants, in concordance with the results found for cave bear bones in French sites (Bocherens *et al.* 1990, 1994). Further, the variation about the mean for the adults (0.37‰ at one standard deviation) is also very similar to that for the French bears (*ibid*), for other animals (ie Angerbjörn *et al.* 1994) and for humans (Lovell *et al.* 1986a). However, there is a very clear correlation (*Fig. 1a*) between the animal's δ ^{13}C value and its age; the newborns have a very light isotopic value which gradually changes to the adult value as the animal grows. Such age differences have not been observed for other species. As examples, carbon isotopic studies of a prehistoric human population (Lovell *et al.* 1986), of modern and prehistoric human mother-infant pairs (Fogel *et al.* 1989), and of modern arctic foxes (Angerbjörn *et al.* 1994) showed no significant differences for individuals of differing ages. However, these present results are in general accord with those for the teeth of adult cave bears (Bocherens *et al.* 1994), as the teeth are formed before weaning and so retain the isotopic signature of the young animal.

Since the bears are born with an unusual carbon isotope value, we must postulate an isotopic effect *in utero* that is different for bears than for other animals. Either the females had an unusual diet while pregnant or they had a metabolism different from that of humans or foxes. The dietary explanation is unlikely, as it is difficult to think of an available diet that could account for the shift. However, the metabolic explanation is in entire accord with present understanding of the remarkable metabolic processes of modern black and grizzly bears (*Ursus americanus* and *arctos*) while in hibernation.

These modern bears have an unusual metabolism while hibernating in that they maintain their body temperature but neither defecate nor urinate (Nelson 1973, 1980, 1989; Nelson *et al.* 1983, Lundberg *et al.* 1976). To do this, they have metabolic mechanisms to use recycled protein and their supply of stored fat to form amino acids for maintenance-level protein synthesis (*ibid*). Since gestation and birth take place during winter hibernation when the mother is not eating, the bone protein of the forming fetus must also incorporate carbon from this fat and from the recycled protein.

While these hibernating metabolic processes have not been isotopically studied in modern bears, they do provide a convincing explanation for the observed isotopically-light values for the young cave bears. Fat has a δ ^{13}C signature about 6‰ more negative than that of collagen (cf Tieszen, Boutton 1989) and protein re-cycling may also involve fractionation towards more negative values. Thus, foetal collagen derived from a hibernating mother's stored fat and from her protein recycling will be isotopically negative as compared to her own collagen. This is unlike the situation for the foetal collagen of the humans and foxes discussed above, in which the carbon isotope ratios are the same as those of the mother and which reflect her diet.

This hypothesis could be further tested. Since modern bears don't urinate while hibernating, they must have a mechanism for avoiding toxic concentrations of the urea which results from protein catabolism. This is done by totally recycling the nitrogen (Nelson *et al.* 1975) and so we might expect this unusual process to be reflected in the stable nitrogen isotopic (δ ^{15}N) values of any collagen produced during hibernation.

Nitrogen processing in non-hibernating animals results in a δ ^{15}N value for bone protein approximately +3‰ higher than that of the food consumed (Wada *et al.* 1980, Minagawa, Wada 1984, Schoeninger, DeNiro 1984, Ambrose 1993), an isotopic "trophic level effect". These fractionating processes also affect other proteins. For example, the δ ^{15}N values of the finger-nails of a human mother and her new-born child are the same, but the child's finger-nail becomes about 3‰ more positive as it is breast-fed, and then returns to the adult value after weaning (Fogel *et al.* 1989). If these fractionating processes operate in non-hibernating species, we might expect them to be especially apparent in the tissue of new-born bears, whose hibernating mothers metabolically recycle their urea while the fetus is forming.

The δ ^{15}N values (*Table 1; Fig. 1b*) subsequently determined for the cave bear samples fully support this prediction, both in the sense and the magnitude of the effect. Unlike humans, the cave bear is not born with the same δ ^{15}N value as that of its mother, but with a value 5‰ higher (about two "trophic levels"). This must be due to metabolic recycling of the mother's proteinaceous tissue. The value falls to one "trophic level" as the cub ages, reflecting the isotopic differences between the mother's diet and her milk and eventually, it reaches adult value some time after the cub is weaned. As with the δ ^{13}C data, this conclusion is in accord with the δ ^{15}N results for the adult bear teeth (Bocherens *et al.* 1994).

The rate of isotopic change must reflect both the gradual change of the cub's diet after birth and it's growth rate. Since there is no detailed information on the weaning age or growth of this extinct animal, we cannot quantitatively compare the observed isotopic change with that predicted from a food-mixing curve. In fact, if our over-all interpretation is correct, the isotopic data may in themselves provide an accurate measure of the bear's maturation process. For example, the $\delta\ ^{15}$N-value for sample B2:173-3 seems out of rank for the estimated age of the animal. While we do not have sufficient bone-size data for this suite of samples to enable a detailed quantitative comparison with the isotopic results, there was sufficient remaining material to compare the smallest shaft diameters of the tibia of Groups 1 and 2. We found that sample B2:173-3 was in fact small for Group 2, and on this criterion it should perhaps originally have been placed in the "neonate" group as the isotopic data suggest.

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

The data obtained for both carbon and nitrogen isotopes show that new-born cave bears began life with anomalous isotopic ratios, as compared to the other species for which we have data, and that they gradually changed these ratios to those expected for animals feeding on terrestrial diets. These anomalous values are consistent with present understanding of the metabolism of existing hibernating bear species, and so we conclude that this extinct species was also a hibernator with a similar metabolism.

This conclusion immediately suggests further studies in a number of areas. First, we predict that existing hibernating bears will have similar isotopic signatures. If this is found to be true, it will substantially confirm our conclusion for the cave bears. Next, we suggest that the isotopic signature may be an accurate measure of maturity for hibernating bear species, both present and extinct.

Further, if these conclusions are correct, the isotopic method should prove useful in testing the hibernating metabolisms of other species and in the chemical study of these strange metabolic processes. The possibility extends beyond bone collagen to other proteins and tissues (eg teeth, bone carbonate) which have different formation mechanisms, maturation times and turn-over times. As well, the different amino acids in protein have different isotopic signatures, as do the different carbon atoms in the amino acids (Hare *et al.* 1991; Abelson, Hoering 1961; Keeling 1997). Can we examine metabolic details by the isotopic signatures of these compounds?

Such studies may have applications beyond the metabolism of hibernation. For example, starvation apparently induces metabolic responses in non-hibernating animals (eg anorexic humans) that are similar to a bear's hibernating metabolism (Nelson 1989; Nedergaard, Cannon 1990). Can these isotopic measures provide useful information in studies of starvation, both for present and for past populations? The isotopic consequences of starvation should be distinguishable from those of hibernation, as starving individuals have no stored, isotopically-light fat on which to draw, but does starvation induce fractionation from protein recycling? There is much to be explored.

Last, the conclusion that the cave bears were hibernators with metabolisms similar to modern bears provides very useful information to biologists studying the behaviour of these extinct animals and to archaeologists interested in their interactions with prehistoric mankind. It provides an explanation for the large numbers of bones of bears of all ages found in the cave sites, as it is known that modern bears sometimes fail to achieve proper hibernating mode and then die of starvation (Lundberg *et al.* 1976). Finally, we speculate that any winter-time interactions of cave-dwelling humans with cave bears must have been delicate, as modern hibernating bears are easily aroused, quickly capable of self-defense (*ibid*), and likely to be "grouchy as a bear" if rudely awoken.

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15. METRIČNA ŠTUDIJA LOBANJ JAMSKEGA MEDVEDA IZ DIVJIH BAB I

BORUT TOŠKAN

Izvleček

Morfometrična analiza 12 razmeroma dobro ohranjenih lobanj jamskega medveda iz facij A in B je izpostavila prevlado samcem pripisanih primerkov. Primerjava z gradivom iz nekaj drugih mlajšepleistocenskih najdišč je pokazala, da so razlike v morfologiji lobanje med primerki istega spola iz različnih najdišč bistveno manjše od razlik med lobanjami samcev in samic iz istega najdišča. Analizirane lobanje iz Divjih bab I se sicer v merjenih dimenzijah v ničemer ne razlikujejo od kronološko nekoliko mlajših primerkov iz Potočke zijalke.

Med večletnimi izkopavanji mlajšepleistocenskega jamskega najdišča Divje babe I (Z Slovenija) je bilo poleg drugega pridobljenih tudi 16 razmeroma dobro ohranjenih lobanj jamskega medveda (*Ursus spelaeus* Rosenmüller, 1794). Časovno je najdbe mogoče umestiti v geološko obdobje OIS 3 (≈ interpleniglacial). V pričujočem poglavju so predstavljeni rezultati metrične in paleobiolološke analize omenjenih lobanj.

GRADIVO IN METODE

Najdb lobanjskih kosti jamskega medveda je v gradivu iz Divjih bab I veliko, zaradi izrazite fragmentiranosti pa jih pretežni del ni bilo mogoče vključiti v načrtovano raziskavo. Vzorec, ki sem ga imel na razpolago, je tako obsegal le 12 razmeroma nepoškodovanih lobanj ter še dodatne štiri primerke, pri katerih je bila zadovoljivo ohranjena predvsem zgornja čeljustnica. V vseh primerih je šlo za lobanje odraslih živali, ki so v Divjih babah I poginile v obdobju med pribl. 65.000 in 35.000 leti pred sedanjostjo (p. s.). Obravnavano gradivo hrani Narodni muzej Slovenije v Ljubljani.

Podrobni podatki o najdišču in poteku terenskega raziskovanja so podani v 1. poglavju tega zbornika, zato na tem mestu predstavljam le metodologijo obdelave lobanj. Na vsakem primerku sem s kljunastim merilom izmeril do 18 različnih dimenzij (glej *prilogo 15.1*). Pri tem sem sledil smernicam, ki jih je objavil Torres (1988). V okviru raziskave sem poskušal posamezne primerke najprej grupirati po spolu, nato pa sem opravil še metrično analizo. Kot referenčni vzorec sem uporabil lobanje jamskega medveda z visokoalpinske postaje Potočka zijalka v Savinjskih Alpah (Pacher 2004a), ki so datirani v obdobje med 35.000 in 26.000 leti p. s. (Rabeder, Pohar 2004). Mestoma sem uporabil tudi podatke iz nekaterih drugih mlajšepleistocenskih najdišč v regiji (npr. Mokriška jama, Gamssulzenhöhle, Drachenhöhle) in širše (Cueva de Arrikrutz, Cueva de Cubias Negras).

V okviru statistične obdelave sem uporabljal neparametrične prijeme (mediana kot mera centralne tendence, Kruskal-Wallisov test, Mann-Whitney U-test, Schefféjev test; StatSoft, Inc. 2001), saj porazdelitev analiziranih podatkov praviloma odstopa od normalne. Morfologijo 15 najbolje ohranjenih primerkov (pet iz Divjih bab I, sedem iz Potočke zijalke in tri iz Španije) sem dodatno proučil z uporabo analize glavnih komponent (*Principal Components Analysis*; PCA). Omenjena metoda omogoča variacijo p osnovnih x-spremenljivk zadovoljivo pojasniti z (bistveno) manjšim številom glavnih komponent (PC_i), kar olajša interpretacijo znotrajvzorčne variabilnosti (Manly 1994; StatSoft Inc. 2001). Statistična obdelava je bila narejena s programskim paketom StatSoft 2001, STATISTICA za Windows, verzija 6.0.

REZULTATI IN RAZPRAVA

GRUPIRANJE PO SPOLU

Grupiranje lobanj jamskega medveda po spolu največkrat temelji na meritvah širine in dolžine krone zgornjih podočnikov, saj ti kažejo izrazit spolni dimorfizem (Kurtén 1955). Ker pa so bili med 16 lobanjami iz Divjih bab I podočniki primerno ohranjeni le pri osmih primerkih (*tab. 15.1*), sem v okviru tukaj predstavljene analize v ta namen uporabil tudi nekaj ostalih merjenih dimenzij.

Glede na ugotovitve različnih avtorjev (Torres 1988; Grandal d'Anglade 1993b; Pacher 2004a; Grandal d'Anglade, López-González 2005) naj bi bilo pri lobanjah brez ohranjenih podočnikov razlikovanje med spoloma najzanesljivejše na osnovi podatkov o največji mas-

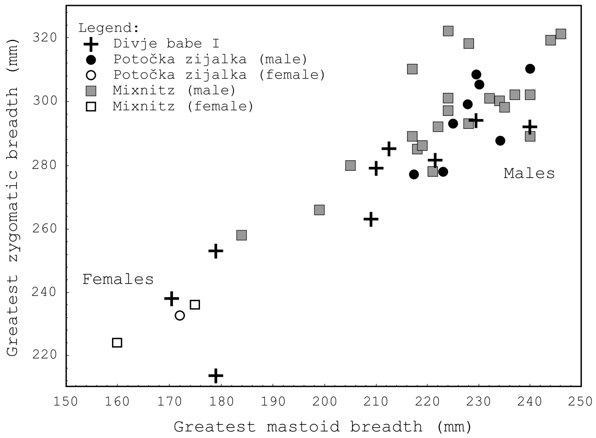
Tab. 15.1: Prečni premer zgornjih podočnikov pri osmih lobanjah jamskega medveda (*Ursus spelaeus*) iz Divjih bab I in njihovo grupiranje po spolu. Za primerjavo sta podana povprečje (X) in razpon vrednosti za isto dimenzijo pri izoliranih podočnikih jamskega medveda iz Divjih bab I (N = 516; Debeljak 2002).
Tab. 15.1: Transverse diameter of upper canines from eight skulls of cave bear from Divje babe I (*Ursus spelaeus*) and their grouping by sex. For comparison, the average (X) and range of values for the same dimension for isolated canines of cave bear from Divje babe I is given (N = 516; Debeljak 2002).

Inventory number	Females	Males
s.n.		22.5
D.b. 962	16.5	
D.b. 1313		26.0
D.b. 1400		25.0
D.b. 1848		21.0
D.b. 1993		20.0
D.b. 1996		19.5
D.b. 2123	18.0	
Isolated canines	X = 15.2 13.0–18.0	X = 19.9 17.0–23.0

toidni širini (Var 8), največji zigomatični širini (Var 11) ter najmanjši širini neba (Var 16). Z upoštevanjem navedenih ugotovitev je bilo mogoče v vzorcu iz Divjih bab I po spolu grupirati kar 15 od skupno 16 lobanj. Rezultati so izpostavili očitno prevlado samcev (glej npr. *sl. 15.1*), saj so bili ti v obravnavanem vzorcu zastopani s kar 10 primerki. Na prevladujoč delež samcev med ostanki jamskega medveda iz interpleniglacialnih (≈ OIS 3) plasti Divjih bab I kažeta tudi analizi dolgih kosti (glej 16. poglavje v tem zborniku) in metapodijev (glej 17. poglavje v tem zborniku), ne pa tudi metrični podatki izoliranih podočnikov, v skladu s katerimi naj bi bil delež obeh spolov v vzorcu iz OIS 3 v grobem enak (Debeljak 2002b). Verjetni razlogi za navedene razlike v oceni spolne strukture jamskih medvedov iz Divjih bab I so predstavljeni v poglavju o metapodijih jamskega medveda (glej 17. poglavje v tem zborniku).

METRIČNA ANALIZA

Izpovedno vrednost rezultatov metrične analize lobanj jamskega medveda iz Divjih bab I močno omejuje skromnost vzorca, kljub temu pa se zdijo nekateri sklepi razmeroma verodostojni. V tem smislu bi izpostavil predvsem ugotovitev, da gre polimorfizem v obliki in velikosti lobanj povezovati predvsem s spolnim dimorfizmom. Medtem ko se namreč metrični podatki samcev in samic iz Divjih bab I med seboj praviloma bistveno razlikujejo, so razlike med samci iz Divjih bab I in tistimi iz Potočke zijalke pri vseh opazovanih dimenzijah[1] pod mejo statistične značilnosti (Kruskal-Wallisov test: $p < 0,05$; *tab. 15.2*).[2] V tem pogledu predstavljata edini izjemi najmanjša širina senčne kosti (Var 12) in najmanjša širina neba, merjena na sredini diasteme (Var 16); le v teh dveh primerih tvorijo namreč lobanje samic enotno skupino s primerki samcev iz obeh obravnavanih najdišč.[3]



Sl. 15.1: Razmerje med največjo mastoidno širino in največjo zigomatično širino pri lobanjah jamskega medveda (*Ursus spelaeus*) iz Divjih bab I. Za primerjavo so podani podatki za lobanje jamskega medveda iz jam Potočka zijalka v Savinjskih Alpah in Drachenhöhle pri Mixnitzu (Pacher 2004).
Fig. 15.1: Ratio between the greatest mastoid breadth and the greatest zygomatic breadth of skulls of cave bear (*Ursus spelaeus*) from Divje babe I. For comparison, data on the same dimensions of the skulls of cave bear from the caves Potočka zijalka in the Savinja Alps and Drachenhöhle by Mixnitz (Pacher 2004) are given.

Iz zgoraj predstavljenih rezultatov izhaja, da razlike v morfologiji lobanje med samci in samicami iz istega najdišča presegajo razlike med primerki istega spola iz različnih najdišč. Navedena ugotovitev najverjetneje ni posledica (pre)majhnega števila zadovoljivo ohranjenih najdb. To je razvidno že s *slike 15.2*, kjer so prikazani podatki za največjo zigomatično širino lobanj obeh spolov iz več različnih mlajšepleistocenskih najdišč. Na grafu zastopane najdbe namreč "pokrivajo" več deset tisoč let dolgo obdobje, v katerem je najverjetneje prihajalo tudi do določenih evolutivnih sprememb v morfologiji lobanje. Kljub temu pa ostajajo razlike v obravnavani dimenziji med primerki enega in drugega spola visoko statistično značilne (Mann-Whitney U-test: $p < 0,001$), med lobanjami istega spola pa praktično zanemarljive (Kruskal-Wallis test: $p = 0,163$ (samci); $p = 0,193$ (samice)).

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[1] Od 18 merjenih dimenzij sem jih v okviru obravnavane primerjave upošteval le 11, saj je bila pri ostalih velikost vzorca preskromna.

[2] Primerjava med samicami iz obeh navedenih najdišč ni mogoča, saj je v vzorcu iz Potočke zijalke primerno ohranjena ena sama lobanja medvedke (Pacher 2004).

[3] Glede na rezultate Schefféjevega testa, sicer enega bolj konzervativnih post-hoc statističnih testov, tvorijo samci in samice enotno skupino tudi pri dimenziji dolžina kočnikov (Var 18).

Tab. 15.2: Opisna statistika za 11 lobanjskih dimenzij jamskega medveda (*Ursus spelaeus*) iz Divjih bab I in Potočke zijalke. Podani so velikost vzorca (N), mediana (Me) in razpon vrednosti (Min.–Max.). Homogeni nizi temeljijo na Schefféjevem testu. Vzorci: 1 – Divje babe I (samci), 2 – Divje babe I (samice), 3 – Potočka zijalka (samci; Pacher 2004). Vse mere so v mm.
Tab. 15.2: Descriptive statistics for 11 skull dimensions of cave bear (*Ursus spelaeus*) from Divje babe I. Given are the size of the sample (N), median (Me) and range (Min.–Max.). Homogenous sets are based on Scheffé's test. Samples: 1 – Divje babe I (males), 2 – Divje babe I (females), 3 – Potočka zijalka (males; Pacher 2004). All measurements are in mm.

Variable	Sample	N	Me	Min.–Max.	Scheffé's test		Kruskal-Wallis
Var 1	1	6	474.25	441.5–483.0	X		H = 7.51 p = 0.023
	2	3	419.0	392.0–427.5		X	
	3	11	468.0	434.0–486.0	X		
Var 2	1	4	421.75	396.0–444.5	X		H = 7.79 p = 0.020
	2	3	378.0	351.0–382.0		X	
	3	11	413.9	402.5–424.5	X		
Var 8	1	7	221.5	209.0–240.0	X		H = 8.18 p = 0.017
	2	3	179.0	170.5–179.0		X	
	3	7	229.5	217.5–240.0	X		
Var 9	1	3	87.0	86.5–94.0	X		H = 6.89 p = 0.032
	2	3	79.0	76.5–81.0		X	
	3	9	90.0	83.0–96.5	X		
Var 10	1	6	38.5	37.0–40.0	X		H = 7.97 p = 0.018
	2	4	34.5	33.0–37.0		X	
	3	11	39.2	35.5–43.5	X		
Var 11	1	6	282.0	263.0–292.0	X		H = 6.73 p = 0.034
	2	3	238.0	213.0–253.0		X	
	3	8	292.30	266.0–310.2	X		
Var 12	1	5	83.0	82.0–87.0	X		H = 0.65 p = 0.723
	2	4	82.25	80.0–85.0	X		
	3	11	84.6	77.0–88.5	X		
Var 13	1	4	132.5	113.5–137.5	X	X	H = 9.84 p = 0.007
	2	4	115.5	111.5–120.5	X		
	3	10	139.2	130.0–160.0		X	
Var 14	1	5	96.0	71.0–101.5	X	X	H = 9.49 p = 0.009
	2	4	86.75	82.0–91.5	X		
	3	11	99.4	92.0–110.5		X	
Var 16	1	9	83.0	73.5–89.0	X		H = 5.02 p = 0.081
	2	2	73.75	73.5–74.0	X		
	3	7	79.6	76.5–80.0	X		
Var 18	1	11	93.0	84.0–100.5	X		H = 6.55 p = 0.038
	2	4	85.5	83.0–89.0	X		
	3	8	92.2	88.0–104.5	X		

Do enakega sklepa sem prišel ob hkratnem upoštevanju več različnih merjenih dimenzij, kar sem dosegel z uporabo analize glavnih komponent. V analizo sicer ni bilo mogoče vključiti vseh 18 dimenzij (zaradi fragmentiranosti ali obrušenosti večine lobanj namreč nekaterih meritev ni bilo mogoče opraviti; glej *prilogo 15.1*), so pa med sedmimi izbranimi zastopane tako dolžinske kot tudi širinske mere. Te so: največja dolžina (Var 1), največja mastoidna širina (Var 8), največja zigomatična širina (Var 11), najmanjša širina senčne kosti (Var 12), največja širina čela (Var 13), najmanjša širina med očnicama (Var 14) in dolžina kočnikov (Var 18). Oglejmo si projekcijo lobanj jamskega medveda iz Divjih bab I, Potočke zijalke in dveh španskih mlajšepleistocenskih najdišč[4] na prvo in drugo glavno komponento, ki sta bili izračunani na osnovi korelacijske matrike navedenih sedmih dimenzij (*sl. 15.3*). V skladu s pričakovanji oblikujejo primerki jamskega medveda iz obeh slovenskih najdišč dve ločeni skupini, od katerih ena vključuje samice, druga pa samce. V okvir slednje se umeščajo tudi vsi trije primerki jamskih medvedov iz Španije. Faktorske uteži (*Factor loadings*) za prve tri glavne komponente, ki skupaj povzemajo 97,1 % variance izhodiščnega nabora podatkov, so podane v *tabeli 15.3*. Iz njih je mogoče razbrati, da se spolni dimorfizem kaže predvsem v širinskih merah, manj pa v dolžinskih. Podobno sliko kažejo tudi lobanje jamskih medvedov iz Španije, Avstrije, Nemčije in Belgije (Grandal d'Anglade 1993b; Pacher 2004a; Grandal d'Anglade, López-González 2005).

V nasprotju s poudarjenim spolnim dimorfizmom

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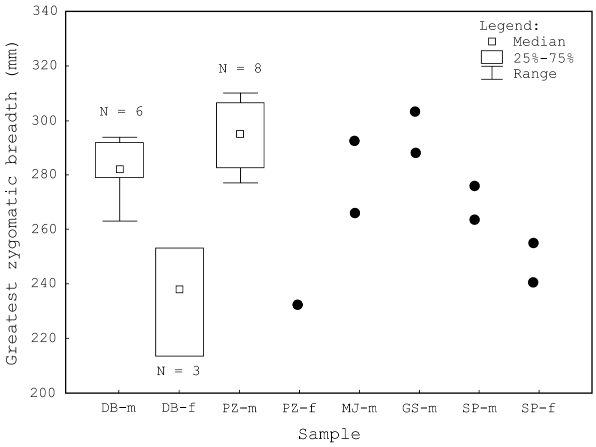
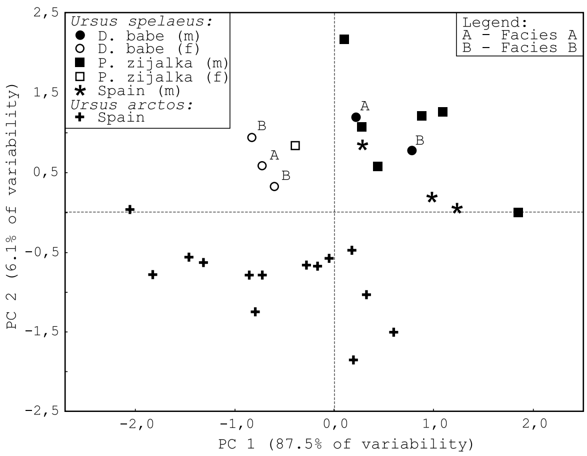
[4] Gre za najdišči Cueva de Arrikrutz (würm III) in Cueva de Cubias Negras (würm).



Sl. 15.2: Največja zigomatična širina pri lobanjah jamskega medveda (*Ursus spelaeus*) iz več različnih mlajšepleistocenskih najdišč. Vzorci: Db – Divje babe I, PZ – Potočka zijalka v Savinjskih Alpah (Pacher 2004), MJ – Mokriška jama v Savinjskih Alpah (Rakovec 1967), GS – Gamssulzenhöhle v Totes Gebirge (Pacher 2004), SP – Španija: več najdišč (Torres 1988); m – samci, f – samice.
Fig. 15.2: The greatest zygomatic breadth of skulls of cave bear (*Ursus spelaeus*) from various Upper Pleistocene sites. Samples: Db – Divje babe I, PZ – Potočka zijalka in the Savinja Alps (Pacher 2004), MJ – Mokriška jama in the Savinja Alps (Rakovec 1967), GS – Gamssulzenhöhle in Totes Gebirge (Pacher 2004), SP – Spain: various sites (Torres 1988); m – males, f – females.



Sl. 15.3: Projekcija lobanj jamskega medveda (*Ursus spelaeus*) iz Divjih bab I, Potočke zijalke in dveh španskih mlajšepleistocenskih najdišč ter lobanj rjavega medveda (*U. arctos*) iz več španskih mlajšepleistocenskih najdišč na prvo in drugo glavno komponento, ki sta bili izračunani na podlagi korelacijske matrike sedmih merjenih dimenzij (Var 1, Var 8, Var 11, Var 12, Var 13, Var 14, Var 18; posamezne dimenzije so obrazložene v prilogi). Osi so bile rotirane z metodo *varimax normalized* (StatSoft, Inc. 2001). Metrične podatke za primerke iz Potočke zijalke podaja Pacherjeva (2004), za tiste iz Španije pa Torres (1988). Legenda: PC – glavna komponenta, m – samci, f - samice. Za obrazložitev glej besedilo.
Fig. 15.3: Projection of skulls of cave bear (*Ursus spelaeus*) from Divje babe I, Potočka zijalka and two Spanish Upper Pleistocene sites and of skulls of brown bear (*U. arctos*) from various Spanish Upper Pleistocene sites to the first and second principal components, which were calculated on the correlation matrix of seven measured dimensions (Var 1, Var 8, Var 11, Var 12, Var 13, Var 14, Var 18; individual dimensions are explained in the annex). Axes have been rotated by the method of *varimax normalized* (StatSoft, Inc. 2001). Metric data for specimens from Potočka zijalka are from Pacher (2004), and from Torres (1988) for Spain. Legend: PC – principal component, m – males, f - females. See text for explanation.

se zdi znotrajspolna (intraseksualna) variabilnost v morfologiji lobanj jamskega medveda iz posameznih najdišč skromnejša. Upoštevaje razpoložljive rezultate (sicer temelječe na majhnem vzorcu) bi lahko razlike med primerki istega spola tako morda interpretirali kar kot (predvsem) individualno variabilnost s fenotipskim ali kvečjemu epigenotipskim ozadjem. Znotrajspolna variabilnost v morfologiji lobanj jamskega medveda je navsezadnje dokaj omejena ter ne dosega razlik med npr. lobanjami jamskega in rjavega medveda (*sl. 15.3*). Na podoben način je razlike v velikosti kočnikov jamskega medveda iz več evropskih najdišč razložili tudi Baryshnikov s sodelavci (2003).

SKLEP

Metrična študija lobanj jamskega medveda iz Divjih bab I je omejena s pičlostjo primerno ohranjenih najdb ter z maloštevilnimi primerki samic v primerjalnem vzorcu iz Potočke zijalke. Kljub temu pa se dobljeni rezultati v marsičem ujemajo z ugotovitvami drugih avtorjev, kar nakazuje njihovo verodostojnost. Prevlada samcem pripisanih lobanj[5] se tako povsem ujema z rezultati študije dolgih kosti (glej poglavje 16 v tem zborniku) in metapodijev (glej poglavje 17 v tem zborniku) iz istega najdišča; tudi ti so namreč izpostavili večinski delež samcem pripisanih najdb med ostanki jamskega medveda iz OIS 3.

Zanimiva in skladna s sklepi nekaterih drugih avtorjev (npr. Grandal d'Anglade 1993b; Pacher 2004a) je tudi ugotovitev, da razlike v morfologiji lobanje med samci in samicami iz istega najdišča (običajno) bistveno presegajo razlike med primerki istega spola iz različnih najdišč. Celo več! Razlike med lobanjami samcev iz Divjih bab I in tistih iz Potočke zijalke so v vseh opazovanih dimenzijah pod mejo statistične značilnosti (*tab. 15.2*), praktično zanemarljive pa se zdijo tudi razlike med lobanjami samic iz obeh navedenih najdišč (*sl. 15.3*). Rabeder s sodelavci (2004b) je na osnovi dimenzije meljakov, morfodinamičnih indeksov kočnikov ter dolžine in indeksa zavaljenosti metapodijev ugotovil, da naj bi bili medvedi iz Potočke zijalke filogenetsko zelo blizu "medvedom Gamssulzen",

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[5] Razmerje med spoloma znaša 10:5 v korist samcev.

Sl. 15.4a, b: Lobanji medveda iz Divjih bab I: a – *Ursus spelaeus* (D. b. 1848; plast 8); b – *Ursus arctos* (D. b. 1606a; plast 6). Fotografija: M. Zaplatil.
Fig. 15.4a, b: Bear skulls from Divje babe I: a – *Ursus spelaeus* (D. b. 1848; Layer 8); b – *Ursus arctos* (D. b. 1606a; Layer 6). Photograph M. Zaplatil.

ki jih obravnava kot samostojno vrsto *Ursus ingressus* Rabeder *et al.* 2004. S takšnimi ugotovitvami se ujemajo tudi rezultati raziskav mitohondrijske DNA (Rabeder *et al.* 2004c; a glej tudi Orlando *et al.* 2002). Glede na podobnost v morfologiji lobanj medvedov iz Potočke zijalke in tistih iz Divjih bab I bi bilo tako tudi slednje upravičeno pripisati vrsti *U. ingressus*. Po naselitvi alpskega prostora pred približno 50.000 leti naj bi namreč omenjena vrsta na tem območju v celoti nadomestila vrsto *U. spelaeus* (Rabeder, Hofreiter 2004). Vendar pa lega analiziranih lobanj jamskega medveda iz Divjih bab I na *sliki 15.3* takšnega sklepa ne podpira. Sicer maloštevilni razpo-

Tab. 15.3: Faktorske uteži (*Factor loadings*) za prve tri glavne komponente, ki so bile izračunane na podlagi korelacijske matrike sedmih merjenih dimenzij lobanj jamskega in rjavega medveda iz Divjih bab I in Potočke zijalke. Vrednosti nad 0,70 so osenčene. Legenda: PC – glavna komponenta. Posamezne dimenzije (variable) so predstavljene v prilogi.
Tab. 15.3: Factor loadings for the first three principal components, which were calculated on the basis of the correlation matrix of seven measured dimensions of the skulls of cave and brown bear from Divje babe I and Potočka zijalka. Values over 0.70 are shaded. Legend: PC – principal component. Individual dimensions (variables) are given in the annex.

Variable	PC 1	PC 2	PC 3
Var 1	0.557	0.721	0.354
Var 8	0.658	0.670	0.276
Var 11	0.736	0.542	0.370
Var 12	0.456	0.385	0.800
Var 13	0.866	0.316	0.345
Var 14	0.765	0.428	0.446
Var 18	0.297	0.894	0.296

ložljivi primerki iz uvodnih faz OIS 3 in morda celo zaključnega dela OIS 4 (tj. facije B[6]) se namreč v opazovanih dimenzijah ne razlikujejo od tistih iz osrednjega dela OIS 3 (tj. facije A[7]), prav tako pa tudi ne od tistih iz Potočke zijalke, ki so datirani v sam zaključek OIS 3. Obenem se v skupino samcev iz obeh slovenskih najdišč umeščajo tudi vsi trije primerki istega spola iz Španije.

Seveda ni mogoče izključiti možnosti, da bi se predstavljena slika ob povečanju vzorca do neke mere spremenila. Po drugi strani pa velja opozoriti tudi na nekatere potencialno problematične korake v postopku nastajanja filogenetskega drevesa Rabederja in sodelavcev (2004), kot je npr. brezkompromisna povezava indeksa zavaljenosti metapodijev z evolutivno stopnjo jamskih medvedov (glej npr. Hofreiter *et al.* 2004 (glej tudi dodatek objavljen skupaj s člankom na medmrežju); Withalm 2001; 2004).[8] Navsezadnje tudi Grandal d'Anglade in López-González (2005) ugotavljata, da gre polimorfizem v obliki in velikosti lobanj pri jamskem medvedu pripisati predvsem spolnemu dimorfizmu. Vloga ostalih virov znotrajvrstne variabilnosti (npr. klinalna variabilnost geografske ali kronološke narave, politipizem) naj bi bila, nasprotno, zanemarljiva.

ZAHVALA

Zahvaljujem se dr. Ivanu Turku, ki mi je omogočil študijo obravnavanega gradiva. Hvaležen sem mu tudi za spodbudne razprave, ki so spremljale celoten potek raziskave.

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[6] Sediment facije B naj bi nastal v obdobju od pribl. 65.000 do pribl. 48.000 let p. s. (glej poglavji 6 in 7 v tem zborniku).

[7] Sediment facije A naj bi nastal v obdobju od pribl. 48.000 do pribl. 35.000 let p. s. (glej poglavji 6 in 7 v tem zborniku).

[8] Problem je podrobneje predstavljen v poglavju o metapodijih jamskega medveda (poglavje 17 v tem zborniku). Glej tudi Toškan (2007).

15. METRIC STUDY OF CAVE BEAR SKULLS FROM DIVJE BABE I

BORUT TOŠKAN

Abstract

Morphometric analysis of 12 relatively well preserved cave bear skulls from facies A and B showed a predominance of males. Comparison with material from some other Upper Pleistocene sites showed that differences in the morphology of skulls among specimens of the same sex from various sites are essentially less than differences among skulls of males and females from the same site. The analysed skulls from Divje babe I do not differ in the measured dimensions in any way from chronologically slightly more recent specimens from Potočka zijalka.

During the lengthy excavations of the Upper Pleistocene cave site of Divje babe I (Slovenia), items obtained included 16 relatively well preserved skulls of cave bear (*Ursus spelaeus* Rosenmüller, 1794). The finds originate from the Oxygen Isotopic Stage 3 (= OIS 3 or Inerpleniglacial). This chapter presents the results of metric and paleobiological analysis of the aforementioned skulls.

MATERIAL AND METHODS

There were a great many finds of cave bear skull bones among the material from Divje babe I, but most of them could not be included in the planned research because of pronounced fragmentation. The sample available thus numbered only 12 relatively undamaged skulls and an additional four specimens with which mainly the upper jaw had been adequately preserved. All specimens were skulls of adult animals, which had died in the cave in the period from approximately 65,000 to 35,000 years ago. The material in question is held by the National Museum of Slovenia in Ljubljana.

Detailed data about the site and the course of fieldwork are given in Chapter 1 of this volume, so only the methodology of analysing the skulls is dealt with here. Using a vernier calliper gauge, up to 18 different dimensions were measured on each specimen (see *Annex 15.1*). Guidelines published by Torres (1988) were followed. Within the framework of the research, individual specimens were first grouped by sex, whereupon a detailed metric analysis was performed. Cave bear skulls from the high alpine outpost of Potočka zijalka in the Savinja Alps (Pacher 2004a) was used as reference sample, which had been dated to the period between 35,000 and 26,000 years BP (Rabeder, Pohar 2004). Data from certain other Upper Pleistocene sites in the region (e.g., Mokriška jama, Gamssulzenhöhle, Drachenhöhle) and wider (Cueva de Arrikrutz, Cueva de Cubias Negras) were occasionally used.

A non-parametric approach was used in statistical processing (median as a measure of the central tendency, Kruskal-Wallis test, Mann-Whitney U-test, Scheffé test; StatSoft, Inc. 2001), since the distribution of the analysed data generally deviates from normal. The morphology of the 15 best preserved specimens (five from Divje babe I, seven from Potočka zijalka and three from Spain) were additionally studied using principal components analysis (PCA). This method enables a satisfactory explanation of the variation of a given number of basic *X* variables with a (considerably) lower number of principal components (PC_i), which renders the interpretation of the intrasample variability considerably easier (Manly 1994; StatSoft Inc. 2001). Statistical processing was done with the StatSoft software package Statistica for Windows, version 6.0.

RESULTS AND DISCUSSION

GROUPING BY SEX

Grouping the cave bear skulls by sex is usually based on measurements of the transverse and longitudinal diameter of upper canines, since these show explicit sexual dimorphism (Kurtén 1955). Since the canines had been adequately preserved in only eight specimens of the 16 skulls from Divje babe I (*Tab. 15.1*), some other measured dimensions were also used for this purpose.

In view of the findings of various authors (Torres 1988; Grandal d'Anglade 1993b; Pacher 2004a; Grandal d'Anglade, López-González 2005) distinguishing between the sexes in the case of skulls without preserved canines is most reliably done on the basis of the greatest mastoid breadth (Var 8), the greatest zygomatic breadth (Var 11) and the least palatal breadth (Var 16). On the basis of the aforementioned dimensions, it was possible to sex 15 of the 16 skulls in the sample from Divje babe I. The results showed a clear predominance of males (see e.g., *Fig. 15.1*), since 10 of the specimens were ascribed to male bears. Analysis of the long bones (see Chapter 16 in this volume) and metapodials (see Chapter 17 in this volume) also indicate a predominance of males among cave bear remains from the interpleniglacial (≈ OIS 3) layers of Divje babe I. A different picture emerged from analysis of metric data of isolated canines, according to which the share of the two sexes in the sample from OIS 3 is roughly the same (Debeljak 2002b). Probable reasons for these differences in sex ratio assessment are presented in the chapter on cave bear metapodials (see Chapter 17 in this volume).

METRIC ANALYSIS

The value of the results of metric analysis of cave bear skulls from Divje babe I is greatly limited by the smallness of the sample. Nevertheless, some conclusions seem relatively credible. Sexual dimorphism as the main source of variability in the size and shape of the skulls stands out in this sense. While metric data of male and female specimens from Divje babe I generally differ essentially, differences between males from Divje babe I and those from Potočka zijalka were not statistically significant in none of the observed dimensions[1] (Kruskal-Wallis test: $p < 0.05$; *Tab. 15.2*).[2] The only exceptions in this respect are the least breadth of the temporalia (Var 12) and the least palatal breadth, measured in the middle of diastema (Var 16); only in these two cases, namely, do skulls of males form a uniform group with skulls of females from both sites in question.[3]

It follows from the results presented above that difference in the morphology of skulls between males and females from the same site exceed differences among specimens of the same sex from different sites. This is probably not a result of (too) few satisfactorily preserved finds, as can be seen from the greatest zygomatic breadth of skulls of both sexes from a number of different Upper Pleistocene sites (*Fig. 15.2*). The finds represented on the graph, namely, "cover" several tens of thousands of years, in which certain evolutionary changes in the morphology of skulls probably occurred. Nevertheless, differences in the dimensions treated between specimens of the two sexes remain highly statistically significant (Mann-Whitney U-test: $p < 0.001$), and among skulls of the same sex practically negligible (Kruskal-Wallis test: $p = 0.163$ (males); $p = 0.193$ (females)).

The same conclusion was reached by principal component analysis, i.e. by simultaneously taking into account a number of different measured dimensions. Although it was not possible to include all 18 dimensions in the analysis (because of fragmentation of the majority of skulls some measurements could not have been taken; see *Annex 15.1*), the seven chosen include measurements of both length and width. These are: total length (Var 1), greatest mastoid breadth (Var 8), greatest zygomatic breadth (Var 11), least breadth of temporalia (Var 12), greatest frontal breadth (Var 13), least breadth between the orbis (Var 14) and the length of check-teeth row (Var 18). A projection of the skulls of cave bears from Divje babe I, Potočka zijalka and two Spanish Upper Pleistocene sites[4] on the first and second principal components, which were calculated on the basis of a correlation matrix of the aforementioned seven dimensions, is shown in *Figure 15.3*. As expected, specimens of cave bear from both Slovene sites form two distinct groups, one of males and the other of females. All three specimens from Spain are placed within the context of the latter. Factor loadings for the first three principal components, which together account for 97.1% of the variability of the initial data set, are given in *Table 15.3*. It can be inferred from them that sexual dimorphism appears mainly in width measurements, and less so in length. Cave bear skulls from Spain, Austria, Germany and Belgium (Grandal d'Anglade 1993b; Pacher 2004a; Grandal d'Anglade, López-González 2005) show a similar pattern.

In contrast with the pronounced sexual dimorphism, intrasexual variability in the morphology of cave bear skulls from individual sites seems to be more modest. Taking into account the available results (although based on a small sample) differences among specimens of the same sex could perhaps be interpreted as (mainly) individual variability with a mainly phenotypic or epigenotypic background. Namely, the intrasexual variability in the morphology of cave bear skulls is rather limited and is not comparable to differences between skulls of fossil cave and brown bear (*Fig. 15.3*). Similar conclusions in explaining size differences have been reached by Baryshnikov *et al.* (2003) while studying the morphometric variability of check teeth in *Ursus spelaeus* from various Europaean sites.

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[1] Of 18 measured dimensions, only 11 were taken into account in this comparison, since the sample was too small with the others.

[2] Comparison among females from the two sites is not possible, since only one skull of a female bear from Potočka zijalka is adequately preserved (Pacher 2004).

[3] In view of the results of the Scheffé test (= one of the better conservative post-hoc statistical tests), males and females also form a uniform group with the length of cheeck teeth row (Var 18).

[4] These are the sites Cueva de Arrikrutz (Würm III) and Cueva de Cubias Negras (Würm).

CONCLUSION

Metric study of cave bear skulls from Divje babe I is limited by the paucity of adequately preserved finds and the small number of female specimens in the comparative sample from Potočka zijalka. Nevertheless, the results obtained correspond with the findings of other authors, suggesting their reliability. The predominance of male cave bear skulls[5] entirely corresponds to the results of the study of long bones (see Chapter 16 in this volume) and metapodials (see Chapter 17 in this volume) from the same site. Namely, in both studies the majority of cave bear remains from OIS 3 were also ascribed to male specimens.

It is also interesting, and in line with the conclusions of some other authors (e.g., Grandal d'Anglade 1993b; Pacher 2004a), that differences in the morphology of skulls between males and females from the same site (normally) significantly exceed differences among specimens of the same sex from different sites. Furthermore, differences among skulls of males from Divje babe I and those from Potočka zijalka are below the limit of statistical significance in all observed dimensions (*Tab. 15.2*). Differences among the skulls of females from the two sites also seem negligible (*Fig. 15.3*). Rabeder *et al.* (2004b), on the basis of the dimensions of molars, morphodynamic indexes of check teeth and the index of plumpness of metopodials, established that bears from Potočka zijalka are phylogenetically very close to "Gamssulzen bear". The latter is being treated as an independent species *Ursus ingressus* Rabeder *et al.* 2004, as it was shown also by the analyses of fossil DNA (Rabeder *et al.* 2004c; but see also Orlando *et al.* 2002). In view of the similarity in the morphology of the cave bear skulls from Potočka zijalka and those from Divje babe I, it would thus be justifiable to ascribe the cave bear from Divje babe I to *U. ingressus*, too. In accordance with the assumptions of Rabeder and Hofreiter (2004), namely, this species is assumed to have immigrated into the Alps around 50,000 BP, whereupon it gradually replaced *U. spelaeus* in the area. However, the location of the analysed cave bear skulls from Divje babe I on *Figure 15.3*, does not support such a conclusion. Namely, the available specimens from the concluding parts of OIS 4 and the introductory phases of OIS 3 (i.e., facies B[6]) do not deviate in the observed dimensions from those from the central part of OIS 3 (i.e., facies A[7]), and similarly also not from those from Potočka zijalka, which are dated to the very end of OIS 3. At the same time, all three specimens of the same sex from Spain are placed in the group of males from the two Slovene sites.

It is of course possible that the relative position of specimens on *Figure 15.3* would change to some extent with a larger sample size, thus allowing for a different (i.e., more phylogenetically oriented) interpretation of the emerged morphological differences between analyzed skulls than the one based on sexual dimorphism. On the other hand, it is also worth highlighting some potentially problematic steps in the procedure of constructing the phylogenetic tree of Rabeder *et al.* (2004), such as the uncompromising link of the index of plumpness of metapodials with the evolutionary rate of cave bears (e.g., Hofreiter *et al.* 2004 (see also supplement data available with the article online); Withalm 2001; 2004).[8] Moreover, Grandal d'Anglade and López-González (2005) argue that sexual dimorphism has by far the most noticeable effects in the size and shape of cave bear skulls. The role of other sources of intraspecific variability (e.g., clinal variation of a geographical or chronological nature, polytypism) seems to be, on the contrary, rather limited.

ACKNOWLEDGEMENT

I am grateful to Dr. Ivan Turk, who enabled me to study the material in question. I am also grateful for the simulating discussions which accompanied the entire course of the research.

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[5] The sex ratio is 10 : 5 to the advantage of males.

[6] Sediment of facies B is thought to have been deposited in the period from approx. 65,000 to approx. 48,000 years ago (see Chapters 6 and 7 in this volume).

[7] Sediment of facies A is thought to have been deposited in the period from approx. 48,000 to approx. 35,000 years ago (see Chapters 6 and 7 in this volume).

[8] The problem is discussed in more detail in the chapter on cave bear metapodials (see Chapter 17 in this volume) and by Toškan (2007).

PRILOGA / ANNEX

Pril. 15.1: Dimenzije izmerjenih lobanj jamskega medveda (*Ursus spelaeus*) iz Divjih bab I. Vsi primerki so interpleniglacialne (≈ OIS 3) starosti. Lobanje so bile merjene v skladu z navodili, ki jih je objavil Torres (1988). Posamezne dimenzije so predstavljene v nadaljevanju. Vse mere so izražene v mm.
Tab. 15.1: Dimensions of measured skulls of cave bear (*Ursus spelaeus*) from Divje babe I. All specimens are of Interpleniglacial (≈ OIS 3) age. The skulls were measured in accordance with the instructions published by Torres (1988). Individual dimensions are shown below. All measurements are in mm.

Var.	**Inventory number**															
	962	**1277**	**1313**	**1397**	**1398**	**1400**	**1848**	**1993**	**1995**	**1996**	**2033**	**2123**	**2124**	**2343**	**2349**	**s.n.**
1	419.0	481.5	–	473.0	–	483.0	441.5	–	–	–	392.0	427.5	–	–	476.5	457.0
2	382.0	444.5	–	419.0	–	424.5	396.0	–	–	–	351.0	378.0	–	–	–	–
4	178.0	195.5	–	198.5	196.0	201.0	191.0	–	201.0	–	167.5	178.0	–	–	192.5	–
5	–	100.0	–	–	–	–	95.5	–	–	–	–	–	–	100.0	–	–
6	222.5	–	–	253.0	–	364.5	244.5	–	–	–	–	233.0	–	–	255.0	–
8	179.0	–	229.5	212.5	221.5	229.5	209.0	–	–	–	–	170.5	–	179.0	210.0	240.0
9	79.0	–	–	86.5	–	94.0	87.0	–	–	–	–	81.0	–	76.5	–	–
10	33.0	38.0	39.0	37.0	40.0	40.0	37.0	–	–	–	34.0	37.0	–	35.0	–	–
11	253.0	–	294.0	285.0	279.5	–	263.0	–	–	–	–	238.0	–	213.5	279.0	–
12	83.0	87.5	–	83.0	–	82.5	84.5	–	–	–	80.0	81.5	–	85.0	82.0	–
13	118.5	135.0	–	130.5	–	–	113.5	–	–	–	112.5	120.5	–	111.5	137.5	–
14	88.5	96.0	–	98.0	–	–	89.0	71.0	–	–	82.0	85.0	–	91.5	101.5	–
15	63.0	–	69.0	–	–	67.0	59.0	59.5	65.0	59.0	57.0	67.5	67.0	–	72.0	–
16	74.0	83.0	–	89.0	83.0	82.0	75.5	73.5	87.0	75.0	73.5	–	–	–	86.0	–
17	135.5	146.0	–	–	–	–	130.0	121.0	143.0	129.0	125.0	133.5	–	–	143.0	–
18	89.0	93.0	100.5	94.0	99.0	97.0	88.0	92.0	98.0	84.0	86.0	85.0	–	83.0	91.0	89.0
19	72.0	73.0	76.5	70.0	72.5	73.5	71.0	72.0	74.0	64.0	69.0	67.5	–	63.0	–	–
20	16.5	–	26.0	–	–	25.0	21.0	20.0	–	19.5	–	18.0	–	–	–	22.5

Uporabljene okrajšave / Abbreviations (*cf.* Torres 1988):
Var 1 – največja dolžina (Acrocranion-Posthion) / total length (Acrocranion-Posthion)
Var 2 – bazalna dolžina (Basion-Prosthion) / basal length (Basion-Prosthion)
Var 4 – zobna dolžina (Postdentale-Prosthion) / dental length (Postdentale-Prosthion)
Var 5 – nosna dolžina (Rhinion-Nasion) / nasal length (Rhinion-Nasion)
Var 6 – dolžina trdega neba (Staphylion-Posthion) / length of hard palate (Staphylion-Posthion)
Var 8 – največja mastoidna širina (Otion-Otion) / greatest mastoid breadth (Otion-Otion)
Var 9 – največja širina zatilnih čvršev / greatest breadth of the occipital condyles
Var 10 – največja širina velike line / greatest breadth of the foramen magnum
Var 11 – največja zigomatična širina (Zygion-Zygion) / greatest zygomatic breadth (Zygion-Zygion)
Var 12 – najmanjša širina senčne kosti / least breadth of the temporalia
Var 13 – največja širina čela (Ectorbitale-Ectorbitale) / greatest frontal breadth (Ectorbitale-Ectorbitale)
Var 14 – najmanjša širina med očnicama (Entorbitale-Entorbitale) / least breadth between the orbits (Entorbitale-Entorbitale)
Var 15 – širina neba (merjeno med jezičnima robovoma M^2) / palatal breadth (measured at lingual borders of M^2)
Var 16 – najmanjša širina neba (merjeno na sredini diasteme) / least palatal breadth (measured in the middle of diastema)
Var 17 – dolžina od posteriornega roba C^1 do posteriornega roba M^2 / length between the posterior border of C^1 and the posterior border of M^2
Var 18 – dolžina kočnikov / length of cheek teeth row
Var 19 – dolžina meljakov / length of molar row
Var 20 – širina krone C^1 / crown breadth of C^1

16. VELIKE DOLGE KOSTI JAMSKEGA MEDVEDA IZ NAJDIŠČA DIVJE BABE I

GORDANA JAMBREŠIĆ in IVAN TURK

Izvleček

Velike dolge kosti jamskega medveda so bile analizirane osteometrično s pomočjo bi- in multivariatnih statističnih tehnik. Cilj raziskave je bil razlikovati med velikimi dolgimi kostmi okončin glede na velikost oz. spol in stratigrafsko lego.

Zaradi selektivnih tafonomskih dejavnikov vzorci posamičnih velikih dolgih kosti ne pripadajo več enotni statistični populaciji (glej *sl. 16.2*). Tej se najbolj približa vzorec golenic (*tab. 16.2e*), ki sva ga zato podrobneje raziskala, rezultate pa imava za reprezentativne za vse velike dolge kosti okončin v najdišču.

Najprej sva s kombinacijo širinskih in širinsko-dolžinskih mer preverila, ali imamo v vzorcu golenic zastopane hkrati velike medvede in medvede, ki so hkrati majhni in čokati. Širinske mere kosti takšnih medvedov bi se namreč lahko med seboj prekrivale. *Slika 16.3 a, b* kaže, da ni tako. Nato sva vzorec golenic preučila razdeljen v facije A–C, ki domnevno predstavljajo določen tip klime in okolja (glej poglavje 7 v tem zborniku) in ga nedvomno kronološko stratificirajo.

Slika 16.4a, b kaže, da med facijami ni razlik, kar zadeva velikosti golenic. To pomeni, da razlaga o razvojnih spremembah in/ali imigraciji (Rabeder *et al.* 2004c) ne drži ter da lahko razloživa velikostni skupini samo s spolnim dimorfizmom. Edino izjemo lahko eventualno predstavlja facija C, ki se, kot kaže, nahaja med obema velikostnima skupinama, kar bi lahko pomenilo, da gre za biometrično drugačno populacijo.

Tako v facijah A kot B je več večjih in robustnejših primerkov, kar razlagava s prevlado samcev. V faciji C je lahko ravno obratno. Če je v faciji C, za katero je domnevno značilna mila klima, domnevno en samec na pet samic, v facijah B in A, za kateri je domnevno značilna hladna in vlažna klima, pa se to razmerje nedvomno poveča na škodo samic, to lahko kaže na rivalstva med spoloma.

To poglavje je bilo prvotno mišljeno kot študija ocene telesne teže jamskega medveda in pripadnosti spoloma na njeni podlagi (Jambrešić, neobjavljeno). Z regresijsko enačbo, dobljeno s pomočjo znanih podatkov o telesni teži, spolu in merah velikih dolgih kosti živečih medvedov, je samo na podlagi mer teoretično mogoče oceniti težo živali in na podlagi telesne teže (mase) določiti spol (Damuth, MacFadden 1990). V teoriji je stvar jasna, v praksi pa naletimo na vrsto težav, ki se jih zaradi pomanjkljivih podatkov o živečih medvedih in metodoloških zapletov pri fosilem gradivu ne da odpraviti. Zato je prva navedena avtorica poizkus na koncu opustila in se skupaj z drugim navedenim avtorjem rajši posvetila izključno analizi neposrednih osteometričnih podatkov velikih dolgih kosti jamskega medveda, najdenih v Divjih babah I v plasteh facijev A, B in C (glej poglavji 1 in 7 v tem zborniku). Analiza naju je pripeljala do nekaterih zanimivih sklepov, ki bi jih veljalo upoštevati pri razlagi rezultatov bodočih raziskav na tem področju.

Velike dolge kosti jamskega medveda so bile od nekdaj predmet intenzivnega preučevanja. Pri tem so se uporabljale kvantitativne osteometrične tehnike v povezavi s statističnimi tehnikami. Cilji takšnih raziskav niso bili vedno jasno določeni. Večinoma je šlo za ugotavljanje variacijskega razpona posameznih skeletnih delov in ugotavljanje pripadnosti vrsti *Ursus spelaeus* (prim. Rakovec 1967). V skrajnem primeru tudi za določevanje novih vrst in podvrst, kot so *Ursus ingressus*, *Ursus spelaeus eremus* in *Ursus spelaeus ladinicus* (Kavcik, Rabeder 2004).

Cilji najine osteometrične analize, do katerih bi prišla korakoma, so bili:

Prvi korak: Razlikovanje med velikimi dolgimi kostmi okončin glede na velikost oz. spol. Pri medvedih je spolni dimorfizem izražen med drugim tudi v velikosti in mišični masi – samci so praviloma večji in močnejši kot samice (Stubbe 1993), kar se odslikava tudi v kosteh. Če je osebek večji in bolj mišičast, ima večje vse ali večino kostnih mer. Vendar moramo razlikovati med naslednjimi telesnimi tipi: 1.) veliki in mišičasti, 2.) veliki, 3.) majhni in mišičasti, 4.) majhni. Zato razlikovanje po spolu zgolj na podlagi kostnih mer ni niti enostavno niti popolno.

Drugi korak: Stratigrafska analiza vzorca ali vzorcev kosti, razčlenjenih (statistično stratificiranih) na podlagi mer v dve izraziti skupini, ki bi lahko predstavljali bodisi samce in samice bodisi populaciji z različnimi telesnimi merami. Namen stratigrafske analize je ugotoviti morebitne spremembe v spolni sestavi v času ali spremembe, povezane s populacijama z različnimi telesnimi merami. Slednje spremembe bi lahko pripisala razvojnim težnjam obstoječe vrste jamskega medveda ali imigraciji nove vrste ali podvrste medveda (glej Rabeder *et al.* 2004c). Spremembe v spolni sestavi ali v populacijskih značilnostih bi lahko razložila z domnevnimi podnebnimi in okoljskimi spremembami (glej poglavja 5, 6 in 7 v tem zborniku) ter odzivanjem jamskega medveda nanje v smislu tekmovanja med spoloma za jamo brlog oz. v smislu sicer spornega Bergmanovega pravila o korelaciji med telesno maso in klimo.

V kolikor bi bile potrjene kakršne koli spremembe v stratigrafskem nizu, bi bilo smoterno primerjati najin vzorec z vzorci iz drugih najdišč, ki bi bili enako razčlenjeni (stratificirani) na samce in samice oz. velike in majhne primerke ter kronološko zanesljivo opredeljeni. V nasprotnem primeru so vzorci časovno in v notranji zgradbi tako neenotni, da je vsaka primerjava nesmiselna, rezultat primerjave pa zavajajoč (toda glej Kavcik, Rabeder 2004).

Pri razlagi osteometričnih podatkov naletimo na več težav, ki so značilne tudi za vzorec iz Divjih bab I.

Prvič, vzorci v večini najdišč so majhni, in ko jih tako ali drugače stratificiramo, niso več primerno veliki za kvantitativno preučevanje.

Drugič, vsi vzorci so časovno neenotni. Če bi hoteli dobiti časovno enoten vzorec, ki bi npr. obsegal obdobje 100 let in manj, bi se njegova velikost skrčila na vsega nekaj primerkov.

Tretjič, mednajdiščne primerjave ne omogočajo zanesljivih rezultatov zaradi različne časovne neenotnosti vzorcev, tudi ko gre za »sočasna« najdišča (glej uvodno poglavje v tem zborniku).

Četrtič, značilnosti vzorca so zelo odvisne od spolne sestave žive in posledično mrtve ter fosilne populacije, prisotne v najdišču.

Petič, čeprav vse velike dolge kosti po definiciji pripadajo isti populaciji skeletnih delov, dejansko to ne drži zaradi tafonomskega desetkanja (glej podpoglavje 12.4. v tem zborniku, *tab. 12.4.1, sl. 12.4.12*).

Šestič, različne mere lahko različno pripomorejo k razlikovanju med spoloma.

METODA IN GRADIVO

Vzorec adultnih velikih dolgih kosti iz Divjih bab I obsega celotno najdišče oz. tako gradivo izkopavanj M. Brodarja kot J. Dirjeca in I. Turka. Zato ni utežen po stratigrafskih enotah, ki jih tokrat predstavljajo sedimentne plasti z različnimi prostorninami. Ker vzorec obsega obdobje 70.000 let, nas upravičeno zanima, če je v tem času prišlo do razlik v osteometriji in/ali spolni sestavi na podlagi spolnega dimorfizma in/ali populacijskih sprememb. Slednje so bile doslej ugotovljene predvsem med najdišči in se razlagajo bodisi razvojno bodisi taksonomsko (Kavcik, Rabeder 2004).

Od skupno 271 izmerjenih adultnih celih velikih kosti okončin jamskega medveda iz različnih sedimentnih plasti, sva jih statistično analizirala 234, in sicer: 19 humerusov, 70 radiusov, 49 uln, 27 femurjev in 69 tibij (*tab. 16.2a-e*). V standardiziranem bloku sedimentov s prostornino 95 m^3 je bilo 73 adultnih humerusov, 91 adultnih radiusov, 85 adultnih uln, 71 adultnih femurjev, 129 adultnih tibij in 195 adultnih fibul (glej podpoglavje 12.4 v tem zborniku, *tab. 12.4.1*). Od tega je bilo celih 14 humerusov (19 %), 23 radiusov (25 %), 27 uln (32 %), 18 femurjev (25 %), 40 tibij (31 %) in 10 fibul (5 %). Če ne bi bile vse naštete kosti selektivno fragmentirane, bi odstotni deleži kazali zaporedje relativne zastopanosti celih velikih dolgih kosti odraslih jamskih medvedov glede na njihovo trdnost.

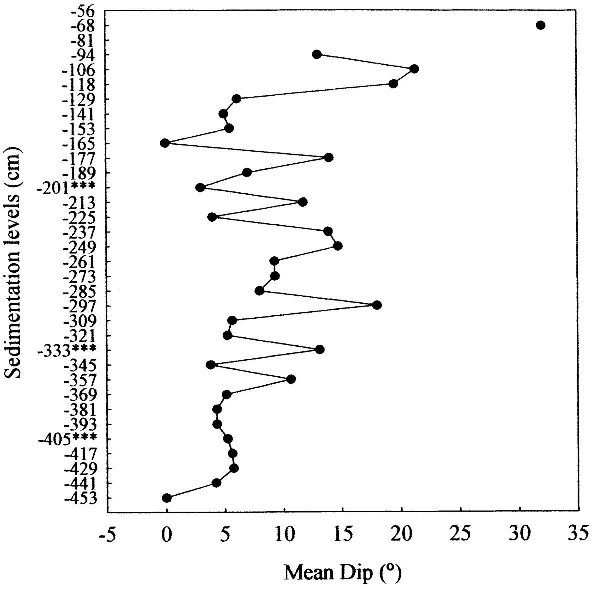
Vse meritve na kosteh je opravila G. Jambrešić s kljunastim merilom v skladu z navodili Von den Drieschove (1976) in drugih avtorjev (Reisinger 1995; Tsoukala, Grandal d'Anglade 1997, 2002). Naklon kosti v sedimentu je meril J. Dirjec, in sicer tako za cele velike dolge kosti kot njihove večje odlomke.

Analitski del raziskave je bil narejen s pomočjo programa STATISTICA 6.0, StatSoft 2001.

Najdbe hrani Narodni muzej Slovenije v Ljubljani.

NAKLONSKI KOT VELIKIH DOLGIH KOSTI V SEDIMENTU

Velik naklon kosti v sedimentu lahko povežemo s posedimentnimi premiki zaradi bio- in predvsem krioturbacije. Ker so bile vse plasti odložene subhorizontalno, so arbitrarno določeni normalni naklonski koti, upoštevaje naklon plasti, veliki do 10°.



Sl. 16.1: Srednja vrednost naklonskih kotov velikih dolgih kosti v sedimentacijskih nivojih bloka sedimentov s prostornino 95 m^3.
Fig. 16.1: Mean value of angle of inclination of large long bones in sedimentation levels of block of sediments with a volume of 95 m^3.

Naklonski kot smo izmerili 347 kostem, najdenimi pri izkopavanjih J. Dirjeca in I. Turka v osrednjem delu jame. Od tega je imelo kot do vključno 10° 248 kosti, od 11° do 20° 54 kosti, od 21° do 30° 17 kosti, od 31° do 40° 12 kosti, od 41° do 50° 8 kosti, od 51° do 60° dve kosti od 61° do 70° ena kost, od 71° do 80° dve kosti in od 80° do 90° tri kosti.

Naklonski koti v sedimentacijskih nivojih standardnega bloka sedimentov s prostornino 95 m^3 so prikazani v *tab. 16.1* in na *sl. 16.1*. Koti, večji od 30°, so značilni za sedimentacijske nivoje plasti 4 in sosednjih plasti (–68 cm do –118 cm), ki so bile krioturbatno nagubane v času poznega glacialnega vrhunca (glej poglavji 4 in 5 v tem zborniku), ter plasti 8, ki ni nagubana. Velik na-

Tab. 16.1: Naklonski koti velikih dolgih kosti v sedimentacijskih nivojih bloka sedimentov s prostornino 95 m^3. Število meritev je popolnoma odvisno od gostote najdb (glej Turk 2006, sl. 12).
Tab. 16.1: Angle of inclination of large long bones in sedimentation levels of block of sediments with a volume of 95 m^3. The number of measurements depends entirely on the density of finds (see Turk 2006, Fig. 12).

Sedimentation level (cm)	Facies	Dip (degree)																	Mean Dip (degree)
-20	A																		
-32	A																		
-44	A																		
-56	A																		
-68	A	**32**																	32.0
-81	A																		
-94	A	26	0																13.0
-106	A	2	5	**90**	20	8	3	21											21.3
-118	A	7	4	**45**	25	**34**	2												19.5
-129	A	4	3	6	3	10	11												6.2
-141	A	4	6																5.0
-153	A	6	7	6	3														5.5
-165	A	0																	0.0
-177	A	14																	14.0
-189	A	7																	7.0
-201***	A	0	6																3.0
-213	A	**33**	3	3	8														11.8
-225	A	4	3	0	6	5	6												4.0
-237	B	5	9	8	2	7	20	7	5	2	13	19	**51**	25	7	15	9	32	13.9
-249	B	9	7	2	5	21	15	**44**											14.7
-261	B	3	7	10	16	11	9	9											9.3
-273	B	5	8	9	12	10	12												9.3
-285	B	12	10	5	9	6	7	7											8.0
-297	B	7	9	6	**47**	10	**35**	21	9										18.0
-309	B	6	4	7															5.7
-321	B	6	6	4	7	4	4	6	7	6	2	6	9	5	7	0			5.3
-333***	B	4	17	**32**	5	10	22	12	16	0									13.1
-345	B	0	0	0	0	19													3.8
-357	B	0	22	6	7	0	15	28	12	6									10.7
-369	B	3	11	0	17	0	5	0											5.1
-381	B	0	10	3															4.3
-393	B	0	10	7	0	7	2												4.3
-405***	B	12	10	0	20	0	0	0	0										5.3
-417	B	7	3	0	12	0	7	3	24	4	2	0							5.6
-429	B	11	7	3	2														5.8
-441	C-1	3	7	0	7														4.3
-453	C-1	0	0																0.0

klon posameznih kosti v plasti 8 zato pripisujeva predvsem bioturbaciji. Če upoštevamo številčnost kostnih ostankov (glej poglavje 12 v tem zborniku, *tab. 12.3.1*), je v plasti 4 in sosednjih plasteh (facija A) relativno precej več kosti z velikim naklonskim kotom kot v plasti 8 (facija B). V spodnjem delu profila (facija C) je naklonski kot kosti najmanjši, in to kljub zgodnjemu glacialnemu vrhuncu, ki je sledil po njihovi odložitvi (glej poglavje 7 v tem zborniku). V zgodnjem glacialnem vrhuncu tudi ni prišlo do izrazitejšega gubanja plasti zaradi delovanja zmrzali.

V profilu najdišča je jasno izražena težnja po zmanjševanju naklonskega kota od zgoraj navzdol oz. od poznega do zgodnjega glacialnega vrhunca (*sl. 16.1*), kar se, mimogrede, ujema s trendom temperaturne krivulje virmskega glaciala v najdišču in drugje (poglavje 6 v tem zborniku, *sl. 6.7a, b*; Turk 2006, sl. 12).

ANALIZA OSTEOMETRIČNIH PODATKOV
REZULTATI, RAZPRAVA IN SKLEPI

Vse mere vsake posamezne kosti in vsaka mera posebej opredeljujejo določenega medveda (samca, samico, velikega, veliko, majhnega, majhno, vitkega, vitko, čokatega, čokato). V normalnih okoliščinah bi se mere podvajale in kvantitativne analize bi dajale enoznačne rezultate. V nenormalnih okoliščinah, ki smo jim priča v arheološki praksi, pa so stvari veliko bolj zapletene.

V *tabeli 16.2a-e* je podana vrsta standardnih mer velikih dolgih kosti, ki pripadajo različnim primerkom medvedov, ki so živeli v različnem času. Zaradi tega enake ali podobne analize mer posameznih kosti ne dajo enoznačnih rezultatov. To je razvidno tudi iz porazdelitve metričnih podatkov, ki je pri nekaterih merah in kosteh bimodalna, pri drugih pa ne oz. je normalna (*sl. 16.2a, b*). Zato sva se v prikazu in razlagi rezultatov osteomometrije omejila na eno izmed velikih dolgih kosti, za katero sva s pomočjo statističnih raziskovalnih tehnik ugotovila, da njene mere največ obetajo v interpretacijskem smislu. Multivariatna analiza (dvodimenzionalno skaliranje) vseh mer vsake velike dolge kosti posebej ni dala pričakovanega smiselnega rezultata pri razporeditvi kosti v facije, ker so vzorci velikih dolgih kosti preveč neenotni, nekateri, kot npr. vzorec nadlahtnic (*humerus*) in stegnenic (*femur*), pa so sploh premajhni za statistično analizo. V smislu enotnosti vzorcev je največ obetal rezultat multivariatne analize vseh mer golenice (*tibia*), ki je razen tega med bolje ohranjenimi in je v najdišču zastopana v dovolj velikem številu. Zato sva njene mere podrobneje analizirala v stratigrafsko razčlenjenem (stratificiranem) vzorcu, rezultate pa štejeva za reprezentativne za vse velike dolge kosti okončin v najdišču. Pri tem se zavedava, da bi večji vzorci verjetno izboljšali izid analize, tako da bi pripomogli k razlikovanju med statističnimi stratumi vzorcev v času in prostoru.

Najprej sva s kombinacijo širinskih in širinsko-dolžinskih mer preverila, ali imamo v vzorcu zastopane hkrati velike medvede in medvede, ki so hkrati majhni in čokati. Širinske mere kosti takšnih medvedov bi se namreč lahko med seboj prekrivale. *Slika 16.3 a, b* kaže, da ni tako.

Tab. 16.2a-e: Mere velikih dolgih kosti jamskega medveda iz Divjih bab I.
Tab. 16.2a-e: Measurements of large long bones of cave bear from Divje babe I.

HUMERUS n°	Layer	GL	PL	Bp	Dp	SD	SDm	Bd	BT	DT caput	DAP caput
29	13	284	273	73		40	45	106	77		
135	4					42	48	126	87		
344	4					48	56.5	125	91		
549	20	417	405	87	105	39	49	129	89	72	75
1328	4	450	435	87	112	45	52	129	89		74
1414	5b	473	456	90.5	105	44	60.5	140	94	77	79
1660	5	423	410	90	99	43	59.5	125	88	78	79
1676	5					48	58	130	99		
1792	8	437	420	90	107.5	39	55		87	75	76
1928	8	415	405			49	54	133	89		
1933	8	423	412			42	52	131	91		
1935	8	400	390	86.5	100	44	50	122	86	75	76
2187	8	390	380	84.5	93.5	40	50		78	73	76
2188	8					43	57.5	117	89		
2189	8 or 10					42	47	105	76		
2409	11							95.3	66.1		
2411	10-11.							101.3	63		
2414	12-13					33.5	39	100	72.5		
2415	11					41	49.5	124	85.5		

Tab. 16.2b

ULNA n°	Layer	GL	DPA	Bp	BIT	SD	SDm	Bd	HPaT
s. n.	2–7	377	80	88	49	29	35	53	92
s. n.	2–7	387	79	84	46	35	42	54	84
120	2–7	390	84	91	52	31.5	37	55	95
134	4	386	78	85	48	33	38	55	95
315	3	397	83.5	89.5	50	27	34	50.5	95
342	3				47.5	30	36		91
343	4	329	72	77	41.5	26	30	48.5	78
356	4	383			49	31.5	37.5		
360	4–5	360	79	84	44	29	36	50	92
370	5–6	400	80		52.5	31	40		
387	?13	340	70	74	41	24	28	44	82
552	18–19	390	83	88	54	27	38	50	88
622	?5	406	82	93	50.5	36	41.5	56	94
1114	3–5a	365			50	29	37	53	
1133	3–5a	396			52	33	37	53	
1244	3–5a	376			50	33	46	55	
1282	3–5a	377			50	30	37	51	
1325	4	400	82	92	51.5	28	35	54.5	94
1327	4	385	85	91	53	30	40	53	90
1333	4–5	375	76	85.5	50.5	29	38.5	51.5	93
1344	4 ?	390	80	90	51	32	42	57	
1358	4 ?	400	81	90	52.5	31	37.5	55	92
1429	5	359	81	86	49	29	37	56	95
1431	5b	390	77	87	51	29	40	55	91.5
1662	7 or 8	369			52	30	39	50	
1695	8	326	67	72	40.5	26.5	30	46.5	82
1798	8	370			51	31	38.5	50.5	
1799	8	365	85	94	52.5	36	40	54	100
1800	8		86	93	52.5	33	40		96
1835	8	360	81.5	89.5	48.5	29	39	54	93.5
1941	8	384	81	87	52	29	35	52	87
1942	8	365	74	81	47.5	30	38	52	88
2190	8	385	77.5	92	49.5	33.5	41	55	101
2196	8 or 10	330	68	71	43.5	23	29	43	77
2199	8	377	77.5	84	54	29	35	53	90
2200	8	358	76	84	45	28.5	38	54	81
2201	8	333	65.5	70	39.5	24	28	43	81
2202	8		86	84	50.5				89
2204	8 or 10		76	83	48				93
2279	8	384	75	87	51	28	35		88
2285	8	310	62	65	41.5	23	32	43.5	75
2287	11	350	64	69	41.5	27	33	44	80.5
2365	13		55	63	36.2	20.6	31.4		
2366	11-12.		81	88	49	26.5	33		95
2369	11-12.		67	78	49	22.5	31		82
2370	12-13.	333			42	21	27.5	44	
2371	13		56	62.5	37	22	25.5		73
2372	12-13.	333	59.5	67	37	20	21.5	40.5	75
2373	11	377	73	82.5	49	27.5	34	53	95

Tab. 16.2c

RADIUS nº	Layer	GL	PL	Bp	SD	Bd	LCr	BCr	LC	DAP art.
s. n.	8	317	295	50	24	77.5	51	37	53	26
s. n.	8	324	295	51	30	76	51	34	63	31
11	8	340	315	56	25.5	86.5	55	41	57	27
161	2	287	270	41	19	57	41		46	24
166	3	290	273	44	19	63			45	27
201	17	289	270	38	16	67	38	21.5	43	25
215	17	267	250	42	20	67	41	26	46	27
312	4	322	300	52	28	76.5	52	35	52	29
391	8	277	260	42	19	65	42	23	45	24
409	11–13.	320	303	54	25	78	54	38	56	29
422	13–14?	333	310	54	22.5	75	53	33	53	28
506	14	296	275	42	23		41	22	44	23
524	10	327	310	48.5	23.5	71	47	30	50	26.5
533	13–14	275	257		17	61			44	24
550	18–19	290	270	45	18	69	45	31	52	24
551	20	277	255		21	55			44	21
623	2	326	300	52	25	82	51	37	54	26
691	3	304	283	42	20	68	42	27	49	23.5
694	3	342	315	52	25	70	52	36.5	58	29
767	3	322	300	52	26	70.5	51		54	25
1144	3–5a	330	305	50	24	78.5	51	36	52.5	28
1152	3–5a	317	293	50	24	78.5	50	37	55	28.5
1209	3–5a	335	312	50.5	25	79.5	49		55	28.5
1264	5	343	320	52	25	83	52	34	55	25
1283	4–5.	310	288	43	21	71	42	29	49	27
1291	5	333	305	48	25	77	47	28	51	29
1362	5	292	270	46	20	63	45	25	47.5	26.5
1363	4	333	310	51	26.5	84	51	35	55	27
1394	4–5.	329	300	53.5	22.5	82.5	52	27	59	32
1401	3–5a	325	305	52	24	80	52	37	55	27.5
1413	5	315	295	48	24	73.5	48	34	50	26
1417	4–5.	322	297	51	25	79	50.5	29	58	26.5
1418	5	320	295	52	26	80	51	33	55	28
1421	5?	316	296	45	25	68	43	21	48	27
1613	8	307	290	44	20	63	43	27	42	23
1625	7 or 8	272	252	39	20	58.5	38.5	23	42	25
1635	5	343	320	55	28	80.5	54	30	60	32
1802	8	320	300		26	71.5			53.5	27.5
1803	8	325	300	51	25	72	51	29	56	30
1804	8	282	265	41	21	65	40.5	26	42.5	23
1805	8	332	310	50	23	81	49	31	53	26.5
1806	8	267	250	40	18	60	39	21	41	22
1947	8	315	290	47	27	76.5	46	30	54	29
1948	8	315	290	52	23	80.5	52		54.5	
1949	8	305	280	50	27	75	49		53	26
1950	8	346	325	48	27	76	48	23	51	26
1951	8	310	285	50	26	79.5	51	35	58.5	
1952	8	280	260	43.5	18	64	42	25.5	48	28
1953	8	280	263	45	19	64	45	29	46	24
1954	8	270	251	43.5	19	66	43	26	50	24
1956	8	275	253		18.5	60	39	23	44	25

continued...

Tab. 16.2c (nadaljevanje /cont.)

RADIUS n°	Layer	GL	PL	Bp	SD	Bd	LCr	BCr	LC	DAP art.
2219	8	315	300	50.5	23.5	78	50	35	57	29
2220	8 or 10	326	302	50	27	73	49	34	52	29
2221	8	325	300	54	25	73.5	53	36	59	30
2222	8 or 10	320	290	52	22	80	51.5	32	54	29
2223	8	350	282	49	25.5	77	48	31	48	28
2224	8	307	290	49	24	75.5	47	37	52	27
2225	8	335	315	52	32	74	52	37.5	61.5	29.5
2228	8	315	300	54	24	76	54	32	55	26.5
2290	8	315	293	50	25	75			56	30
2291	10	325	305	47	23	72	47	29	48	29
2292	11	280	265	39	18	69	39	25	44	26
2293	10 or 11			46	24					
2294	8	279	260	40	20.5	57	39.5	24	47.5	28.5
2359	13	325	305	48.2	23	74	49	35	51.5	25.3
2394	11				15	60			38.5	19
2396	12-13.	290	275	42	17	62			43	23
2399	12	335	310	45.5	22	76.5	46.5	33	52	25.5
2404	12	316	298	45	20	66.5			52.5	25.5
2405	13	295	276	37	17.5	61	37	24.5	42.5	20

Tab. 16.2d

FEMUR n°	Layer	GL	PL	Bp	SD	SDm	Bd	DC	DT caput
170	13	460			45	35	106	58	58
200	17	392	370	103	38	29	90	49	48
381	13	395	365	105	38	27	92	53	51
620	3 or 4	390	378	101	42	31	92.5	52	51
621	?5	459	460	143	52	39.5	115	65	64
1227	3–5a	465	432	132	49	36	104	60	60
1278	5	455	431	140	49	40	110	60	57
1334	4–5.	445	423	131	48	36	107	59	59
1416	5	460	430	130	42	33	105	55	57
1632	4 or 5	420			44	32	105	56	55
1650	7	500	463		48	36.5	112	58	60
1688	8	425	405	124	41	34	108	57.5	56.5
1749	8	457			47	35	110	60.5	61
1793	8	450	427	137	50	38	111	61	61
1830	8	450	417		47	34	106		62
1961	8	430	405	133	50.5	37	110	60	59
1968	?8	450	423	119	42	33.5	105		
1969	?8	442	421	117	45	33.5	100	57	58
1972	?8			118	47.5	33		55	54
2238	8	460	423	129	45	34	102	57	57
2239	8	365	353	103	37.5	29	86.5		
2302	10				45	32	103		
2351	13				33.5	26	87		
2352	14				39	27	88.5		
2355	11	387	367	111	36.5	25	86.5	47	44
2357	14	373	353	98.5	36	23	84		
2416	14			108	37.5	23		47	42.5

Tab. 16.2e

TIBIA n°	Auxiliary n°	Layer	Facies	GL	Bp	SD	SDm	Bd	LFd	BFd	DAP prox.
s. n.	36	2	A	305	101	35	36	84	65	32	73
2		8	B	285		30	30				
35	35	3	A	294	103	36	36	80	66	29.5	75
159	40	2	A	250	76	26	27	62	52	20	54
160	39	2	A	290	102	34	34	82	60	30	71
305		8	B	300		33	35	85	66	31.5	
359		4	A	310		33	35	82	63.5	31.5	73
363	38	4 –5	A	277	94	30	30	76	57	26.5	64
376	37	8	B	293	107.5	36	35	86	63	30	75
382	50	?13	C	260	87.5	29	30	65	55	24	65.5
383		?13	C	260		31	31	66	55	26	65
427		11–13	B/C	287		35	36	73	58	23	
505	49	11–13	B/C	303	108	36	35	88	68	33	77
513		11–13	B/C	303		36	36	88	67	27	
755	26	3	A	295	107.5	35	35	84	60	33	79
880	27	3 or 4	A	272	76.5	29	28	65	50	24.5	57
1121	30	3–5a	A	303	105	34	35	83	62	29	72
1149	32	3–5a	A	296	97	35	36	79	62	31	73
1178		3–5a	A	270		30	30	71.5	57	27.5	64
1179	34	3–5a	A	270	83.5	28	29	67.5	57	26.5	56.5
1210	31	3–5a	A	317	100	33.5	34	85	69	25	75
1226	29	3–5a	A	300	100	36.5	37.5	84	61	34	70
1274	33	5	A	317	111	37	37	89	70	33	77
1276	24	4–5	A	296	101	36	37	81	66	32	73
1284	25	4–5	A	250	74	27	28	61	51.5	22	50
1293		5	A	302		32	33	82	64	30	
1349	21	4	A	292	96	36	37	79	62	30.5	74
1353	22	5	A	310	107	35	35.5	88	67	33.5	82
1391	23	4	A	294	106	37	36	86	66	30.5	78
1395	20	4–5	A	305	110	37	36	85	66	34	77
1406	16	3–5a	A	285	101	33	34	80	60	29.5	69
1423	17	5b	A	303	109	37	36	84	68	30.5	77
1432	18	5	A	282	105	37.5	37.5	85	67	33.5	75.5
1626	13	7 or 8	B	241	76.5	26	27	55	46	23	56
1643	15	5	A	292	103	36	37	81.5	63	35	73
1645	14	8	B	254	68	28	27	60	55	25	50
1646		6 or 7	A/B	293	100	35	37	83.5	66	32.5	69
1658		7	B	300		35	35	68	57	27.5	
1659		5	A	315		35	36	80	64	31.5	
1694		8	B	265		31	32	66	51	23.5	
1696	19	8	B	310	106	35	34	79	59	30.5	68
1788	10	8?	B	326	119	40.5	41	91	63	37	82
1789	11	8	B	306	105.5	36	37	87	63	34	79
1790		8	B	281	99	36	37	89	60	31	
1791	12	8	B	295	103.5	39	38	82.5	63	34	75
1833		8	B	305	109	35.5	38.5			30	79
1837	9	8?	B	287	91.5	37	37	77	60	30.5	78
1969A	3	8	B	276	104.5	33	33	81	66	29	81
1970A		8	B	283	99	35	34.5	78	60.5	32	
1972	2	8	B	293	95	33.5	34	80	67	33	82.5

continued...

Tab. 16.2e (nadaljevanje / cont.)

TIBIA n°	Auxiliary n°	Layer	Facies	GL	Bp	SD	SDm	Bd	LFd	BFd	DAP prox.
1973	1	8	B	292	105	37	37	83	63	33	82.5
1974		8	B	288		36	37	83	64.5	30	
2252	6	8	B	288	98	32	34	77	62	31	81
2253	4	8	B	260	85.5	28	30	64	56	28	67
2254	7	8	B	298	91	37	39	80	61	30	78
2255	5	8	B	292	99	34	37	77	60	33.5	83
2258		8	B		90	32	32				70
2260	8	8	B	252	89	27	28	63.5	57	26.5	63
2374	48	14	C	285	98	28.5	29.5	77	67	30	72
2375	44	13	C	274	92.5	29.5	29.5	71	60	29	69
2376	47	12	B	288	99	28.5	30	79	61	28.5	77
2377	43	11	B	283	106.5	30	32	82.5	65	27	82
2380	45	16	C	295	105	31.2	31.2	77	66	31	79
2382		10	B			32	35	80	71	35	
2383	46	13	C	298	85	29	29.5	76	62	31	70
2384	42	11	B	258	81	25	26	62	49	21.5	60
2385		11	B	255		27	27	65	54	23	69
2386		12-13.	B/C	284		29	32	75	62.4	24.6	72
2391	41	11	B	278	86	28	29	71	56.2	27	75

Uporabljene okrajšave / Abbreviations:
BCr –širina *caput radii* / maximum width of the *caput radii*
Bd – širina distalne epifize, medio-lateralno / maximum width of the distal end, medio-lateral
BFd – največja širina *facies articularis malleoli* (tibija) / maximum width of the *facies articularis malleoli* (tibia)
BIT – širina *incisura trochlearis,* antero-posteriorno (ulna) / maximum width of the *incisura trochlearis,* antero-posterior (ulna)
Bp – širina proksimalne epifize, medio-lateralno / maximum width of the proximal end, medio-lateral
BT – dolžina *trochlea humeri /* maximum width of the *trochlea humeri*
DAPcaput – širina *caput humeri*, antero-posteriorno / antero-posterior diameter of the *caput humeri*
DAPd.art. – širina *cochlea radii* / antero-posterior diameter of the distal articulation (*cochlea radii*)
DAPprox. – širina proksimalne epifize, antero-posteriorno (tibija) / antero-posterior diameter of the proximal end (tibia)
DC – širina *caput femori*, antero-posteriorno / maximum depth of the *caput femori*, antero-posterior
Dp – širina proksimalne epifize, antero-posteriorno / maximum depth of the proximal end, antero-posterior
DPA – diametralna dolžina p*rocesus anconaeus* (ulna) / depth across the *procesus anconaeus* (ulna)
DTcaput – širina *caput humeri*, in *caput femori*, medio-lateralno / transversal diameter of width of the *caput humeri*, and the *caput femori*
GL – največja dolžina / maximum length
HpaT – višina p*rocesus anconaeus* do *tuberculum olecrani* (ulna) / height from the p*rocesus anconaeus* to the *tuberculum olecrani* (ulna)
LC – dolžina *cochlea radii* / maximum length of the *cochlea radii*
LCr – dolžina *caput radii* / maximum length of the *caput radii*
LFd – največja dolžina *facies articularis malleoli* (tibija) / maximum length of the *facies articularis malleoli* (tibia)
PL – fiziološka dolžina / physiological length
SD – najmanjša širina diafize, medio-lateralno / minimum width of the diaphysis, medio-lateral
SDm – najmanjša širina diafize, antero-posteriorno / minimum width of the diaphysis, antero-posterior

Tri širinske mere (Bp, SD in SDm), ki se nanašajo na diafizo in proksimalno epifizo, in označujejo robustnost, sestavljajo dve različni skupini golenic in eno vmesno skupino, ki jo predstavljata štev. 43 in 45 (*sl. 16.3a*). Če mero, ki označuje najmanjšo anteriorno-posteriorno širino diafize (SDm), zamenjamo z največjo dolžino golenice (GL), ostaneta obe skupini golenic nespremenjeni (*sl. 16.3b*). Kosti, ki sestavljajo obe velikostni skupini, so obakrat iste[1]. O tem sva se prepričala s primerjanjem zaporednih številk v obeh diagramih. Z njimi sva zamenjala inventarne številke v *tab. 16.2e*, ki bi bile zaradi dolžine v diagramu neberljive. Pri zamenja-

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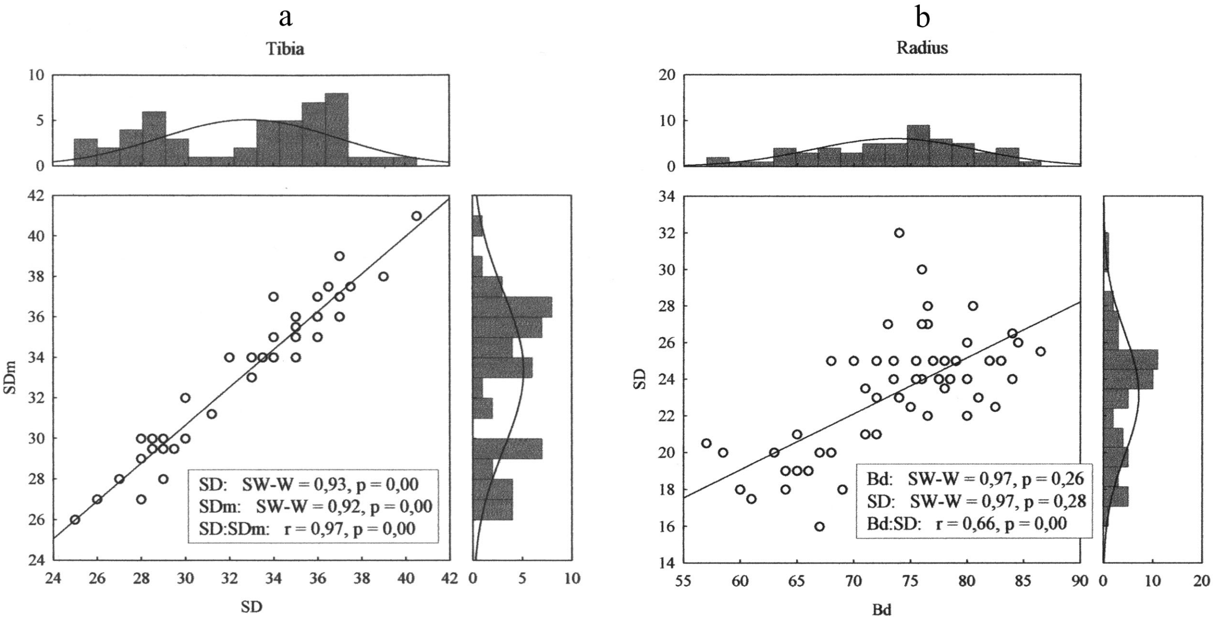
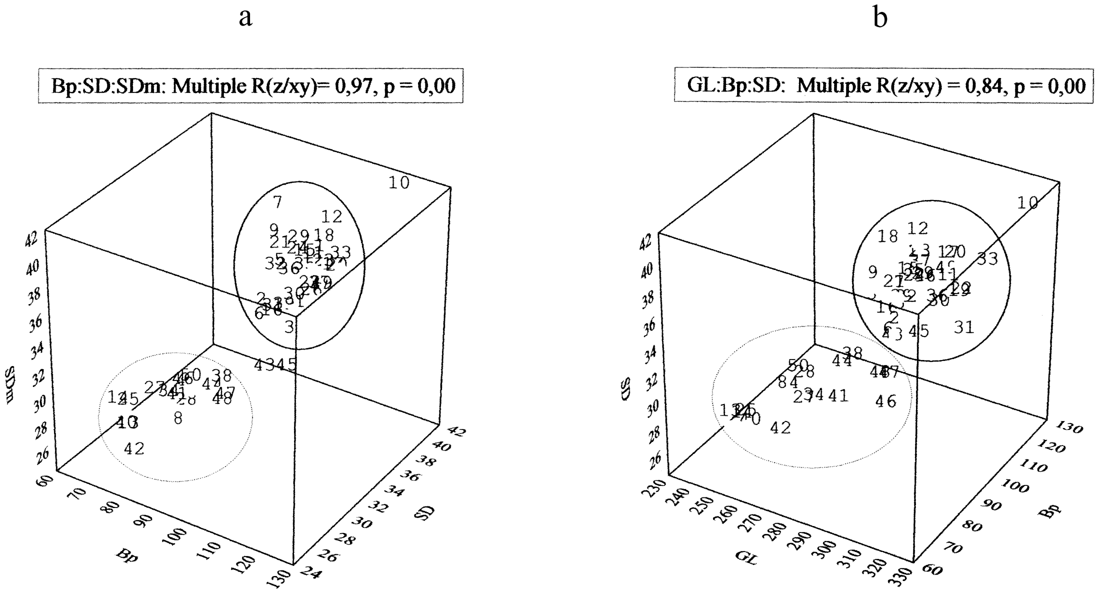
[1] Pri drugih velikih dolgih kosteh ni tako. Pri koželjnici (*radius*) se ne ujema v skupini z manjšimi merami na primer kar 11 kosti od skupno 19 po zamenjavi širinske mere z dolžinsko. To razlagamo z mešanico koželjnic velikih medvedov na eni strani in majhnih ter čokatih na drugi strani.



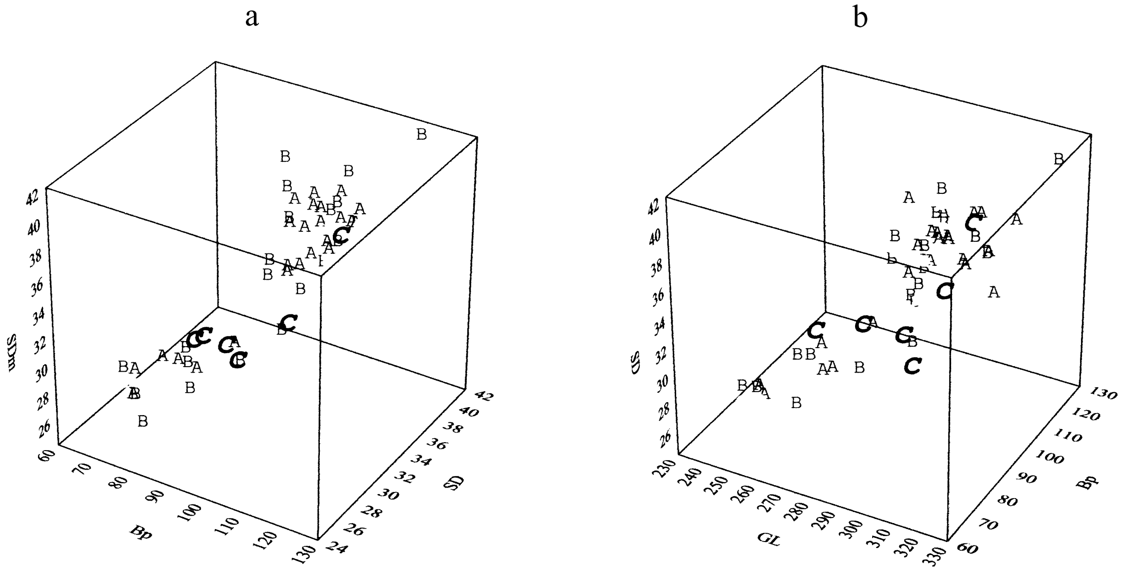
Sl. 16.2a, b: Statistična porazdelitev izbranih mer pri tibiji (a) je izrazito bimodalna (glej vrednost-*p* Shapirovega in Wilkovega testa-W v okvirčku), kar kaže na dvoje statistično značilno različnih osteometričnih populacij (samce in samice). Pri radiusu (b) je statistična porazdelitev izbranih mer unimodalna oz. normalna (glej vrednost-*p* Shapirovega in Wilkovega testa-W v okvirčku), kar kaže na statistično značilno homogeno osteometrično populacijo. Različno močna statistično značilna korelacijska koeficienta *r* sta odsev bodisi večjih oz. manjših tafonomskih izgub bodisi različne povezanosti različnih mer, lahko pa obojega hkrati.

Fig. 16.2a, b: The statistical distribution of selected measurements of tibia (a) is clearly bimodal (see *p*-value of Shapiro-Wilk's W test in the box) which means two statistically significantly different osteometric populations (males and females). With radius (b) the statistical distribution of selected measurements is unimodal or normal (see *p*-value of Shapiro-Wilk's W test in the box) which means a statistically significantly homogenous population in terms of osteometry. The difference in the strength of correlation expressed by the correlation coefficient *r* is either a reflection of more or less taphonomic losses, or of a different relationship of various measurements, or both at once.



Sl. 16.3a, b: Odnos med tremi širinskimi merami tibije, ki označujejo robustnost (a) in odnos med dvema širinskima in eno dolžinsko mero, ki označujejo velikost (b). V obeh primerih sta jasno izraženi dve nespremenjeni skupini tibij: robustne in velike ter vitke in majhne. Podatki so zbrani v *tab. 16.2e*.

Fig. 16.3a, b: The relationship among three measurements of width of tibia, signifying robustness (a) and relationship among two measurements of width and one measurement of length, signifying size (b). In both cases, two unchanged clusters of tibiae are clearly expressed: robust and large on the one hand, and slim and small on the other. Data are collected in *Tab. 16.2e*.



Sl. 16.4a, b: Porazdelitev robustnih in velikih ter vitkih in majhnih tibij v facijah A–C glede na kombinacijo širinskih (a) in širinsko-dolžinskih mer (b). Podatki so zbrani v *tab. 16.2e*.
Fig. 16.4a, b: Distribution of robust and large, and slim and small tibiae in facies A–C in relation to the combination of width measurements (a) and width-length measurements (b). Data are collected in *Tab. 16.2e*.

vi širinske mere z dolžinsko vmesna skupina (štev. 43 in 45) izgine in se združi s skupino daljših in širših kosti. V okviru posamezne skupine torej ne gre za mešanico velikih kosti in kosti, ki so hkrati majhne in čokate. Ta ugotovitev omogoča narediti naslednji korak: analizo obeh velikostnih skupin glede na facije, ki domnevno predstavljajo določen tip klime in okolja ter vzorec nedvomno časovno stratificirajo.

Slika 16.4a, b kaže, da med facijami ni razlik, kar zadeva velikosti golenic. To pomeni, da razlaga o razvojnih spremembah in/ali migraciji ne drži in da lahko razloživa velikostni skupini samo s spolnim dimorfizmom (toda glej Kavcig, Rabeder 2004). Edino izjemo lahko eventualno predstavlja facija C, ki se, kot kaže, nahaja med obema velikostnima skupinama, kar bi lahko pomenilo, da gre za biometrično drugačno populacijo. Od te populacije po robustnosti odstopa štev. 49, podobno kot od celotnega vzorca odstopa štev. 10. Slednja za razliko od prve tudi v dolžinski meri. Po drugačni razlagi lahko primerek štev. 49 v faciji C pripada samcu, vsi preostali primerki pa samicam. V tem primeru bi bile samice v faciji C na skrajni zgornji meji robustnosti samic v facijah A in B, pri samcih pa ne bi bilo razlik.

Tako v facijah A kot B je več večjih in robustnejših primerkov, kar razlagava s prevlado samcev. V faciji C je lahko ravno obratno. Če je v faciji C, za katero je domnevno značilna mila klima, domnevno en samec na pet samic, pa se v facijah B in A, za kateri je domnevno značilna hladna in vlažna klima, to razmerje nedvomno poveča na škodo samic. Vse skupaj lahko kaže na rivalstvo med spoloma. Vendar zaradi tafonomskih dejavnikov, ki so posebej močno prizadeli velike dolge kosti, in majhnih podvzorcev, ki so posledica stratifikacije glavnega vzorca, lahko podvomimo v zanesljivost rezultatov. Čeprav je treba poudariti, da se rezultati ujemajo z rezultati, dobljenimi na veliko večjem številu metapodijev (glej poglavje 17. v tem zborniku).

Ker nama za razdobje 40.000 let, ki ga predstavljata faciji A in B, ni uspelo ugotoviti nikakršnnih strukturnih sprememb, nisva naredila primerjave z drugimi najdišči. Morebitne razlike med najdišči namreč ne bi mogla utemeljeno razložiti.

16. LARGE LONG BONES OF CAVE BEAR FROM THE DIVJE BABE I SITE

GORDANA JAMBREŠIĆ and IVAN TURK

Abstract

Large long bones of cave bear were analysed osteometrically with the aid of bi- and multivariate statistical techniques. The aim of the research was to distinguish among large long bones of extremities in relation to size and sex, and stratigraphic location.

Because of selective taphonomic factors, specimens of individual large long bones no longer belong to a uniform statistical population (see *Fig. 16.2*). The sample of tibias most approaches these (*Table 16.2e*), which was therefore studied in more detail and the results taken to be representative of all large long bones of extremities at the site.

We first checked by a combination of measurements of width and width-length whether large bears and bears which are simultaneously small and stocky are both represented in the sample simultaneously, since the width measurements of bones of such bears could overlap. *Figure 16.3a, b* shows that this is not the case. We then studied the sample of tibias divided into facies A–C, which presumably represent specific types of climate and environment (see Chapter 7 in this volume) and undoubtedly stratify it chronologically.

Figure 16.4a, b shows that there are no differences among facies in terms of size of tibias. This means that an interpretation of evolutionary change and/or imigration (Rabeder *et al.* 2004c) is not supported and that size groups can only be explained by sexual dimorphism. Facies C sample may be the only exception. It appears to be located between the two size groups, which could mean that it belongs to a biometrically distinct population.

In both facies A and B there are a higher number of larger and more robust specimens, which is interpreted as a predominance of males. It is exactly the opposite in facies C. Whereas in facies C, which is presumed to be characterised by a mild climate, there is only one male to five females, in facies A and B, which are thought to be characterised by a cold and damp climate, this ratio undoubtedly increases to the detriment of females, which could indicate inter-sexual rivalry for cave dens under extreme climatic conditions.

This chapter was originally conceived as a study for assessing the body weight of cave bear and sexual affiliation on this basis (Jambrešić, unpublished). Using a regression equation obtained with the aid of known data on body weight, sex and measurements of large long bones of living bears, it is theoretically possible on the basis of measurements alone to assess the weight of an animal and, on the basis of body weight (mass), to determine the sex (Damuth, MacFadden 1990). The matter is clear in theory, in practice we hit on a series of problems that could not be resolved because of the lack of data on living bears and methodological complications with fossil material. The first author therefore finally abandoned the attempt and, together with the second author, focused exclusively on analysis of direct osteometric data of large long bones of cave bear found at Divje babe I in the layers of facies A, B and C (see Chapters 1 and 7 in this volume). The analysis led us to some interesting conclusions, which are worth considering in interpreting the results of future research in this field.

Large long bones of cave bear have been the subject of intensive study for some time, using quantitative osteometric techniques in association with statistical techniques. The aims of such research were not always clearly defined. For the most part they have been concerned with establishing the range of variation of individual skeletal parts and establishing affiliation to *Ursus spelaeus* (see Rakovec 1967); in an extreme case even the identification of new species and sub-species, such as *Ursus ingressus*, *Ursus spelaeus eremus* and *Ursus spelaeus ladinicus* (Kavcik, Rabeder 2004).

The aims of our osteometric analysis, to be achieved in steps, were:

First step: Differentiation between large long bones of extremities in terms of size and sex. Cave bears display pronounced sexual dimorphism, among other things in size and muscular mass – males are generally larger and stronger than females (Stubbe 1993), which is also reflected in bones. If an individual is larger and more muscular, all, or at least most of the bone measurements are larger. However, the following body types must be distinguished: 1) large and muscular, 2) large, 3) small and muscular, 4.) small. So differentiation by sex merely on the basis of bone measurements is neither simple nor complete.

Second step: Stratigraphic analysis of the sample or samples of bone, divided (statistically stratified) on the basis of measurements into two distinct groups, which may represent either males or females, or populations with different bodily measurements. The purpose of the stratigraphic analysis was to discover possible changes in the gender composition over time or changes connected with populations with different body measurements. The latter changes could be ascribed to an evolutionary trend of an existing species of cave bear or immigration of a new species or sub-species of bear (see Rabeder *et al.* 2004c). Changes in the sex composition or in the population characteristics could be explained by suspected climatic and environmental changes (see Chapters 5, 6 and 7 in this volume) and the response of cave bear to these in terms of competition between the sexes for cave lairs or in terms of Bergman's disputed rule of a correlation between body weight and climate.

Insofar as any kinds of change were established in the stratigraphic series, it would be reasonable to compare our sample with samples from other sites which had been similarly divided (stratified) into males and females or large and small specimens and reliably classified chronologically. The samples would otherwise be so non-uniform in terms of time and inner structure that any comparison would be meaningless, and the results of comparison misleading (but see Kavcik, Rabeder 2004).

There are a number of problems in interpreting osteometric data, which also appeared with the Divje babe I sample.

First, samples in the majority of sites are small, and when stratified in one way or another are no longer large enough for quantitative study.

Second, all samples are non-uniform in time. If we wished to obtain a uniform sample in terms of time, covering a period of 100 years or less, its size would be reduced to a few specimens.

Third, inter-site comparison does not give reliable results because of the different temporal non-uniformity of samples, even when these are "contemporary" sites (see Introduction in this volume).

Fourth, the characteristics of the sample are very dependent on the sex composition of living and consequently dead and fossil populations present at the site.

Fifth, although all large long bones belong by definition to the same population of skeletal parts, this is not in practice the case because of taphonomic decimation (see sub-chapter 12.4 in this volume, *Table 12.4.1, Fig. 12.4.12*).

Sixth, different measurements can differently contribute to sexual differentiation.

METHOD AND MATERIAL

The sample of adult large long bones from Divje babe I covers the whole site, i.e., the material from the excavations both of M. Brodar and of J. Dirjec and I. Turk. It is not therefore weighted by stratigraphic units which in this case are represented by layers with different volumes of sediment. Because the sample covers a period of 70,000 years, it is reasonable to ask whether differences in the osteometrics and/or sexual composition occurred on the basis of sexual dimorphism and/or population changes. The latter have so far been found mainly between sites and are explained as either evolutionary or taxonomic (Kavcik, Rabeder 2004).

Of a total of 271 measured whole large bones of extremities of cave bear from various sedimentary layers, 234 were analysed statistically, of which: 19 humeri, 70 radiuses, 49 ulnas, 27 femurs in 69 tibias (*Table 16.2a–e*). In a standardised block of sediments of a volume of 95 m^3 there were 73 adult humeri, 91 adult radiuses, 85 adult ulnas, 71 adult femurs, 129 adult tibias and 195 adult fibulas (see sub-chapter 12.4 in this volume, *Table 12.4.1*). Of these, 14 humeri (19 %), 23 radiuses (25 %), 27 ulnas (32 %), 18 femurs (25 %), 40 tibias (31 %) and 10 fibulas (5 %) were whole. Unless all the enumerated bones had been selectively fragmented, the percentage share would indicate the relative representation of whole large long bones of adult cave bear in relation to their strength.

All measurements were taken by G. Jambrešić with a calliper gauge according to the instructions of Von den Driesch (1976) and other authors (Reisinger 1995; Tsoukala, Grandal d'Anglade 1997). The inclinations of bones in the sediment were measured by J. Dirjec, both whole large long bones and larger fragments.

The analytical part of the research was done using STATISTICA 6.0, StatSoft 2001.

Finds are kept by the National Museum of Slovenia in Ljubljana.

ANGLE OF INCLINATION OF LARGE LONG BONES IN THE SEDIMENT

The large inclinations of bones in the sediment can be linked to post-sedimentational movements because of bio- and above all cryoturbation. Since all layers were deposited sub-horizontally, normal angles of inclination were arbitrarily determined, taking into account the inclination of the layer, which was up to 10°.

Angles of inclination were measured for 347 bones found during the excavations by J. Dirjec and I. Turk in the central part of the cave. Of these, 248 bones had angles of inclination up to 10°, 54 bones from 11° to 20°, 17 bones from 21° to 30°, 12 bones from 31° to 40°, 8 bones from 41° to 50°, two bones from 51° to 60°, one bone from 61° to 70°, two bones from 71° to 80° and three bones from 80° to 90°.

The angles of inclination in the sedimentation levels of a standard block of sediments with a volume of 95 m^3 are shown in *Table 16.1* and in *Fig. 16.1*. Angles greater than 30° are characteristic of the sedimentation levels of Layer 4 and neighbouring layers (–68 cm to –118 cm), which were folded by cryoturbation during the late glacial maximum (see Chapters 4 and 5 in this volume), and Layer 8, which is not folded. The large inclination of individual bones in Layer 8 is therefore ascribed mainly to bioturbation. Bearing in mind the number of bone remains (see Chapter 12 in this volume, *Table 12.3.1*), in Layer 4 and neighbouring layers (facies A), relatively speaking there are considerably more bones with a high angle of inclination than in Layer 8 (facies B). In the lower part of the profile (facies C) the angle of inclination of bones is the smallest, despite the early glacial maximum which followed their deposition (see Chapter 7 in this volume). No pronounced folding of layers due to the action of freezing and thawing occurred in the early glacial maximum.

There is a clearly expressed tendency in the profile of the site for the angle of inclination to decrease from the top downwards or from the late to the early glacial maximum (*Fig. 16.1*) which, incidentally, corresponds to the trend of temperature curve of the Würm glacial at the site and elsewhere (see Chapter 6 in this volume, *Fig. 6.7a, b*; Turk 2006, Fig. 12).

ANALYSIS OF OSTEOMETRIC DATA – RESULTS, DISCUSSION AND CONCLUSIONS

All measurements of each individual bone and each measurement individually define a specific bear (male, female, and of each large, small, stocky). Under normal conditions, measurements could be doubled and quantitative analysis would give uniform results. In abnormal conditions, which we witness in archaeological practice, things are a great deal more complicated.

Table 16.2a–e gives the type of standard measurements of large long bones belonging to various specimens of bear that lived at various times. Because of this, the same or similar analyses of measurements of individual bones do not give uniform results. This is also evident from the distribution of metric data, which is bimodal with some measurements and bones, and with others not, or it is normal (*Fig. 16.2a, b*). In showing and interpreting the results of osteometry, therefore, we were limited to one of the large long bones for which we established with statistical exploratory techniques that its measurements are most promising in terms of interpretation. Multivariate analysis (two-dimensional scaling) of all measurements of each large long bone individually did not give the expected logical result with the distribution of bones in the facies, because the samples of large long bones were too non-uniform, some, such as the sample of humeri and femurs, are far too small for statistical analysis. In terms of uniformity of the sample, the results of multivariate analysis of all measurements of tibias were most promising, which in addition is among the better preserved and is represented at the site in sufficiently large numbers. We therefore analysed tibia measurements in more detail in stratigraphically divided (stratified) sample, and the results are considered to be representative of all large long bones of extremities at the site. We are aware that a larger sample would probably improve the results of analysis, in that it would assist in distinguishing among statistical strata of samples in time and space.

We first checked with a combination of width and width-length measurements whether the sample contains both large bears and bears which are simultaneously small and stocky, since the width measurements of bones of such bears could overlap. *Figure 16.3a, b* shows that this is not the case.

Three width measurements (Bp, SD and SDm), which relate to the diaphysis and proximal epiphysis, and characterise robustness, compose two different groups of tibia and one intermediate group represented by numbers 43 and 45 (*Fig. 16.3a*). If the measurement that characterises the minimum anterior-posterior width of the diaphysis (SDm), is replaced by the maximum width of the tibia (GL), the two groups of tibia remain unchanged (*Fig. 16.3b*). Bones that compose the two size groups are the same[1] both times. This was checked by comparison of successive numbers in the two diagrams. We substituted them for the inventory numbers in *Table 16.2e* which, because of length, would have been unreadable in the diagram. With the substitution of width measurements, the intermediate length group (numbers 43 and 45) disappears and is combined with the group of longer and wider bones. Within the context of individual group, therefore, there is no mixture of longer bones and bones that are simultaneously small and stocky. This finding enables the next step to be made: analysis of the two size groups in relation to facies, which presumably represent specific types of climate and environment and undoubtedly stratify the sample chronologically.

Figure 16.4a, b shows that there is no difference between the facies in terms of size of tibias. This means that an interpretation of evolutionary change and/or immigration is not supported and the size groups can only be explained by sexual dimorphism (but see Kavcig, Rabeder 2004). The only exception may perhaps be facies C sample, which appears to be located between

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[1] It is not so with other large long bones. With radiuses, for example, some 11 bones of a total of 19 do not correspond with the group with smaller measurements after substituting the width measurements for the length. This is interpreted as a mixture of the radiuses of large bears on the one hand and small, stocky bears on the other.

the two size groups, which could mean that it belongs to a biometrically different population. In terms of robustness, number 49 deviates from this population, and similarly number 10 deviates from the entire sample. In the latter case, the width measurement also deviates, in contrast to the former. According to another interpretation, specimen number 49 in facies C may belong to a male and all the other specimens to females. In this case, females in facies C would be at the extreme upper limit of robustness of females in facies A and B, but there would be no difference in males.

In both facies A and B, there are a higher number of longer and more robust specimens, which is interpreted as a predominance of males. It is exactly the reverse in facies C, which is thought to be associated with a mild climate, where there is one male to five females. In facies B and A, which are thought to be characterised by a cold, damp climate, this ratio undoubtedly increases to the detriment of females. Altogether it could indicate rivalry between the sexes. However, because of taphonomic factors, which affected large long bones in particular, and the small size of the sub-samples as a result of stratification of the main sample, the reliability of the results is uncertain. However, it must be stressed that the results correspond with the results obtained with a great deal larger number of metapodia (see Chapter 17 in this volume).

Since we were unable to ascertain any kind of structural changes for the time period of 40,000 years represented by facies A and B, we did not make a comparison with other sites. Explaining potential differences between sites, namely, would not be well-founded.

17. MORFOMETRIČNA ŠTUDIJA METAPODIJEV JAMSKEGA MEDVEDA IZ DIVJIH BAB I

BORUT TOŠKAN

Izvleček

Morfometrična analiza 1.598 metapodijev jamskega medveda iz mlajšepleistocenskih (OIS 3 in OIS 5) plasti Divjih bab I je pokazala, da metrični podatki omogočajo razlikovanje med spoloma. Ugotovljeno je bilo, da je med gradivom iz OIS 5a-5d delež obeh spolov primerljiv, medtem ko med metapodiji iz OIS 3 s približno dvotretjinsko večino prevladujejo primerki samcev. Povečan delež samcev v OIS 3 je bil razložen z daljšimi, hladnejšimi in bolj vlažnimi zimami v navedenem obdobju napram tistim v OIS 5a-5d. Študije recentnih rjavih in črnih medvedov so namreč izpostavile vzročno-posledično povezavo med nastopom ostrejših klimatskih pogojev na eni strani in povečano konkurenco med spoloma za zasedbo razpoložljivih brlogov na drugi. Skladna s takšno interpretacijo je spolna struktura metapodijev iz edinih dveh razmeroma toplih/suhih faz v OIS 3, ki se s primerljivim deležem zastopanosti obeh spolov ne razlikuje od spolne strukture gradiva iz razmeroma toplega in suhega OIS 5a-5d.

V favni evropskih mlajšepleistocenskih najdišč je jamski medved (*Ursus spelaeus* Rosenmüller, 1794) pogosto najbolje zastopana sesalska vrsta (Miracle 1991; Argant 1996a). Tako je tudi v Divjih babah I (zahodna Slovenija; 450 m nm. v.), kjer njegov delež presega 99 odstotkov vseh živalskih ostankov. Zaradi velikega števila najdb je bilo mogoče nekatere skeletne elemente natančneje biometrično obdelati (npr. Debeljak 2002a; poglavje 16 v tem zborniku). To velja tudi za metapodije, katerih študija je predstavljena v nadaljevanju. Glede na njihovo vlogo v biomehaniki hoje (Opavský 1990) ponuja pričujoči prispevek poglobljen vpogled v obseg in smer mikroevolutivnih sprememb morfologije dlančnic in stopalnic ter v spolno strukturo jamskega medveda iz Divjih bab I, vključno z dejavniki, ki naj bi nanjo vplivali.

MATERIAL IN METODE

V okviru tukaj predstavljene študije sem biometrično obdelal le 1.598 od skupno nekaj tisoč metapodijev jamskega medveda, ki so bili pridobljeni med večletnimi izkopavanji v Divjih babah I. Z namenom optimizirati primerjave med dlančnicami oz. stopalnicami različne geološke starosti sem namreč obdelal le primerke z izkopnih polj A in B, kjer je Turk (2003a) analiziral vertikalno porazdelitev strukturnih agregatov in več kot 3 mm velikih kostnih fragmentov velikih sesalcev. Na osnovi dobljenih rezultatov je nato na terenu določene geološke plasti zamenjal z novimi temeljnimi stratigrafskimi enotami, t.i. facijami A, B in C, ki jih sestavlja različno število stratigrafskih nivojev. Ker je takšna prerazporeditev omogočila enačenje litostratigrafskih in biostratigrafskih enot, sem prej enoten vzorec 1.598 metapodijev razdelil na tri podvzorce: Db–A (vključuje primerke iz facije A), Db–B (facija B) in Db–C (facija C). Takšna delitev je predstavljala izhodišče za analizo razlik v velikosti oz. morfologiji dlančnic in stopalnic različne geološke starosti.[1]

Podrobne podatke o najdišču in poteku terenskega raziskovanja podaja Turk (poglavje 1 v tem zborniku), zato na tem mestu predstavljam le metodologijo obdelave metapodijev. Na vsakem primerku sem s kljunastim merilom izmeril osem različnih dimenzij (*sl. 17.1*): največja dolžina (gL), medio lateralna širina proksimalne epifize (pB), antero-posteriorna širina proksimalne epifize (pH), najmanjša medio-lateralna širina diafize (sDB), najmanjša dorzo-palmarna oz. dorzo-plantarna širina diafize (sDH), največja medio-lateralna širina distalne epifize (gDB), medio-lateralna širina sklepne površine distalne epifize (dB) in antero-posteriorna širina distalne epifize (dH). Biometrično sem obdelal le v celoti osificirane primerke, pri katerih naj bi bila rast kostnega tkiva torej že končana.[2] Analize rentgenskih posnetkov šap črnega medveda (*Ursus americanus*) so po-

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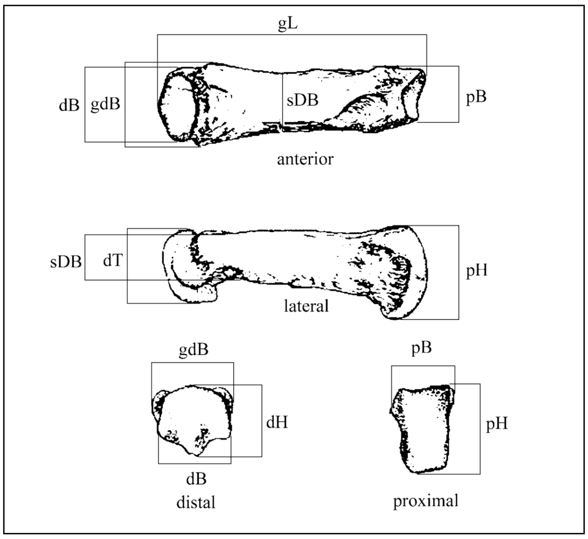
[1] Faciji A in B sta nastali v OIS 3 (tj. interpleniglacial), facija C pa v OIS 5a-5d (tj. zgodnji glacial). OIS 4 (tj. pleniglacial I) v jami ni zastopan, saj je takrat prišlo do zastoja v sedimentaciji (poglavji 6 in 7 v tem zborniku).

[2] Študije skeletov nekaterih vrst kopitarjev so sicer opozorile na možnost občutne rasti kostnega tkiva tudi pri kosteh z že zraščenima epi- in diafizo. Vendar pa se v tem smislu omenjajo predvsem lopatica, distalni del nadlahtnice ali skočnica, ki vse osificirajo zelo zgodaj v ontogenetskem razvoju (npr. Legge, Rowley-Conwy 1988, Payne, Bull 1988; Luff 1993). Kljub temu sem metapodije z vidnimi eksostozami iz analize preventivno izključil.



Sl 17.1: Metapodij jamskega medveda (*Ursus spelaeus*) z označenimi merjenimi dimenzijami. Za opredelitev posamezne dimenzije glej besedilo.
Fig. 17.1: Cave bear (*Ursus spelaeus*) metapodial with measured dimensions marked. See text for definition of individual dimensions.

kazale, da se zraščanje epi- in diafiz pri dlančnicah konča z dopolnitvijo drugega leta življenja, v nadaljnjih nekaj mesecih pa se dokončno oblikuje še greben distalne epifize (Marks, Erickson 1966). Pri jamskem medvedu naj bi se razvoj metapodijev v povprečju končal nekoliko pozneje (tj. šele tik pred dopolnitvijo tretjega leta starosti), saj je bil ontogenetski razvoj skeleta pri omenjeni vrsti domnevno počasnejši (prim. Debeljak 2002b). Poleg tega je tempo zraščanja epi- in diafiz v študiji Marksa in Ericksona najverjetneje nekoliko precenjen, saj njuni sklepi izhajajo iz analize rentgenskih posnetkov (1966; glej tudi Moran, O'Connor 1994).

Med obdelanimi metapodiji prevladujejo v celoti ohranjeni primerki, pri katerih je bilo mogoče izmeriti vseh osem dimenzij. Z namenom oblikovati kar najobsežnejši (in s tem reprezentativen) vzorec sem analiziral tudi vse tiste delno poškodovane dlančnice in stopalnice, kjer ene od meritev ni bilo mogoče opraviti. Manjkajoče podatke sem pri teh nadomestil z ocenami, ki sem jih pridobil z metodo regresije postopnih korakov (*Forward Stepwise Regression*). Gre za postopek, kjer z analizo nepoškodovanih primerkov oblikujemo linearno kombinacijo tistih dimenzij, katerih meritev je bila mogoča tudi pri delno fragmentiranih metapodijih. Omenjene dimenzije se vključujejo v enačbo postopoma, korak za korakom, dokler vključevanje dodatnih ne prispeva več k bistveno boljši napovedi (StatSoft Inc. 2001). Uspešnost napovedi sem testiral na nepoškodovanih primerkih. Pri tem odsotnost statistično značilnih razlik med izmerjenimi in ocenjenimi vrednostmi (F-test: $p < 0{,}05$) dokazuje ustreznost uporabljene metode.

Grupiranje metapodijev po spolu temelji na rezultatih analize glavnih komponent (*Principal Components Analysis*; PCA). Omenjena metoda omogoča variacijo p osnovnih x spremenljivk zadovoljivo pojasniti z (bistveno) manjšim številom glavnih komponent (PC_i), kar zelo olajša interpretacijo znotrajvzorčne variabilnosti (Manly 1994; StatSoft Inc. 2001). Pred izvedbo same analize glavnih komponent sem razpoložljive metrične podatke najprej standardiziral. S tem sem izničil razlike v absolutnih vrednostih posamezne dimenzije med petimi dlančnicami (Mc I do V) oz. stopalnicami (Mt I do V). V nadaljnje analize sem tako prenesel le relativna odstopanja posameznih primerkov od povprečne vrednosti dane dimenzije pri referenčnem vzorcu.[3] Posledično sem lahko vse dlančnice oz. stopalnice združil v enoten statistični vzorec, ki je bil zato bistveno bolj reprezentativen. Metrične podatke sem standardiziral po formuli:

$$\text{standardizirana vrednost} = (x - M) / S$$

kjer x predstavlja posamezno meritev, ki jo želimo standardizirati, M in S pa povprečje in standardno deviacijo za isto dimenzijo pri referenčnem vzorcu.

Z analizo glavnih komponent sem poskušal prepoznati tudi razlike v morfologiji metapodijev različne geološke starosti. Kot izhodišče sem uporabil metrične podatke, iz katerih sem odstranil v tem primeru motečo velikostno komponento (t.i. *Burnaby size-out*). V morfometriji velikost praviloma razloži največji delež variance. Ker v analizi glavnih komponent prva izmed njih (tj. PC 1) praviloma opiše najvišji delež variance osnovne množice podatkov, jo lahko razumemo kot vektor velikosti oz. nosilko velikostne informacije (Lemen 1983). Ostanki regresijske analize (*residuals*) pri pravokotni projekciji matrike osnovnih (tj. velikost vsebujočih) podatkov na PC 1 so tako domnevno velikosti prosti in jih lahko vključimo v nadaljnje multivariatne analize (Burnaby 1966).

Pri statistični obdelavi sem uporabljal programski paket StatSoft 2001, STATISTICA za Windows, verzija 6.0, ter NTSYS-pc, verzija 2.0. Nomenklatura posameznih (delov) skeletnih elementov je povzeta po Riglerju (1985).

Vse obdelane metapodije jamskega medveda iz Divjih bab I hrani Narodni muzej Slovenije v Ljubljani.

SPOLNA STRUKTURA

Samci jamskega medveda naj bi bili v povprečju za približno tretjino težji od samic (Viranta 1994), kar kaže na zelo izražen spolni dimorfizem (npr. Kurtén 1955; Reisinger, Hohenegger 1998; Grandal D'Anglade 2000). Kljub temu je analiza kar 4.459 dlančnic in stopalnic vrst *U. spelaeus* in *U. deningeri* iz osmih avstrijskih in

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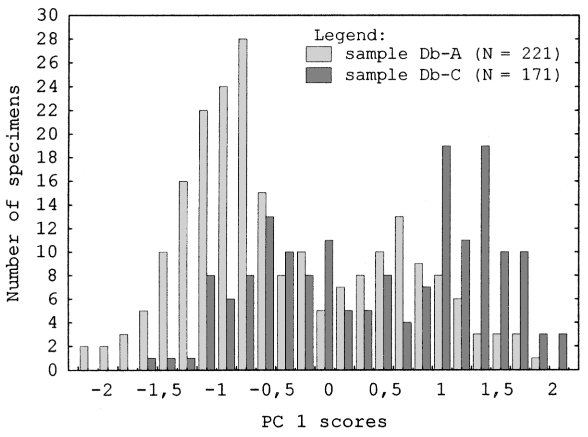
[3] Odstopanja so izražena v standardnih deviacijah.

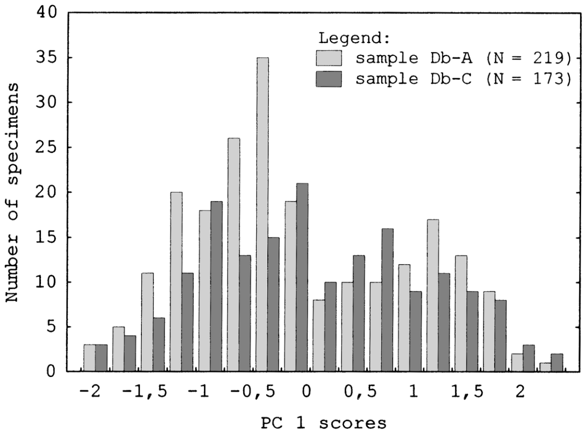
enega italijanskega najdišča pokazala, da njihovo grupiranje po spolu le na osnovi posameznih linearnih dimenzij ni mogoče (Withalm 2001). Zaradi navedenega sem se ugotavljanja spolne strukture metapodijev jamskega medveda iz Divjih bab I lotil z uporabo analize glavnih komponent (PCA); takšen pristop namreč omogoča hkratno obravnavo več parametrov (v tem primeru osmih). Zaradi predhodnega standardiziranja metričnih podatkov[4] sem lahko variabilnost v velikosti metapodijev primerjal na združenem vzorcu vseh petih dlančnic oz. stopalnic.

Kot vstopni podatek za PCA sem uporabil korelacijsko matriko standardiziranih vrednosti vseh osmih parametrov, in sicer ločeno za dlančnice in stopalnice. Prva glavna komponenta povzema 83,7 odstotka variabilnosti osnovnega nabora podatkov pri dlančnicah in 72,8 odstotka pri stopalnicah. Faktorske uteži (*factor loadings*) vseh osmih parametrov so negativne in nihajo med vrednostmi -0,76 in -0,94. Delež pojasnjene variance posameznih spremenljivk (*communalities*) je visok, preostale soodvisnosti med njimi (*residual correlations*) pa so nizke. Zaradi navedenega sem lahko pretežni del variance osnovnega nabora podatkov zadovoljivo ponazoril že z obema prvima glavnima komponentama.



Sl. 17.2: Porazdelitev vrednosti prve glavne komponente (PC 1), izračunane na osnovi korelacijske matrike standardiziranih podatkov osmih dimenzij dlančnic jamskega medveda (*Ursus spelaeus*) iz Divjih bab I: vzorca Db-A in Db-C. Vrednosti so bile standardizirane po podatkih iz vzorca Db-B. PC 1 pojasnjuje 83,7 odstotka vse v osnovnem naboru podatkov zaobjete variance. Za obrazložitev glej besedilo.

Fig. 17.2: Distribution of first principal component (PC 1) scores, calculated on the correlation matrix of standardised measurements of cave bear (*Ursus spelaeus*) metacarpals from Divje babe I: samples Db-A and Db-C. Measurements were standardised using sample Db-B as reference. PC 1 accounts for 83.7 percent of the total variance in analysed metacarpals. See text for explanation.



Sl. 17.3: Porazdelitev vrednosti prve glavne komponente (PC 1), izračunane na osnovi korelacijske matrike standardiziranih podatkov osmih dimenzij stopalnic jamskega medveda (*Ursus spelaeus*) iz Divjih bab I: vzorca Db-A in Db-C. Vrednosti so bile standardizirane po podatkih iz vzorca Db-B. PC 1 pojasnjuje 72,8 odstotka vse v osnovnem naboru podatkov zaobjete variance. Za obrazložitev glej besedilo.

Fig. 17.3: Distribution of first principal component (PC 1) scores, calculated on the correlation matrix of standardised measurements of cave bear (*Ursus spelaeus*) metatarsals from Divje babe I: samples Db-A and Db-C. Measurements were standardised using sample Db-B as reference. PC 1 accounts for 72.8 percent of the total variance in analysed metatarsals. See text for explanation.

Frekvenčna porazdelitev vrednosti prve glavne komponente (*PC 1 scores*) je izrazito bimodalna tako pri dlančnicah/stopalnicah iz vzorca Db-A, kot tudi pri tistih iz vzorca Db-C (*sl. 17.2* in *sl. 17.3*).[5] Takšno porazdelitev sem interpretiral kot odsev spolnega dimorfizma, kar omogoča vsaj približno oceno razmerja med številom metapodijev samcev in samic. Prekrivanje med vrednostmi obeh spolov je pri stopalnicah nekoliko večje kot pri dlančnicah. Zaradi konstitucije jamskega medveda je takšna ugotovitev povsem pričakovana in je bila dokazana tudi na dolgih kosteh obeh parov okončin (Reisinger, Hohenegger 1998).

Iz frekvenčnih porazdelitev vrednosti PC 1 izhaja, da je v zgodnjeglacialnem vzorcu Db-C (=OIS 5a-5d) število dlančnic in stopalnic obeh spolov v grobem enako. Drugače je pri gradivu interpleniglacialne (=OIS 3) starosti (tj. vzorec Db-A), kjer s približno dvotretjinskim deležem prevladujejo primerki samcev.[6] V tem smislu bistvenih odstopanj ne kaže nobeden od desetih metapodijev (tj. Mc I do V, Mt I do V), v primeru treh od skupno petih dlančnic pa so razlike v spolni strukturi med vzorcema Db-A in Db-C celo visoko statistično

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[4] Kot referenčni vzorec sem uporabil metapodije iz facije B, saj se ti po svojih dimenzijah umeščajo med primerke iz facij A in C (glej prilogo 17).

[5] Ker sem metapodije iz vzorca Db-B uporabil kot referenčni vzorec pri standardiziranju, sem jih v tej fazi raziskave iz nje izločil.

[6] Zaradi negativnih faktorskih uteži tvorijo večji (tj. samcem pripisani) metapodiji na *sl. 17.2* in *sl. 17.3* levega od obeh vrhov, manjši (tj. samicam pripisani) primerki pa desnega.

Tab. 17.1: Statistično testiranje razlik v spolni strukturi med vzorcem vseh v Db-A in Db-C zastopanih dlančnic jamskega medveda (*Ursus spelaeus*) na eni strani ter le metacarpus II iz istih dveh vzorcev na drugi.
Tab. 17.1: Statistical testing of differences in the sex structure between samples of all metacarpals of cave bear (*Ursus spelaeus*) represented in Db-A and Db-C, on the one hand, and only metacarpus II from the same two samples on the other.

Sample Db-A	♂	♀	**Total**	**χ^2 test**
Mc II (left)	21	6	27	$\chi^2 = 1.50$
All metacarpals	146 (= 65.7 %)	76 (= 34.3 %)	222	p = 0.220

Sample Db-A	♂	♀	**Total**	**χ^2 test**
Mc II (right)	23	7	30	$\chi^2 = 1.35$
All metacarpals	146 (65.7 %)	76 (= 34.3 %)	222	p = 0.245

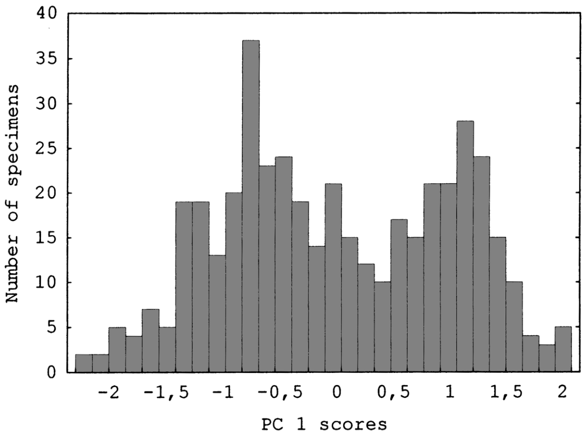
Sample Db-C	♂	♀	**Total**	**χ^2 test**
Mc II (left)	14	12	26	$\chi^2 = 0.80$
All metacarpals	76 (= 44.4 %)	95 (= 55.6 %)	171	p = 0.370

Sample Db-C	♂	♀	**Total**	**χ^2 test**
Mc II (right)	5	8	15	$\chi^2 = 0.18$
All metacarpals	76 (= 44.4 %)	95 (= 55.6 %)	171	p = 0.675

značilne (χ^2 test: $p < 0{,}01$). Pri tem sicer posameznih primerkov praviloma nisem ločeval na leve in desne, saj so bili vzorci za kaj takega preskromni. Edini takšen poskus delitve sem izvedel pri drugih dlančnicah, ki so med vsemi metapodiji najbolje zastopane (Mc II: N = 96). Tudi v tem primeru pa rezultati v celoti potrjujejo zgornje ugotovitve: v vzorcu zgodnjeglacialne (= OIS 5a-5d) starosti je namreč razmerje med spoloma uravnoteženo, medtem ko v interpleniglacialnem vzorcu Db-A (=OIS 3) prevladujejo druge dlančnice samcev (*tab. 17.1*).

Doslej predstavljeni rezultati nasprotujejo mnenju Withalma (2001), po katerem naj metapodiji ne bi bili primerni za ocenjevanje spolne strukture jamskih medvedov. Kljub merjenju povsem istih dimenzij kot navedeni avtor je bilo namreč mogoče z multivariatnim statističnim pristopom spol določiti blizu 90 odstotkom vseh dlančnic in približno 75 odstotkom vseh stopalnic. Kar pri dobljenih rezultatih preseneča, je odstopanje zgoraj predstavljene spolne strukture jamskih medvedov iz Divjih bab I od tiste, ki izhaja iz biometrične analize podočnikov odraslih živali iz istega najdišča (Debeljak 2002b). V primeru vzorca iz OIS 5a-5d se rezultati obeh pristopov sicer ujemajo, saj oba kažeta na približno enakomerno zastopanost vsakega od obeh spolov. Drugače je z gradivom iz OIS 3, kjer študija podočnikov ni dokazala večinskega deleža samcev. V okviru primerjave obeh spolnih struktur sem od vseh analiziranih podočnikov (Debeljak 2002b) upošteval le tiste, ki so pripadali več kot tri leta starim živalim. S tem sem izključil najmlajše starostne kategorije, ki v vzorcu metapodijev niso zastopane.

Ugotovljena razlika med ocenama verjetno ni posledica neustreznosti ene ali druge metode, saj so se metrični podatki v obeh primerih porazdelili izrazito bimodalno. Res je sicer, da vzorec podočnikov obsega vse razpoložljive primerke interpleniglacialne (= OIS 3) starosti, medtem ko so v Db-A zaobjeti le metapodiji iz sklopa plasti 2 do 7 (metrične podatke metapodijev iz vzorca Db-B sem namreč uporabil kot referenco pri standardizaciji). Vendar pa prevlado samcev v OIS 3 dokazuje tudi porazdelitev PC 1 vrednosti standardizi-



Sl. 17.4: Porazdelitev vrednosti prve glavne komponente (PC 1), izračunane na osnovi korelacijske matrike standardiziranih podatkov osmih dimenzij dlančnic jamskega medveda (*Ursus spelaeus*) iz Divjih bab I: vzorec Db-B (N = 434). Vrednosti so bile standardizirane po podatkih celotnega fosilnega vzorca iz Divjih bab I. PC 1 pojasnjuje 77,0 odstotkov v osnovnem naboru podatkov zaobjete variance. Vse faktorske uteži prve glavne komponente so negativne. Za obrazložitev glej besedilo.
Fig. 17.4: Distribution of first principal component (PC 1) scores, calculated on the correlation matrix of standardised measurements of cave bear (*Ursus spelaeus*) metacarpals from Divje babe I: sample Db-B (N = 434). Measurements were standardised using the entire fossil sample from Divje babe I as reference. PC 1 accounts for 77.0 percent of the total variance in analysed metacarpals. All factor loadings of the first principal component are negative. See text for explanation.

Tab. 17.2: Razmerje med številom levih spodnjih podočnikov (C_1) in levih prvih spodnjih meljakov (M_1) nad tri leta starih jamskih medvedov (*Ursus spelaeus*) iz Divjih bab I v vzorcu iz OIS 5a-5d (tj. Db-C) in tistem iz OIS 3 (tj. Db-A + Db-B). Število levih C_1 je bilo ocenjeno na četrtino vseh v obravnavani vzorec zajetih podočnikov. Razlika med obema razmerjema je statistično značilna (χ^2 = 4,47, p = 0,034). Podatke o številu zob podaja Debeljak (2002a).

Tab. 17.2: Ratios between the number of left lower canines (C_1) and left first lower molars (M_1) of cave bears (*Ursus spelaeus*) above three years of age from Divje babe I in the samples from OIS 5a-5d (i.e. Db-C) and from OIS 3 (i.e. Db-A + Db-B). The number of left C_1 was assessed on a quarter of all canines included in the sample. The difference between the two ratios is statistically significant (χ^2 = 4.47, p = 0.034). Data on the number of teeth provided by Debeljak (2002a).

Sample (layers)	M_1 (left specimens)	C_1 & C^1 (all)	C_1 (left specimens)	C_1 (left) / M_1 (left)
Db-A + Db-B (layers 2-10)	123.5	303	76	0.61
Db-C (layers 12-20)	46	193	48	1.05

ranih[7] metričnih podatkov dlančnic iz vzorca Db-B (*sl. 17.4*). Razlika med obema spolnima strukturama tako najverjetneje izhaja iz dejanskega neskladja v deležu vsakega od obeh spolov med interpleniglacialnima vzorcema podočnikov in metapodijev. V tem smislu je zanimiv podatek, daj je količnik med številom levih prvih spodnjih meljakov in levih prvih spodnjih podočnikov nad tri leta starih medvedov v vzorcu zgodnjeglacialne (= OIS 5a-5d) starosti statistično značilno manjši od vrednosti istega količnika pri gradivu iz OIS 3 (*tab. 17.2*), kar kaže na "primanjkljaj" podočnikov v vzorcu interpleniglacialne (= OIS 3) starosti.

Podobnega primanjkljaja v primeru metapodijev ni mogoče potrditi. Koeficient korelacije med številom vseh biometrično obdelanih dlančnic in stopalnic na eni strani ter številom vseh več kot 3 mm velikih kostnih drobcev jamskega medveda na drugi je namreč zelo visok (Spearman R = 0,89; p = 0,000).[8] Število kostnih drobcev na cel metapodij je sicer v faciji A statistično značilno večje kot v faciji B (Mann Whitney U-test: p = 0,022), vendar pa naj bi se v tem odražala predvsem večja fragmentiranost ostankov v zgornjih stratigrafskih nivojih (*sl. 17.5*; podpoglavje 12.3 v tem zborniku). Omeniti moramo tudi večjo vrednost količnika med številom metapodijev in številom pogačic v vzorcu iz facije A glede na vzorec iz facije B (podpoglavje 12.4 v tem zborniku), saj bi to lahko kazalo na "primanjkljaj" metapodijev v gradivu iz facije B. Tudi če je res tako, pa to še ne pomeni, da je treba tezo o večinskem deležu samcem pripisanih ostankov v gradivu iz OIS 3 ovreči. V to obdobje je namreč datirano tudi gradivo iz facije A, kjer delež samcem pripisanih dlančnic in stopalnic prav tako statistično značilno presega tistega iz zgodnjeglacialnega vzorca Db-C (= OIS 5a-5d).

Kot kaže, je razliko v deležu obeh spolov med vzorcema fosilnih metapodijev in podočnikov dejansko mogoče povezati s "primanjkljajem" slednjih. Manj jasno je, zakaj je do "primanjkljaja" sploh prišlo. Starostna struktura jamskih medvedov iz Divjih bab I kaže, da je množično pojavljanje njihovih ostankov domnevno posledica naravne smrtnosti med hibernacijo oz. tik po njej (Debeljak 2002a). Če je to res, lahko ugotovljeni "primanjkljaj" podočnikov kaže le na delovanje biotskih (zveri, človek) in/ali abiotskih (nihanje temperature in vlage, vodni transport) poodložitvenih dejavnikov. Da so bile tafonomske izgube v Divjih babah I dejansko velike, sta pokazala že Turk in Dirjec (1991). Njuna analiza množičnih živalskih ostankov je namreč v marsičem potrdila obstoj močne zverske (domnevno predvsem medvedje) destrukcije dolgih cevasti kosti. Ker pa naj bi bila vloga zveri pri drobljenju zob bistveno manjša, gre vzroke za "primanjkljaj" podočnikov v facijah A in B iskati drugje. Dokaj obrobna se zdi tudi vloga različne intenzivnosti razpadanja zob. Že preliminarna študija množičnosti kostnih drobcev različnih velikostnih razredov za spodnji del plasti 8 in zgornji del sklopa plasti 10 do 14 je namreč pokazala, da se relativno večji "primanjkljaj" podočnikov stratigrafsko ne ujema z večjim deležem bolj razdrobljenih fragmentov (Turk *et al.* 1988-1989). Enako pa kaže tudi razmerje med številom zobnih odlomkov in številom vseh celih zob na posamezno plast (*sl. 17.5*). Statistično značilne razlike so bile namreč ugotovljene le med obema interpleniglacialnima (= OIS 3) vzorcema Db-A in Db-B (Mann-Whitney U-test: p = 0,000), ne pa tudi med Db-B in zgodnjeglacialnim (= OIS 5a-5d) vzorcem Db-C (Mann-Whitney U-test: p = 0,882). Naj pri tem spomnim, da med vzorcema Db-A in Db-B bistvenih razlik v razmerju med številom levih C_1 in levih M_1 nad tri leta starih medvedov ni (χ^2 test: p = 0,818),[9] oba vzorca pa sta si zelo podobna tudi po deležu metapodijev vsakega od obeh spolov. Da stratigrafski nivoji z največjim "primanjkljajem" podočnikov ne izstopajo tudi po velikem številu zobnih drobcev, je potrdila tudi analiza gradiva iz profilov (Toškan 2004); volumen pregledanega sedimenta je bil sicer v tem primeru bistveno manjši (Turk 2003a), so pa bili zato zaradi natančne kontrole iz njega zagotovo pobrani prav vsi celi in zdrobljeni zobje.

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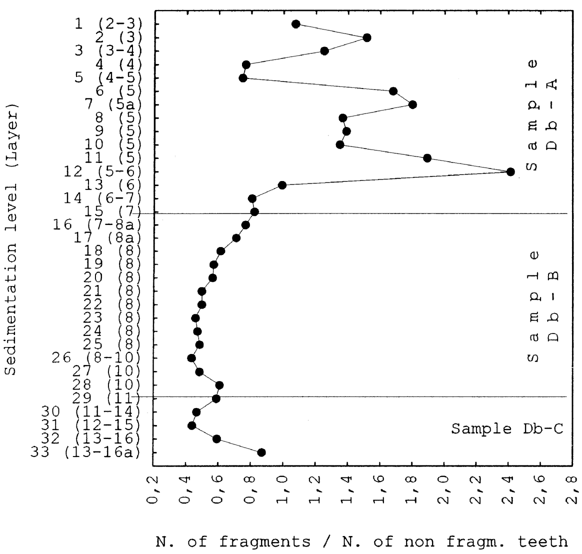
[7] Vrednosti so bile standardizirane po podatkih celotnega fosilnega vzorca iz Divjih bab I (tj. Db-A + Db-B + Db-C).

[8] Korelacije med številom podočnikov in številom več kot 3 mm velikih kostnih drobcev jamskega medveda ni mogoče oceniti, saj se podatki o številu kostnih fragmentov (tako kot to velja tudi za število metapodijev) nanašajo le na izkopni polji A in B, medtem ko so bili podočniki pobrani s celotnega izkopnega polja.

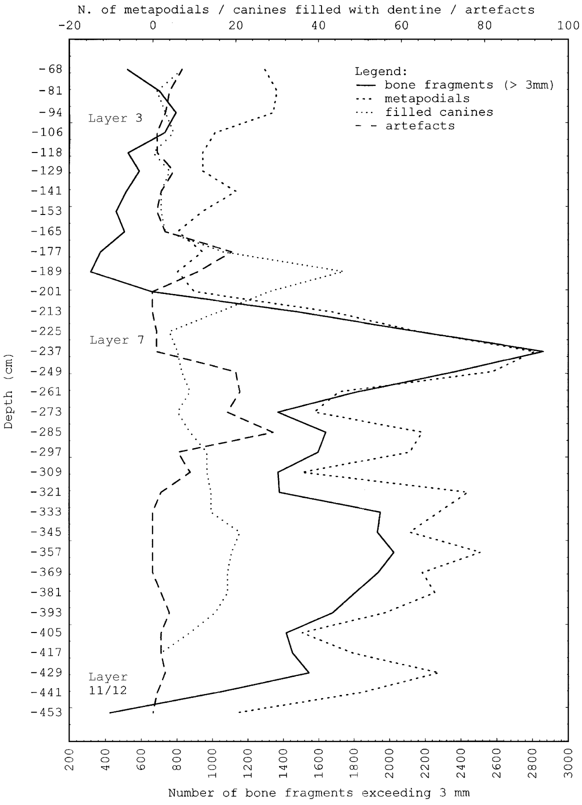
[9] Podatke o številu zob podaja Debeljak (2002a).



Sl. 17.5: Nihanje deleža med številom odlomkov in številom vseh celih zob jamskega medveda (*Ursus spelaeus*) iz Divjih bab I po plasteh. Podatki se nanašajo izključno na izkopni polji A in B in jih podaja Turk *et al.* (2002a).
Fig. 17.5: The quotient between the number of fragments and the number of all complete teeth of cave bear (*Ursus spelaeus*) from Divje babe I by layers. Data refer exclusively to excavation areas A and B and are taken from Turk *et al.* (2002a).

Med dejavnike, ki bi lahko prispevali k nastalemu "primanjkljaju" podočnikov več kot 3 leta starih medvedov, sodi tudi človek. Znane so razprave o pomenu in obsegu t.i. kulta jamskega medveda (npr. Kurtén 1972; Chase 1987). Med drugim se omenja tudi možnost, da so medvedji podočniki nekoč (kot to navsezadnje velja še tudi danes) veljali za trofejo, zato naj bi jih človek veliko odtujil (Turk *et al.* 1988-1989; Turk 2003b). Iz mlajšega paleolitika je znanih več prevrtanih podočnikov jamskega medveda (npr. Schreve, Currant 2003; Tejero *et al.* 2005; Vercoutère *et al.* 2006), še starejši pa so podobni primerki lisičjih zob (Vercoutère 2002; Valde-Nowak, Charles 2003). Tu so še preluknjane prstnice severnega jelena, za katere je morda prav tako odgovoren srednjepaleolitski človek (Chase 2001). Arheologi poročajo celo o dobro dokumentiranih primerih namernih pokopov neandertalcev ter o določenih okrasnih ali drugače nenavadnih predmetih, ki naj bi dokazovali obstoj simbolizma, religije in umetnosti (npr. Chase 1987; Germonpré 2001; Horusitzky 2003; Turk *et al.* 2003a; Valde-Nowak, Charles 2003; Maureille 2004).

Da je "primanjkljaj" podočnikov med gradivom iz OIS 3 morda res utemeljeno povezovati (tudi) s človekom, kaže *sl. 17.6*. Kot vidimo, se vertikalna porazdelitev metapodijev v celoti ujema s porazdelitvijo vseh koščenih fragmentov, večjih od 3 mm. V številu dlančnic in stopalnic na stratigrafski nivo se torej kaže predvsem naravna smrtnost medvedov v jami v posameznih obdobjih (vsaj metapodiji iz vzorcev Db-A in Db-C ne izkazujejo "primanjkljajev", kakršne sem ugotovil pri podočnikih). Zanimivejša je zato primerjava vertikalnih porazdelitev metapodijev oz. z dentinom že zapolnjenih podočnikov z vertikalno porazdelitvijo kamenih artefaktov. Presežki v številu metapodijev se s presežki v številu podočnikov namreč ujemajo le v plasteh, kjer je število pobranih lusk, odbitkov, orodij, jeder in razbitin zanemarljivo (npr. sediment od -309 do -417 cm globine). Drugače je s sedimentacijskimi nivoji, kjer veliko število pobranih kamenih artefaktov nakazuje povečano frekvenco oz. trajanje človekovih obiskov jame (npr. sediment od -237 do -297 cm globine). V teh ostaja namreč število z dentinom zapolnjenih kaninov majhno kljub sicer mnogim najdbam metapodijev in koščenih fragmentov. Pri tem se je seveda treba zavedati, da večje število pobranih lusk, odbitkov, orodij, jeder in razbitin ni zanesljiv kazalec daljšega človekovega zadrževanja v jami. Prav tako drži, da stratigrafski nivoji z izrazitim "primanjkljajem" podočnikov ne izstopajo vedno tudi



Sl. 17.6: Primerjava vertikalnih porazdelitev metapodijev, z dentinom že zapolnjenih podočnikov, kamenih artefaktov ter več kot 3 mm velikih kostnih fragmentov za izkopno polje B. Podatki o številu artefaktov, zob in kostnih fragmentov so povzeti po Turk (2003a) in Turk *et al.* (2002b).
Fig. 17.6: Comparison of vertical distributions of metapodials, root-filled canines, stone artefacts and more than 3 mm bone fragments from excavated area B. Data on the number of artefacts, teeth and bone fragments are taken from Turk (2003a) and Turk *et al.* (2002b).

po relativno velikem številu kamenih artefaktov. Je pa mogoče “primanjkljaj” podočnikov kljub vsemu bolje razložiti z domnevno večjo frekvenco človekovih obiskov jame kot pa s klimatskimi nihanji v obravnavanem obdobju. Podobnost med vertikalnima porazdelitvama z dentinom zapolnjenih C_1 in deležem v sedimentu zastopanih kongelifraktov (kazalec temperaturnih nihanj) oz. med vertikalnima porazdelitvama z dentinom zapolnjenih C_1 in deležem v sedimentu zastopanih agregatov (kazalec nihanj vlažnosti) je namreč praktično nična (Toškan 2004).

V kolikor je človek v OIS 3 iz Divjih bab I dejansko odnašal podočnike jamskega medveda, pričakujem, da je prednostno zbiral večje, odraslim samcem pripadajoče primerke. Preferenca do večjih, trofejnih podočnikov je bila nenazadnje večkrat jasno izražena celo ob modernih izkopavanjih arheoloških in paleontoloških najdišč (npr. Kurtén 1972; Weinstock 2000). Takšno selektivno odtujevanje primerkov bi (je?) seveda porušilo izhodiščno razmerje med spoloma in s tem prispevalo k podcenjenemu deležu podočnikov samcev v analizi Debeljakove (2002b). Z domnevo o človekovi preferenci do večjih, trofejnih zob se ujema tudi ugotovitev, da je mogoče “primanjkljaj” podočnikov statistično dokazati le na vzorcu zob odraslih živali (χ^2 test: p = 0,032), ne pa tudi pri gradivu s primerki vseh več kot 2 leti starih medvedov (χ^2 test: p = 0,118). V vzorcu podočnikov vseh več kot 2 leti starih medvedov namreč močno prevladujejo primerki mladih (<3 leta) živali (Debeljak 2002a), ki so še votli in razmeroma majhni (Debeljak 1996). Kot taki so bili za potencialnega “zbiratelja” najverjetneje nezanimivi, zato naj bi bilo njihovo odtujevanje iz jame zanemarljivo.

ANALIZA VELIKOSTI

Metrični podatki dolgih kosti omogočajo zanesljivejšo oceno velikosti (mase) fosilnih medvedov, kot to velja za metapodije (npr. Jackson 1989; Damuth, MacFadden 1990; Christiansen 1999). V okviru analize velikosti tako nisem ugotavljal absolutnih razlik v masi medvedov različne geološke starosti, ampak le relativne. Dobljeni rezultati so kljub temu pomembni, saj je število v celoti ohranjenih metapodijev v fosilnem gradivu iz Divjih bab I bistveno večje od števila nepoškodovanih dolgih kosti ($N_{\text{metapodiji}}$ = 1.598; $N_{\text{dolge kosti}}$ = 272).

Relativne razlike v velikosti metapodijev različne geološke starosti so prikazane na *sliki 17.7*. Zaradi večje obremenitve prednjih okončin je razlika v vrednostih prve glavne komponente pri dlančnicah[10] bistveno večja kot pri stopalnicah, pri katerih sploh ne presega meje statistične značilnosti (samci: F = 0,20 p = 0,650; samice: F = 0,46 p = 0,495). V nasprotju s tem so razlike pri dlančnicah celo visoko statistično značilne (*tab. 17.3*).[11]

Predstavljeni rezultati kažejo na to, da so Divje babe I v OIS 3 obiskovali večji jamski medvedi kot v OIS 5a-5d. Brez primerjalnih podatkov iz vsaj še nekaj drugih jam v regiji seveda navedene ugotovitve ni mogoče *a priori* posplošiti na celotno populacijo, saj le eno najdišče ne more v zadovoljivi meri povzeti heterogenosti nekdanjih biotopov.[12] Žal pa je večina objavljenih metričnih podatkov metapodijev jamskega medveda iz bližnje (npr. Rakovec 1967; Pohar 1981; Krklec 1997; Withalm 2001) in nekoliko bolj oddaljene (npr. Torres 1988; Argant 1991) okolice v tem smislu neuporabna. Njihovo primerjalno vrednost namreč bistve-

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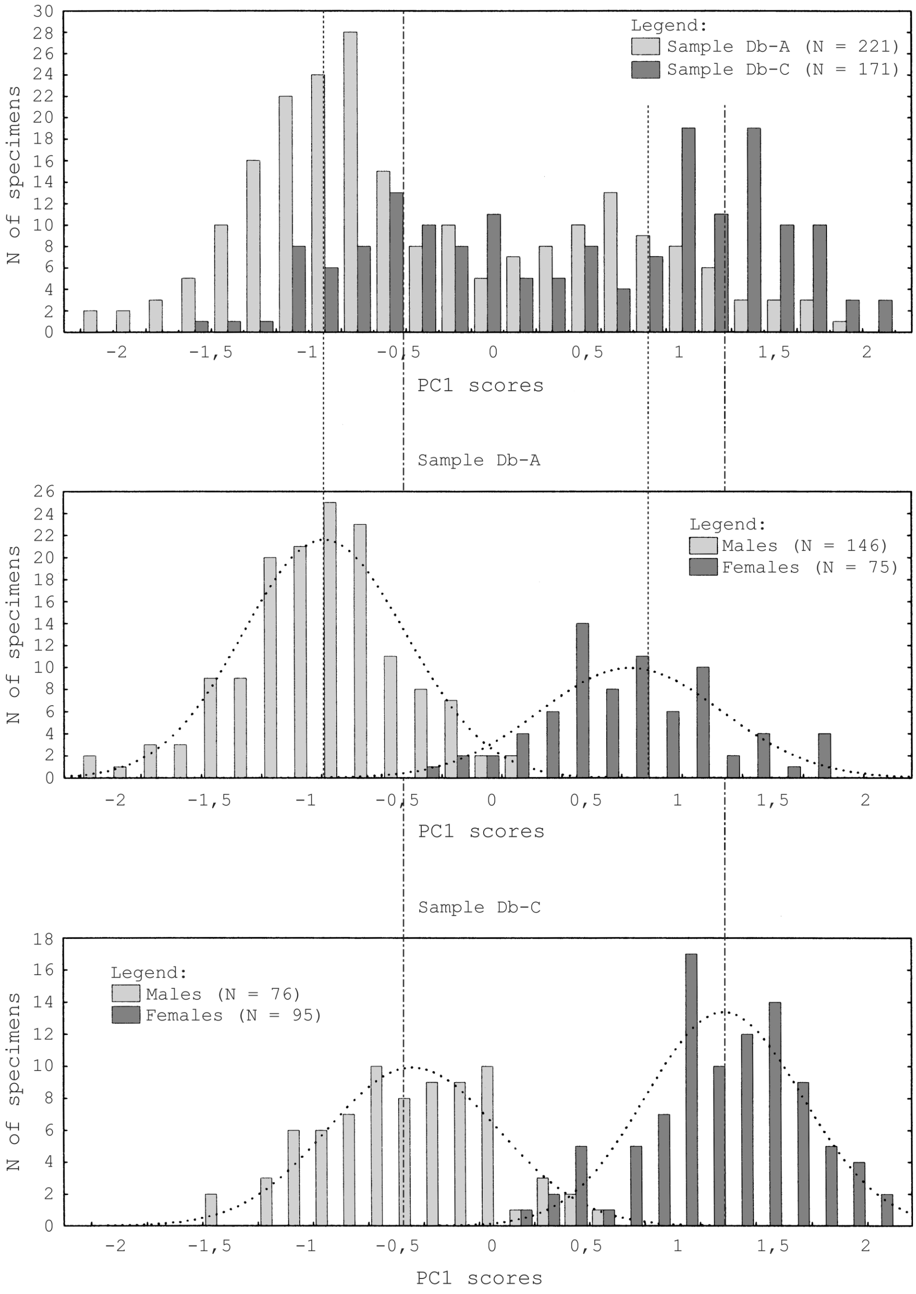
[10] PC 1 povzema nad 70 odstotkov variance v osnovnem naboru metričnih podatkov.

[11] Razlika je visoko statistično značilna ne glede na to, kako med oba spola porazdelim po dimenzijah “vmesne” dlančnice (N = 47), ki jih sicer ni mogoče z zanesljivostjo pripisati nobenemu od obeh spolov (Toškan 2004).

[12] Reprezentativnost razpoložljivih ostankov je do neke mere vprašljiva že zato, ker v jami najdeni ostanki prvenstveno kažejo na lastnosti med “zimskim spanjem” poginulih (ne pa vseh nekdaj živečih) živali (Fenster *et al.* 1992).

Tab. 17.3: Testiranje statistične značilnosti razlik med spoloma v vrednostih prve glavne komponente (PC 1), izračunane na osnovi korelacijske matrike standardiziranih podatkov osmih dimenzij po spolu ločenih dlančnic jamskega medveda (*Ursus spelaeus*) iz Divjih bab I: vzorca Db-A in Db-C. Vrednosti so bile standardizirane po podatkih iz vzorca Db-B. PC 1 pojasnjuje 83,7 odstotka vse v osnovnem naboru podatkov zaobjete variance. Vse faktorske uteži prve glavne komponente so negativne. Obrazložitev simbolov: M – povprečna vrednost. Za obrazložitev glej besedilo.
Tab. 17.3: Testing the statistical significance of differences between sexes in the first principal component (PC 1) scores, calculated on the correlation matrix of standardised measurements of cave bear (*Ursus spelaeus*) metacarpals separated by sex, from Divje babe I: samples Db-A and Db-C. Measurements were standardised using sample Db-B as reference. PC 1 accounts for 83.7 percent of the total variance in analysed metacarpals. All PC 1 factor loadings are negative. Explanation of symbols: M – average value. See text for explanation.

Sex	**PC 1$_{\text{Db-A}}$ scores**	**PC 1$_{\text{Db-C}}$ scores**	**F-test**	**Mann-Whitney U test**
♂	M = -0.91 min = -2.21 max = 0.19	M = -0.44 min = -1.56 max = 0.55	F = 28.38 p = 0.000	Z = -6.63 p = 0.000
♀	M = -0.71 min = -0.35 max = 1.81	M = -1.21 min = 0.14 max = 2.14	F = 25.46 p = 0.000	Z = -6.28 p = 0.000



Sl. 17.7: Porazdelitev vrednosti prve glavne komponente (PC 1), izračunane na osnovi korelacijske matrike standardiziranih podatkov osmih dimenzij dlančnic jamskega medveda (*Ursus spelaeus*) iz Divjih bab I. Prikazani so rezultati za skupen vzorec Db-A + Db-C (zgoraj), vzorec Db-A (= OIS 3; sredina) in vzorec Db-C (= OIS 5; spodaj). Vrednosti so bile standardizirane po podatkih iz vzorca Db-B. PC 1 pojasnjuje 83,7 odstotka vse v osnovnem naboru podatkov zaobjete variance. Pikčasta črta (····) označuje povprečje vrednosti prve glavne komponente za dlančnic samcev in samic iz vzorca Db-A, prekinjena črta (– · · –) pa za tiste iz vzorca Db-C. Za obrazložitev glej besedilo.

Fig. 17.7: Distribution of first principal component (PC 1) scores, calculated on the correlation matrix of standardised measurements of cave bear (*Ursus spelaeus*) metacarpals from Divje babe I. Shown are the results for the pooled sample Db-A + Db-C (top), sample Db-A (= OIS 3; middle) and sample Db-C (= OIS 5; bottom). Measurements were standardised using sample Db-B as reference. PC 1 accounts for 83.7 percent of the total variance in analysed metacarpals. Dot line (····) represents the average value of PC1 scores for male and female metacarpals from sample Db-A, while dash-and-dot line (– · · –) represents the average value of PC1 scores for male and female metacarpals from sample Db-C. See text for explanation.

no zmanjšujejo premajhna časovna ločljivost vzorcev, neznano razmerje med spoloma in/ali neprimeren način predstavitve rezultatov brez podajanja vsaj osnovne opisne statistike.

ANALIZA OBLIKE

Za razliko od ekofenotipsko plastične velikosti velja oblika za bolj konzervativno komponento morfološke variabilnosti, kar ji daje bistveno večjo "filetsko težo". Morebitne razlike v obliki metapodijev jamskega medveda različnih geoloških starosti bi bilo zato mogoče povezovati z (mikro)evolutivnimi spremembami. Morfometrične in morfogenetske študije dlančnic in stopalnic iz sklopa plasti K do M iz jame Vindija pri Donji Voći (Krklec 1997; Gužvica, Radanović-Gužvica 2000) ter iz Jame pod Herkovimi pečmi na Kozjaku (Pohar 1981) kažejo prav to. Na osnovi pridobljenih rezultatov je bilo namreč za obdobje prehoda iz riško-würmskega interglaciala v würm mogoče potrditi sočasno prisotnost "klasičnih" jamskih medvedov in pa manjših "zamudnikov" kroga deningeri.

Analizirani metapodiji iz Divjih bab I so geološko bistveno mlajši od tistih iz Vindije (sklop plasti K do M) in iz Jame pod Herkovimi pečmi,[13] zato neposredna primerjava med navedenimi najdišči ni mogoča. V tem pogledu so uporabnejši metrični podatki dlančnic in stopalnic jamskega medveda iz več avstrijskih in ene italijanske jame, ki jih je objavil Withalm (2001). Žal njihovo primerjalno vrednost zmanjšuje preohlapen in včasih vprašljiv časovni okvir posameznih vzorcev (prim. Turk *et al.* 2003b). Še bolj problematično je nepoznavanje razmerja med spoloma, kar onemogoča razlikovanje med spolno in filogenetsko pogojenimi razlikami v morfologiji dlančnic in stopalnic. Po Withalmu (2001; 2004) naj bi tako naraščajoče vrednosti indeksa zavaljenosti[14] metapodijev srednjeevropskih jamskih medvedov v würmu kazale na pojav vse naprednejših oblik te vrste. Kot kažejo tukaj predstavljeni rezultati, pa ni nujno tako. Podoben trend je bil sicer sprva res ugotovljen tudi pri gradivu iz Divjih bab I, a le na vzorcu, ki je združeval primerke obeh spolov! Ko sem namreč med seboj primerjal po spolu ločene dlančnice in stopalnice, razlike v vrednosti indeksa zavaljenosti niso bile več statistično značilne (*tab. 17.4*). Po vrednostih I_z se sicer samicam pripisane dlančnice iz Divjih bab I v grobem ujemajo s primerki iz avstrijskih najdišč Windener Bärenhöhle (pribl. 35.000 p.s.), Gamssulzenhöhle (pribl. 40.000–25.000 p.s.) in Ramesch-Knochenhöhle (pribl. 30.000–60.000 p.s.). V nasprotju s tem so dlančnice samcev v povprečju nekoliko bolj zavaljene in kot take bližje tistim iz Potočke zijalke (pribl. 35.000–26.000 p.s.; Withalm 2001; 2004).

Še spornejša od računanja indeksa zavaljenosti pri vzorcih metapodijev brez znanega razmerja med spoloma je uporaba t.i. indeksa K[15] (npr. Gužvica, Radanović-Gužvica 2000; Withalm 2001; 2004). Ker je namreč v imenovalcu izražena linearna meritev (tj. gL), v števcu pa zmnožek dveh linearnih meritev (tj. pB*pH), je naraščanje vrednosti v imenovalcu bistveno počasnejše od naraščanja tiste v števcu tudi v (hipotetičnih) primerih, ko se vrednosti vseh treh dimenzij (tj. pB, pH in gL) sicer povečujejo enakomerno. Uporaba K-indeksa v morfometričnih študijah je torej neustrezna tudi ob poznavanju razmerja med spoloma (prim. Atchley, Anderson 1978).

Pomembna pomanjkljivost "klasičnih" pristopov k morfometričnim analizam oblike skeletnih elementov je tudi, da praviloma ne omogočajo zanesljivega

Tab. 17.4: Vrednosti indeksa zavaljenosti za po spolu ločene dlančnice jamskega medveda (*Ursus spelaeus*) iz vzorcev Db-A in Db-C. Obstoj statistično značilnih razlik med gradivom različne geološke starosti je bil testiran z uporabo Mann-Whitneyjevega U testa. Za opredelitev indeksa zavaljenosti glej besedilo. Opredelitev simbolov: Me – mediana.
Tab. 17.4: Values of the index of plumpness for metacarpals of cave bear (*Ursus spelaeus*) from samples Db-A and Db-C divided by sex. The existence of statistically significant differences between materials of different geological age was tested using the Mann-Whitney U test. See text for definition of the index of plumpness. Explanation of symbols: Me – mediana.

Metacarpal	**Sex**	**Db-A**		**Db-C**		**Mann-Whitney U test**	
		Me	**25% - 75%**	**Me**	**25% - 75%**		
Mc I	♂	31.2	30.0 - 32.1	31.2	30.6 - 31.8	Z = -0.35	p = 0.728
	♀	28.9	27.7 - 30.0	29.1	28.6 - 30.4	Z = -0.74	p = 0.456
Mc II	♂	34.6	33.6 - 35.7	34.9	33.7 - 35.9	Z = -0.54	p = 0.590
	♀	32.7	32.3 - 34.3	32.7	32.4 - 33.3	Z = 0.07	p = 0.941
Mc III	♂	32.9	32.0 - 34.3	32.5	31.1 - 34.4	Z = 0.63	p = 0.527
	♀	31.8	30.6 - 32.7	30.4	29.7 - 31.1	Z = 1.95	p = 0.051
Mc IV	♂	33.3	32.2 - 34.1	32.9	31.8 - 34.2	Z = 0.85	p = 0.395
	♀	30.5	29.7 - 32.1	30.8	30.1 - 31.6	Z = -0.67	p = 0.499
Mc V	♂	35.2	33.8 - 36.6	35.4	34.9 - 36.5	Z = -0.33	p = 0.742
	♀	33.2	32.3 - 34.8	32.7	32.3 - 33.6	Z = 0.90	p = 0.369

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[13] Domnevno namreč niti najstarejši primerki iz Divjih bab I (tj. tisti iz plasti 16a) ne presegajo geološke starosti 80.000 let p.s.

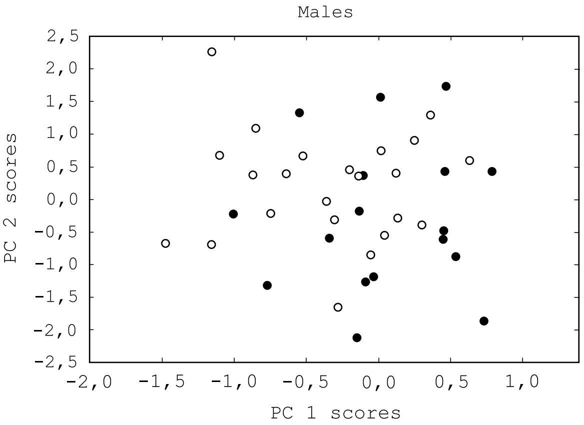
[14] Indeks zavaljenosti (I_Z) je opredeljen kot v odstotkih izražen količnik med največjo medio lateralno širino distalne epifize (gdB) in največjo dolžino metapodija (gL).

[15] K-indeks je opredeljen kot (pB*pH)/gL, kjer gL predstavlja največjo dolžino metapodijev, pB in pH pa največjo širino oz. največjo višino proksimalne epifize.

razlikovanja med obliko in velikostjo (za izjemi glej npr. Grandal d'Anglade (1993b) in Grandal d'Anglade, López-Gonzáles (2005)). Problem sem skušal odpraviti z uporabo analize glavnih komponent, pri čemer sem velikostno informacijo iz izvirne množice podatkov odstranil s t.i. Burnabyjevo metodo odstranitve velikosti. Če namreč tako modificirane podatke v obliki korelacijske matrike ponovno vpeljem v analizo PCA, lahko načeloma vse ugotovljene statistično značilne razlike med primerjanimi vzorci v vrednosti posameznih glavnih komponent interpretiram kot odraz razlik v obliki.

V okviru analize oblike sem primerjal tako metakarpalne kosti enega in drugega spola iste geološke starosti (npr. Mc III samcev in samic iz vzorca Db-A), kot tudi istemu spolu pripisane primerke iz dveh različnih vzorcev (npr. Mc II samcev iz vzorcev Db-A in Db-C). Ker posamezne glavne komponente pojasnjujejo razmeroma enakomeren delež variance,[16] sem v nadaljevanju analize upošteval vrednosti prvih štirih do šestih glavnih komponent na posamezno primerjavo. Takšna odločitev mi je omogočila operirati z vsaj 84 odstotki variabilnosti velikosti prostega nabora podatkov (celoten razpon: 84 % do 95 %; Me = 88,5 %).

Rezultati bilateralnih primerjav kažejo, da so odstopanja med vrednostmi posameznih glavnih komponent statistično značilna le v treh (od skupno 25) primerih (Mann-Whitney U-test: p < 0,05). To kaže na odsotnost večjih razlik v morfologiji tako med dlančnicami enega in drugega spola iste geološke starosti kot tudi med samcem ali samicam pripisanimi primerki različne geološke starosti. V tem smislu predstavljajo edini izjemi samicam pripisane četrte dlančnice, kjer obstaja med primerki iz Db-A in tistimi iz Db-C statistično značilna razlika v morfologiji proksimalne epifize (Mann-Whitney U-test: p = 0,002), ter tretje dlančnice samcev (*sl. 17.8*), kjer se primerki obeh vzorcev razlikujejo v obliki proksimalne epifize (p = 0,003) in diafize (p = 0,020).



Sl. 17.8: Projekcija tretjih dlančnic samcev jamskega medveda (*Ursus spelaeus*) iz vzorcev Db-A (●) in Db-C (○) iz Divjih bab I na prvo in drugo glavno komponento, ki sta bili izračunani na osnovi korelacijske matrike velikosti prostih podatkov osmih merjenih dimenzij. PC 1 pojasnjuje 34 odstotkov, PC 2 pa 19 odstotkov vse v izhodiščnem naboru podatkov zaobjete variance. Variable, pri katerih absolutne vrednosti faktorskih uteži presegajo vrednost 0,70, so: gL, gdB in dB pri prvi glavni komponenti ter pB pri drugi. Osi so bile rotirane z metodo *varimax normalized* (StatSoft Inc., 2001). Legenda: PC – glavna komponenta. Za obrazložitev glej besedilo.

Fig. 17.8: Projection of male third metacarpals of cave bear (*Ursus spelaeus*) from samples Db-A (●) and Db-C (○) from Divje babe I to the first and second principal components, which were calculated on the correlation matrix of the size-free measurements of third metacarpals. PC 1 and PC 2 account for 34 percent and 19 percent of the total variance in analysed metacarpals, respectively. Variables in which the absolute values of factor loadings exceed 0.70 are: gL, gdB and dB in the case of the first principal component (PC 1) and pB in the case of the second principal component (PC 2). Axes were rotated by the method of *varimax normalized* (StatSoft Inc., 2001). Legend: PC – principal component. See text for explanation.

Pri jamskem medvedu je bila plantigradnost domnevno bolj izražena, kot to velja za rjavega medveda (Couturier 1954; Chagneau 1985; Krklec 1997). Ker se na nivoju metapodijev takšen način hoje praviloma kaže v pahljačasti razširitvi distalnih delov epifiz in distalnih epifiz (npr. Ewer 1973; Kurtén, Poulianos 1977), so ugotovljene razlike v morfologiji dlančnic oz. nartnic različne geološke starosti iz Divjih bab I do neke mere presenetljive. Glede na tezo o progresivno vse bolj plantigradni hoji jamskega medveda in njegovi specializirani uporabi prednjih šap pri izkopavanju podzemnih delov rastlin (a glej tudi Pinto Llona, Andrews (2001)) bi namreč razlike prej pričakoval v oblikovanosti distalnih delov metapodijev (npr. Kurtén 1969; Viranta 1994; Krklec 1997). Chagneau (1985) je sicer pri *os scapholunare* opazil nekatere specifične morfološke modifikacije, ki naj bi jim botrovali prav plantigradna hoja in/ali uporaba prednjih šap pri kopanju (ker navedena karpalna kost artikulira s četrto dlančnico, bi določene prilagoditve torej lahko pričakovali tudi v oblikovanosti njene proksimalne epifize). Brez odgovora pa ostajata vprašanji, zakaj je do morfoloških modifikacij prišlo le pri enem od obeh spolov ter zakaj česa podobnega ni opaziti tudi na proksimalni epifizi katere od drugih dlančnic? Morfometrična študija karpalnih kosti jamskega medveda je namreč izpostavila tudi kopico drugih prilagoditev na vse bolj izraženo plantigradnost (Chagneau 1985).

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[16] Gre za pričakovano posledico Burnabyjeve odstranitve velikostne informacije.

SKLEP

Obravnava metapodijev jamskega medveda iz Divjih bab I z uporabo multivariatnih statističnih metod je razkrila nekatere slabosti "klasičnih" morfometričnih raziskav. Poleg tega je učinkovito ovrgla tezo, po kateri naj dlančnic in stopalnic jamskega medveda ne bi bilo mogoče grupirati po spolu (prim. Withalm 2001).[17] Ocenjena spolna struktura se sicer nekoliko razlikuje od tiste, ki temelji na metričnih podatkih podočnikov (Debeljak 2002a), se pa zato v celoti ujema z rezultati biometrične analize dolgih kosti (poglavje 16 v tem zborniku; *sl. 16.3a, b*). Predstavljeni izsledki tako obenem tudi nakazujejo, da sicer zelo popularna metoda ocenjevanja razmerja (!) med spoloma na osnovi metričnih podatkov podočnikov ni vedno zanesljiva (prim. Turk *et al.* 1989).

Namen pričujočega prispevka pa ni le opozoriti na metodološke pomanjkljivosti "klasičnih" morfometričnih raziskav. Pridobljeni podatki namreč ponujajo tudi zanimivo izhodišče za poglobljen vpogled v življenje jamskega medveda in v njegove odzive na klimatska nihanja. Izsledki sedimentoloških, paleontoloških, palinoloških in antrakotomskih raziskav kažejo, da naj bi bila klima v OIS 3 bistveno bolj hladna, vlažna in manj stanovitna kot v OIS 5a-5d (Šercelj, Culiberg 1991; Turk *et al.* 2002b; poglavja 6, 8, 10 in 11 v tem zborniku). Izhajajoč iz biologije recentnih medvedov je s takšnimi ugotovitvami skladna tudi spolna struktura jamskega medveda. Spolno specifična izbira brloga pri fosilnih in recentnih vrstah rodu *Ursus* naj bi bila sicer odvisna predvsem od velikosti jame, njene nadmorske višine, naklona in lege pobočja, vegetacije v okolici ter oddaljenosti od različnih motečih točk (Slobodyan 1976; Rogers 1981; Camarra 1983; Groff *et al.* 1998; Stiner *et al.* 1998; Reisinger, Hohenegger 1998). Vendar pa ima pri tem zelo pomembno vlogo tudi klima. Kot kažejo študije recentnih medvedov, določa fiziološko pripravljenost na "zimsko spanje" in grobo tempiranje njegovega začetka cirkanualni ritem, ki je vezan na sezonski cikel rastlin (Ewer 1973). Odločilen impulz za dejanski prehod v letargično stanje pa naj bi sprožilo predvsem splošno poslabšanje vremena v kombinaciji z zmanjševanjem količine razpoložljive hrane (Johnson, Pelton 1980). Za današnje črne (*U. americanus*) in rjave (*U. arctos*) medvede vemo, da v klimatsko ugodnih pogojih brloge prve zasedejo breje samice. Sledijo jim subadultni osebki in nazadnje še samci (Slobodyan 1976; Pasitschniak-Arts 1993). Zamik (pri samcih včasih celo popoln izostanek) v začetku "zimskega spanja" lahko sprožijo obilne letine žira, želoda ipd. (Johnson, Pelton 1980; Germonpré, Sablin 2001). Drugače je ob ostrejših klimatskih pogojih in/ali pomanjkanju hrane. Takrat naj bi pričeli namreč samci hibernirati približno sočasno s subadultnimi osebki in (brejimi) samicami (Slobodyan 1976; Pasitschniak-Arts 1993), kar vodi do povečane konkurence za ugodne, bolj zaščitene brloge (Johnson, Pelton 1980; Stiner 1998b). V takšnih razmerah so seveda pri izbiri brloga v prednosti samci, saj se breje samice oz. samice v spremstvu subadultnih mladičev pred njimi običajno umaknejo drugam.

Podobno vedênje je bilo verjetno prisotno tudi pri jamskem medvedu. Na to kažejo nadpovprečno visoke vrednosti δ^{15}N pri osebkih iz hladnih faz würma, kar naj bi bilo povezano z reciklažo uree pri sintezi aminokislin med hiberniranjem (Fernández Mosquera *et al.* 2000; 2001). V manjšem deležu samic znotraj interpleniglacialnih vzorcev Db–A in Db–B se tako verjetno kaže predvsem povečan pritisk samcev na potencialne brloge zaradi manj ugodnih klimatskih razmer v OIS 3 glede na tiste v OIS 5a-5d. Takšno tezo potrjuje tudi podatek, da spolna struktura medvedov iz edinih dveh razmeroma toplih in/ali suhih faz interpleniglaciala[18] ne kaže na večinski delež samcev, kot je to sicer značilno za preostalo gradivo iz OIS 3. Namesto tega je delež samcev v gradivu iz omenjenih dveh faz praktično enak deležu samic, tako kot to velja za zgodnjeglacialni vzorec Db–C (*sl. 17.9*; glej tudi *sl. 17.2* in *sl. 17.4*).

Alternativno razlago spolnemu dimorfizmu kot vzroku za obstoj različno velikih metapodijev jamskega medveda v mlajšepleistocenskih najdiščih Italije, Avstrije, Nemčije, Slovenije in Hrvaške podajajo Withalm (2004; 2005) in Hofreiter s sodelavci (2004). Po videnju omenjenih avtorjev naj bi bil povečan delež večjih in bolj zavaljenih metapodijev na nekaterih najdiščih posledica imigracije robustnejših jamskih medvedov, ki jih obravnavajo kot samostojno vrsto *Ursus ingressus* Rabeder *et al.*, 2004 (Rabeder *et al.* 2004b,c). Po naselitvi alpskega prostora pred približno 50.000 leti naj bi namreč omenjena vrsta na tem območju v celoti nadomestila vrsto *U. spelaeus* (Rabeder, Hofreiter 2004).[19] Vendar pa odsotnost statistično značilnih razlik v obliki metapodijev različne geološke starosti iz Divjih bab I takšni razlagi v našem primeru nasprotuje. Withalm (2004; 2005), Hofreiter s sodelavci (2004) ter Rabeder s sodelavci (2004c) namreč jasno navajajo, da se vrsti *U. spela-*

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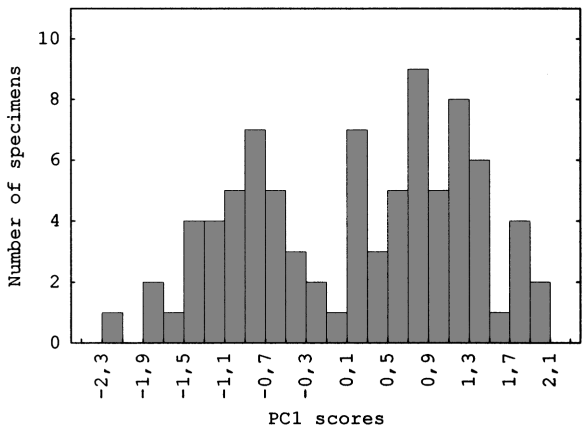
[17] Skladne s tem so tudi ugotovitve, ki jih podajajo Krklecova (1997) ter Quiles, Monchot (2004).

[18] V takih pogojih naj bi nastala sklopa plasti 2 do 5 (brez plasti 5a) in 6 do 7. Žal je zaradi krioturbacije sklop plasti 2 do 5 naguban, tako da posameznih najdb ni mogoče z zanesljivostjo ločiti od tistih iz plasti 5a, ki je sicer nastala v obdobju hladne in razmeroma vlažne klime. Kljub temu je zanimivo, da je število dlančnic samcev, ki sem jih pogojno uvrstil v plast 5a, visoko statistično značilno večje od števila dlančnic samic, ki sem jih pogojno uvrstil v isto plast (χ^2 test: p = 0,000). Drugače je s preostalimi dlančnicami iz sklopa plasti 2 do 5, kjer razlika v številu primerkov vsakega od obeh spolov ni statistično značilna (χ^2 test: p = 0,144).

[19] Skladen s takšnimi razmišljanji je tudi obstoj sočasnih, a med seboj domnevno reproduktivno izoliranih populacij jamskega medveda (Hofreiter *et al.* 2004; a glej tudi Orlando *et al.* 2002).



Sl. 17.9: Porazdelitev vrednosti prve glavne komponente (PC 1), izračunane na osnovi korelacijske matrike standardiziranih podatkov osmih dimenzij dlančnic jamskega medveda (*Ursus spelaeus*) iz Divjih bab I: primerki iz plasti 6 in 7 (N = 85). Vrednosti so bile standardizirane po podatkih iz vzorca Db-B. PC 1 pojasnjuje 72,8 odstotka vse v osnovnem naboru podatkov zaobjete variance. Za obrazložitev glej besedilo.
Fig. 17.9: Distribution of first principal component (PC 1) scores, calculated on the correlation matrix of standardised measurements of cave bear (*Ursus spelaeus*) metacarpals from Divje babe I: specimens from layers 6 and 7 (N = 85). Measurements were standardised using sample Db-B as reference. PC 1 accounts for 72.8 percent of the total variance in analysed metacarpals. See text for explanation.

eus in *U. ingressus* razlikujeta tudi v morfologiji metapodijev (Toškan 2007). Prav tako je izpovedna odsotnost statistično značilnih razlik v vrednostih indeksa zavaljenosti med prvimi dlančnicami iz vzorca Db-A in tistimi iz Db-C, čeprav naj bi bil prav to eden boljših diagnostičnih znakov za razlikovanje med obema vrstama jamskih medvedov (Rabeder *et al.* 2004c). Metapodiji iz facije C so namreč časovno umeščeni v OIS 5 in so zatorej (za razliko od tistih iz facije A) starejši od 50.000 let, ko naj bi se v Alpah prvič pojavil *U. ingressus*. Glede na navedeno se zdi tako obstoj različno velikih metapodijev jamskega medveda v Divjih babah I vendarle bolj utemeljeno povezovati z razlikami med spoloma znotraj ene vrste (tj. *U. spelaeus*), kot pa z razlikami med osebki vrste *U. spelaeus* na eni strani in tistimi vrste *U. ingressus* na drugi.

Sprememba klime ob koncu zgodnjega glaciala naj bi na mikrolokaciji Divjih bab I odsevala predvsem v obilnejši in dlje časa trajajoči snežni odeji ter posledično v izrazito sezonski razpoložljivosti rastlinske hrane. Zaostritev klimatskih pogojev je od domnevno rastlinojedega jamskega medveda (Bocherens *et al.* 1994; 1997; Nelson *et al.* 1998) zahtevala oblikovanje obilnejših energetskih zalog v obliki adipoznega tkiva (prim. Searcy 1980). Pri večjih živalih dane vrste predstavlja namreč maščoba večji odstotek telesne mase kot pri manjših (Lindstedt, Boyce 1985), zato naj bi bili v okoljih z izrazito sezonsko razpoložljivo hrano večji osebki favorizirani v primerjavi z manjšimi (Millar, Hickling 1990). Ugotovitev, da so Divje babe I v OIS 3 obiskovali statistično značilno večji jamski medvedi kot v OIS 5a-5d (*tab. 17.3*; *sl. 17.7*), je torej iz tega zornega kota povsem pričakovana. Res je sicer, da se v nihanju mase recentnih medvedov kaže tudi obilo drugih dejavnikov (npr. populacijska gostota, energetska vrednost razpoložljive hrane, starost samic ob prvi kotitvi). V okoljih z razmeroma nizko primarno produkcijo in izrazito sezonsko razpoložljivostjo hrane pa naj bi bila za povečanje mase vendarle odločilna prav potreba po obilnejših energetskih zalogah pred začetkom "zimskega spanja" (Ferguson, McLoughlin 2000).

Žal hipoteze o povečevanju mase medvedov zaradi nastopa ostrejših klimatskih razmer ne morem testirati na fosilnih metapodijih iz sosednjih najdišč, ker je ustrezno podanih objav premalo. Zanimiv, čeprav izoliran podatek ponuja Torres s sodelavci (2000). Pri riških (OIS 6) jamskih medvedih iz takrat domnevno hladnejšega osrednjega dela Španije so namreč opazili značilno večje dimenzije zob kot pri primerkih iz sočasnih najdišč priobalnega, severnega dela države, kjer je bila klima domnevno milejša. Isti avtorji še dodajajo, da so bili vsi navedeni primerki hkrati v povprečju manjši od tistih, ki so priobalni pas naseljevali v še hladnejšem pleniglacialu I (OIS 4).[20] Načeloma bi lahko velikost medvedov iz Divjih bab I pojasnili tudi (predvsem?) s specifičnimi genetskimi in/ali epigenetskimi dejavniki. Vendar pa raziskave na recentnih medvedih dokazujejo, da je pretežni del intraspecifične variabilnosti v velikosti mogoče razložiti že s spremenljivimi ekološkimi dejavniki (npr. Rausch 1962; Rogers 1976; Herrero 1978).

ZAHVALA

Zahvaljujem se dr. Ivanu Turku, ki mi je omogočil študij fosilnih metapodijev iz Divjih bab I. Članek je v pretežnem delu povzetek lastne doktorske disertacije, zato bi se želel na tem mestu zahvaliti mentorici prof. dr. Vidi Pohar ter članoma komisije prof. dr. Jerneju Pavšiču in prof. dr. Borisu Bulogu. Podiplomsko usposabljanje je financiralo Ministrstvo za šolstvo, znanost in šport. Za spodbudne razprave med raziskavo sem hvaležen dr. Ivanu Turku in dr. Ivanu Kosu, za nasvete v zvezi s statistično obdelavo pa dr. Andreju Blejcu.

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[20] Zobje so sicer podvrženi specifičnim selekcijskim pritiskom, zato pri njih ugotovljene evolucijske vzorce ni utemeljeno *a priori* posploševati na preostale skeletne elemente (Patterson 1983; Dayan *et al.* 2002).

17. MORPHOMETRIC STUDY OF CAVE BEAR METAPODIALS FROM DIVJE BABE I

BORUT TOŠKAN

Abstract

Morphometric analysis of 1,598 cave bear metapodials from the Upper Pleistocene (OIS 3 and OIS 5) layers of Divje babe I showed that the metric data allow differentiation between the sexes. It was found that the share of the two sexes among the material from OIS 5a-5d is comparable, while approximately two thirds of metapodials from OIS 3 are male. The increased share of males in OIS 3 is explained by longer, colder and damper winters in this period than in OIS 5a-5d. Namely, studies of recent brown and black bear have highlighted a causal link between the occurrence of harsher climatic conditions, on the one hand, and increased intersexual competition for available lairs on the other. The sex ratio from the only two relatively warm/dry phases in OIS 3, with which the comparative share of representation of the two sexes does not differ from the sex structure of material from the relatively warm and dry OIS 5a-5d, is in line with such an interpretation.

Cave bear (*Ursus spelaeus* Rosenmüller, 1794) is often the best represented species in the fauna of European Upper Pleistocene sites (Miracle 1991; Argant 1996a). This is also the case in Divje babe I (western Slovenia; 450 m asl.), where its share exceeds 99 percent of all animal remains. Because of the large number of finds, it was possible to process some skeletal elements in more detail biometrically (e.g., Debeljak 2002a; Chapter 16 in this volume). This included metapodials, the study of which is presented below. In view of their role in the biomechanics of walking (Opavský 1990) this contribution provides an in depth view of the extent and direction of micro-evolutionary changes in the morphology of metacarpals and metatarsals and into the sex structure of cave bear from Divje babe I, including factors which would have had an impact on it.

MATERIAL AND METHODS

Only 1,598 of a total of several thousand cave bear metapodials obtained during extended excavation of Divje babe I were processed within the framework of the study presented here. In order to optimise comparison between metacarpals or metatarsals of different geological age, only specimens excavated from excavation fields A and B were processed. On these two excavation fields, Turk (2003a) analyzed the vertical distribution of the structure of aggregates and more than 3 mm large bone fragments of large mammals. On the basis of the results obtained, geological layers determined on site during the excavation were replaced by new basic stratigraphic units, i.e., facies A, B and C, which consist of various stratigraphic levels. Since such redistribution allows litostratigraphic and biostratigraphic units to be equated, the previously uniform sample of 1,598 metapodials was divided into three sub-samples: Db-A (including specimens from facies A), Db-B (facies B) and Db-C (facies C). Such a division provided a starting point for analysis of variability in the size and/or morphology of metacarpals and metatarsals of different geological ages.[1]

Detailed data on the site and course of the fieldwork are given by Turk (Chapter 1 in this volume), so only the methodology of processing the metapodials is presented here. Using a calliper gauge, eight different dimensions were measured (Fig. 17.1): greatest length (gL), medio-lateral breadth of the proximal end (pB), antero-posterior breadth of the proximal end (pH), smallest medio-lateral breadth of the diaphysis (sDB), smallest dorso-palmar or dorzo-plantar breadth of the diaphysis (sDH), greatest medio-lateral breadth of the distal end (gDB), medio-lateral breadth of the distal epiphysis (dB) and antero-posterior breadth of the distal end (dH). Only fully fused specimens were included in the analysis.[2] X-ray pictures of the paws of black bear (*Ursus americanus*) have shown that growth of the epi- and diaphyses of met-

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[1] Facies A and B were deposited in OIS 3 (i.e., Interpleniglacial), and facies C in OIS 5a-5d (i.e., Early Glacial). OIS 4 (i.e., Pleniglacial I) is almost not represented in the cave, since there was a hiatus in sedimentation (Chapters 6 and 7 in this volume).

[2] Studies of the skeletons of some species of ungulates have highlighted the possibility of appreciable growth of bone tissue even after the bone was fully fused. However, mention is mainly made of the scapula, the distal part of the humerus or astragalus, which all ossify very early in ontogenetic develop-

acarpals ends at the end of the second year, and in the following few months the ridge of the distal epiphysis is finally formed (Marks, Erickson 1966). With cave bear, the development of the metapodials is thought to have ended on average somewhat later (i.e., only just before completing the third year), since the ontogenetic development of the skeleton with the latter species is thought to have been slower (see Debeljak 2002b). In addition, the tempo of fusion of epi- and diaphyses in the study of Marks and Erickson is probably slightly underestimated, since their conclusions derive from analysis of X-ray pictures (1966; see also Moran, O'Connor 1994).

Fully preserved specimens predominate among the analysed metapodials, with which it was possible to take all eight dimensions. In order to create the most extensive (and thus representative) sample, partially damaged metacarpals and metatarsals with which one measurement could not be taken were also analysed. The missing data for these was replaced with an estimate obtained by the method of Forward Stepwise Regression. This is a procedure in which, by the analysis of undamaged specimens, a linear combination of dimensions which could be taken also on partially fragmented metapodials is created. The cited dimensions are included in the combination gradually, step by step, until further addition no longer contributes to an essentially better estimate of the "missing" dimension (StatSoft Inc. 2001). The success of the forecast was tested on undamaged specimens. The absence of statistically significant differences between the measured and estimated values (F-test: $p < 0.05$) shows that the method was successful.

The sexing of metapodials is based on the results of principal components analysis (PCA). This method enables the variations of a given number of basic *x* variables to be satisfactorily explained with (significantly) fewer principal components (PC_i), which very much facilitates the interpretation of the within-sample variability (Manly 1994; StatSoft Inc. 2001). Prior to carrying out the principal components analysis I first standardised the available metric data. By doing so I was able to substitute the absolute differences in values of individual dimensions between metacarpals (Mc I to V) / metatarsals (Mt I do V) with the relative deviation[3] of individual specimens from the average value of the given dimension in a reference sample. These relative deviations were then transferred to further analysis. Consequently, all metacarpals/metatarsals could be pooled together to form a uniform statistical sample, which was thus essentially more representative. Metric data were standardised according to the formula:

$$\text{standardised value} = (x - M) / S$$

where x represents the individual measurement to be standardised, and M and S the average and standard deviation for the same dimension in a reference sample.

By means of principal components analysis an attempt was also made to identify differences in the morphology of metapodials of different geological ages. Metric data from which the size component had been removed (i.e., Burnaby size-out) were used as a starting point. In morphometry, size generally explains the highest share of variance. Since in principal components analysis the first of them (i.e., PC 1) generally describes the highest share of variance of the original data set, it can be understood as a size vector or bearer of size information (Lemen 1983). The residuals of regression analysis with a rectangular projection of the matrix of original (i.e., size containing) data set to PC 1 are thus presumably size free and can be included in further multi-variant analysis (Burnaby 1966).

The programme package StatSoft 2001, Statistica for Windows, version 6.0, and NTSYS-pc, version 2.0 were used for statistical processing.

All the analysed cave bear metapodials from Divje babe I are kept by the National Museum of Slovenia in Ljubljana.

SEX PROFILE

Cave bear males were on average about a third heavier than females (Viranta 1994), which indicates a very pronounced sexual dimorphism (e.g., Kurtén 1955; Reisinger, Hohenegger 1998; Grandal D'Anglade 2000). Nevertheless, analysis of 4,459 metacarpals and metatarsals of *U. spelaeus* and *U. deningeri* from eight Austrian and one Italian site showed that it is not possible to group them by sex on the basis of purely linear dimensions (Withalm 2001). Because of this, the sexing of cave bear metapodials from Divje babe I was done by principal components analysis (PCA), enabling the simultaneous treatment of several parameters (in this case eight). Because of the prior standardisation of the metric data[4] the variability in size/shape of metapodials could be compared within a pooled sample of all metacarpals/metatarsals.

The correlation matrix of standardised values of all eight parameters was used as entry data, separately for metacarpals and metatarsals. PC1 accounts for 83.7 % of variability of the original data set with metacarpals and 72.8 % with metatarsals. Factor loadings of all eight parameters are negative and range between -0.76 and -0.94. The communalities are high, and the residual correlations between them are low. Most of the variance of the

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ment (e.g., Legge, Rowley-Conwy 1988, Payne, Bull 1988; Luff 1993). Nevertheless, metapodials with visible exostosis were preventively excluded from the analysis.

[3] Deviations are expressed as standard deviations.

[4] Metapodials from facies B were used as a reference sample, since in terms of their dimensions, they are ranked between specimens from facies A and C (see *Annex 17A-17J*).

original data set can therefore be satisfactorily explained by both first principal components alone.

The frequency of distribution of PC 1 scores is explicitly bimodal both with metacarpals/metatarsals from sample Db-A and with those from sample Db-C (*Fig. 17.2* and *Fig. 17.3*).[5] Such a distribution was interpreted as a reflection of sexual dimorphism, thus enabling at least an approximate estimate of the sex ratio. Overlapping between scores of the two sexes is slightly greater with metatarsals than with metacarpals. Because of the constitution of the cave bear, such a finding is entirely to be expected and has also been shown in the long bones of both pairs of extremities (Reisinger, Hohenegger 1998).

It follows from the frequency of distribution of PC 1 scores that the number of metacarpals and metatarsals of the two sexes is roughly equal in the early glacial sample Db-C (= OIS 5a-5d). The material of Interpleniglacial age (i.e., sample Db-A) is different, with approximately two thirds of specimens being male.[6] In this sense, none of the metapodials (i.e., Mc I to V, Mt I to V) show any essential deviation. In the case of three out of a total of five metacarpals, differences in the sex structure between samples Db-A and Db-C are even highly statistically significant (χ^2 test: $p < 0.01$). However, individual specimens were not as a rule divided into left and right, because the samples were too small for this. The only such attempt was done with the second metacarpal, since it is best represented of the metapodials (Mc II: N = 96). It is noteworthy that in this case, too, the ratio between the sexes is balanced in the early glacial sample (= OIS 5a-5d) while male-ascribed second metacarpals predominate in the interpleniglacial sample Db-A (= OIS 3) (*Tab. 17.1*).

The results presented above are in conflict with the opinion of Withalm (2001), according to whom metapodials are not suitable for assessing the sex profile of cave bear assemblages. Despite measuring entirely the same dimensions as the cited author, it was possible using a multivariate statistical approach to identify the sex of roughly 90 percent of all metacarpals and approximately 75 percent of all metatarsals. What is surprising about the results obtained is the deviation of the metapodial-based sex profile of cave bear assemblage from Divje babe I from the one based on the size of canines of adult animals from the same site (Debeljak 2002b). In the case of the sample from OIS 5a-5d, the results of the two approaches correspond, with both showing an approximately equal representation of each of the two sexes. It is otherwise with the material from OIS 3, where the study of canines did not show a majority share of males (for the sake of comparability only canines belonging to animals more than three years old were taken into account, since younger age categories are not represented in the sample of metapodials).

The established difference between the two sex ratio estimates is probably not a result of the unsuitability of either of the methods. The distribution of both canine metric data and metapodial PC1 scores are, namely, explicitly bimodal. It is true that in the case of canines all the available specimens of interpleniglacial age (= OIS 3) were taken into account, while only PC 1 scores of metapodials from layers 2 to 7 (= sample Db-A) are shown in *Fig. 17.2* and *Fig. 17.3*. The remaining metacarpals/metatarsals from OIS 3 (= sample Db-B) were not sexed to this point of the research because they were used as reference in the standardisation (see above). However, as shown on *Fig. 17.4*, the distribution of PC 1 scores of standardised[7] metric data of metacarpals from sample Db-B entirely confirms the hypothesis of the predominance of males in the material from OIS 3. The difference in the two sex profiles therefore probably derives from an actual discordance in the share of each of the two sexes between the interpleniglacial samples of canines and metapodials. In this sense, it is interesting to note that the quotient of the number of left first lower molars of bears above three years of age and left first lower canines of the same age group in the early glacial (= OIS 5a-5d) sample is statistically significantly lower than the value of the same quotient in the material from OIS 3 (*Tab. 17.2*), suggesting a "lack" of canines in the interpleniglacial sample (= OIS 3).

There are no indications of a similar lack in the case of metapodials. The coefficient of correlation between the number of all morphometrically analysed metacarpals and metatarsals, on the one hand, and the number of all cave bear bone fragments larger than 3 mm on the other, is very high (Spearman $R = 0.89$; $p = 0.000$).[8] It is true that the number of bone fragments per metapodial in facies A is statistically significantly higher than in facies B (Mann Whitney U-test: $p = 0.022$), but this is probably due to a greater fragmentation of remains in the upper stratigraphic levels (*Fig. 17.5*; sub-chapter 12.3 in this volume). It is also worth mentioning the higher quotient value between the number of metapodials and the number of patellae in the sample from facies A in relation to the sample from facies B (sub-chapter 12.4

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[5] Since metapodials from sample Db-B were used as a reference sample in standardisation, they were excluded in this phase of the research.

[6] Due to negative factor loadings, the large (i.e., male-ascribed) metacarpals / metatarsals form the left of the two peaks in *Fig. 17.2* and *Fig. 17.3* and small (i.e., female-ascribed) specimens the right one.

[7] Values were standardised according to data of the complete sample of cave bear metacarpals / metatarsals from Divje babe I (i.e., Db-A + Db-B + Db-C).

[8] The correlation between the number of cave bear canines and the number of bone fragments larger than 3 mm cannot be estimated, since data on the number of bone fragments (just as this also applies to the number of metapodials) refer only to excavation fields A and B, while canines were collected from the whole excavation field.

in this volume), since this could indeed indicate a "lack" of metapodials in the material from facies B. Even if this is the case, however, the hypothesis of the larger share of males in the material from OIS 3 should not be rejected since a predominance of male-ascribed metapodials was also found in the other interpleniglacial sample, i.e. sample Db-A.

Taking the above into account it appears that the sex ratio estimate between the samples of metapodials and canines can actually be linked to the "lack" of the latter. It is less clear why there is such a lack. The age structure of cave bears from Divje babe I suggests that the accumulation of their remains is related to natural mortality during hibernation or immediately afterwards (Debeljak 2002a). If this is true, then the "lack" of canines is not ascribable to specific agencies of bone collection but, rather, to a variety of post-depositional factors (activity of carnivores and man, water transport, oscillations in temperature and humidity etc.). Turk and Dirjec (1991) have already shown that taphonomic loss in Divje babe I was actually quite substantial. Their analysis in many respects confirmed the existence of powerful carnivorous (presumably mainly bear) destruction of long bones. However, since the role of carnivores in fragmenting cave bear teeth would have been essentially smaller, the cause of the "lack" of canines in facies A and B must be sought elsewhere. The role of differential preservation of teeth also seems fairly marginal. As preliminary studies of the numbers of bone fragments of various size classes for the lower part of Layer 8 and upper part of the complex of layers 10 to 14 showed, the relatively greater "lack" of canines does not correspond stratigraphically to a larger share of more fragmented teeth/bones (Turk *et al.* 1988–1989). The ratio between the number of tooth fragments and the number of non fragmented teeth in individual layers shows the same (*Fig. 17.5*), with statistically significant differences being found only between the two interpleniglacial (= OIS 3) samples Db–A and Db–B (Mann-Whitney U-test: $p = 0.000$), but not also between Db–B and the early glacial (= OIS 5a–5d) sample Db–C (Mann-Whitney U-test: $p = 0.882$). Note that there is no significant difference between samples Db–A and Db–B in the ratio between the number of left C_1 and left M_1 of cave bears over three years old (χ^2 test: $p = 0.818$),[9] and the two samples are also very similar in terms of the share of metapodials of the two sexes. That stratigraphic layers showing the greatest "lack" of canines do not stand out in terms of a large number of tooth fragments is also confirmed by the analysis of cave bear remains from the profiles (Toškan 2004). It is true that the volume of examined sediment was significantly smaller in this case (Turk 2003a), but because of careful control we have the absolute assurance that even the smallest tooth fragments were collected from it.

Palaeolithic people are one of the factors that could have contributed to the "lack" of canines of cave bears more than 3 years old. Various papers have been presented on the importance and extent of the cave bear cult (e.g., Kurtén 1972; Chase 1987). Among other things, mention is made of (cave) bear canines formerly (as indeed still today) being considered trophies, so people may have removed a lot of them (Turk *et al.* 1988–1989; Turk 2003b). Several pierced cave bear canines are known from the Upper Palaeolithic (e.g., Schreve, Currant 2003; Tejero *et al.* 2005; Vercoutère *et al.* 2006), and similar specimens of fox teeth are even older (Vercoutère 2002; Valde-Nowak, Charles 2003). Pierced phalanges of reindeer, for which Middle Palaeolithic people were perhaps similarly responsible, are also worth noting (Chase 2001). Archaeologists have even reported well documented cases of the deliberate burial of Neanderthals and certain decorative or otherwise unusual items which are thought to prove the existence of symbolism, religion and art (e.g., Chase 1987; Germonpré 2001; Horusitzky 2003; Turk *et al.* 2003a; Valde-Nowak, Charles 2003; Maureille 2004).

That the "lack" of canines among the material from OIS 3 is perhaps really (also) based on a link with Palaeolithic man is shown by *Figure 17.6*. As can be seen, the vertical distribution of metapodials fully corresponds with the distribution of all bone fragments larger than 3 mm. The number of metacarpals and metatarsals per stratigraphic level thus seems to reflect the natural mortality of bears in Divje babe I in individual periods. It is therefore more interesting to compare distributions of metapodials or root-filled canines with the distribution of stone artefacts. Peaks in the number of metapodials in fact correspond with peaks in the number of canines only in layers in which the number of microflakes, flakes, tools, cores and debris collected is negligible (e.g., sediment from a depth of –309 to –417 cm). It is otherwise with sedimentation levels in which the large number of collected stone artefacts indicates an increased frequency or duration of human visits to the cave (e.g., sediment from –237 to –297 cm depth). In these, the number of root-filled canines remains small, despite the peak in the number of metapodials and bone fragments. One must bear in mind, of course, that a larger number of collected microflakes, flakes, tools, cores and debris is not a reliable indicator of extended human presence in the cave. Similarly, stratigraphic levels with a pronounced "lack" of canines do not also always deviate in terms of a relatively large number of stone artefacts. However, it is possible nevertheless to explain the "lack" of canines better with the suspected greater frequency of human visits to the cave than with climatic variations in the period in question. The similarity between the vertical distribution of dentine filled C_1 and the share of congelifracts represented in the sediment (an indicator of temperature oscillations) or between the vertical distributions of den-

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[9] Data on the number of teeth is provided by Debeljak (2002a).

tine filled C_1 and the share of aggregates represented in the sediment (an indicator of humidity oscillations) is, namely, practically nil (Toškan 2004).

Insofar as people actually removed the canines of cave bear from Divje babe I in OIS 3, one would expect them to have preferentially collected the largest specimens, belonging to adult males. A preference for larger trophy canines has recently been clearly expressed even with modern excavations of archaeological and palaeontological sites (e.g., Kurtén 1972; Weinstock 2000). Such a selective removal of specimens would of course modify the original sex profile and thus contribute to an underestimation of the share of male canines in Debeljak's analysis (2002b). An assumption of man's preference for larger, trophy teeth also corresponds with the finding that the "lack" of canines is statistically significant only in the sample of teeth from adult animals (χ^2 test: $p = 0.032$), and not also in the material containing specimens of all cave bears more than 2 years old (χ^2 test: $p = 0.118$). This finding is noteworthy since specimens of young (<3 years) animals, which are hollow and relatively small (Debeljak 1996), greatly predominate in the sample of canines of all bears more than two years old (Debeljak 2002a). As such, they were probably uninteresting to potential "collectors", so their removal from the cave was probably negligible.

ANALYSIS OF SIZE

Metric data of long bones enables a more reliable assessment of the size (mass) of fossil cave bear than is the case for metapodials (e.g., Jackson 1989; Damuth, MacFadden 1990; Christiansen 1999). Within the framework of analysis of size, no absolute but only relative differences in the mass of cave bears of different geological age were therefore analysed. The results obtained are nevertheless significant, since the number of completely preserved metapodials in the fossil material from Divje babe I is essentially greater than the number of undamaged long bones ($N_{\text{metapodials}} = 1.598$; $N_{\text{long bones}} = 272$).

Relative differences in the size of metapodials of different geological age are shown in *Figure 17.7*. Because of the greater burden carried by the front extremities, differences in values of PC 1 with metacarpals[10] are significantly greater than with metatarsals, which do not exceed the limit of statistical significance (males: $F = 0.20$, $p = 0.650$; females: $F = 0.46$, $p = 0.495$). In contrast, differences with metacarpals are even very highly statistically significant (*Tab. 17.3*).[11]

The results presented show that larger cave bears visited Divje babe I in OIS 3 than in OIS 5a-5d. Without comparative data from at least a few other caves in the region, of course, this finding cannot *a priori* be generalised to the entire population, since one site cannot satisfactorily cover the heterogeneity of former biotopes.[12] Unfortunately, the majority of published metric data on cave bear metapodials from the vicinity (e.g., Rakovec 1967; Pohar 1981; Krklec 1997; Withalm 2001; 2004) and slightly further away (e.g., Torres 1988; Argant 1991) is unusable for this purpose, since the excessively loose time framework of samples, unknown sex ratios and/or unsuitable method of presentation of the results without giving at least basic descriptive statistics, all significantly reduce their comparative value.

ANALYSIS OF SHAPE

In distinction from ecophenotypically plastic size, the shape is a more conservative component of morphological variability, which gives it a significantly greater "filetic weight". Possible differences in the shape of cave bear metapodials of different geological ages may therefore be linked with (micro-) evolutionary changes. Morphometric and morphogenetic studies of metacarpals and metatarsals from the complex of layers K to M of the Vindija cave by Donja Voća, Croatia (Krklec 1997; Gužvica, Radanović-Gužvica 2000) and from Jama pod Herkovimi pečmi cave on Kozjak, Slovenia (Pohar 1981) show just that. On the basis of the obtained results, it was possible to confirm the contemporary presence of both "classical" cave bears and smaller "latecomers" of the circle of *deningeri* for the period of transition from the Riss-Würm interglacial to the Würm glacial.

The analysed metapodials from Divje babe I are geologically significantly younger than those from Vindija (layers K to M) and from Jama pod Herkovimi pečmi,[13] so direct comparison between the aforementioned sites is not possible. From this point of view, metric data of cave bear metacarpals and metatarsals from several Austrian and one Italian cave published by Withalm (2001) are more useable. Unfortunately, their comparative value is somewhat reduced by the excessively loose and sometimes dubious time framework of some samples (see Turk *et al.* 2003b). Even more problematic is the unknown sex ratio, which prevents the differentiation between sexual and phylogenetic conditioned dif-

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[10] PC 1 accounts for over 70 percent of variability in the original data set.

[11] The difference is highly statistically significant regardless of how the metrically "intermediate" metacarpals ($N = 47$), which cannot reliably be ascribed to either sex, are actually sexed (Toškan 2004).

[12] The representativeness of the available remains is already to some extent dubious because the remains found in the cave primarily reflect the property of animals which died during the hibernation (and not the property of all formerly living animals) (Fenster *et al.* 1992).

[13] Presumably not even the oldest analysed specimens from Divje babe I (i.e., those from Layer 16a) reach a geological age of 80,000 let BP.

ferences in the morphology of metacarpals and metatarsals. Thus, according to Withalm (2001; 2004), increasing values of the index of plumpness[14] in Central European cave bear metapodials during the Würm indicate the appearance/immigration of ever more advanced forms (even species) of cave bears. However, as the results given here show, it is not necessarily so. A similar trend was indeed initially established with the material from Divje babe I, but only on a sample which combines specimens of both sexes! When male and female metacarpals/metatarsals were compared separately, differences in the value of the index of plumpness were no longer statistically significant (*Tab. 17.4*). According to values of I_z female-ascribed metacarpals from Divje babe I roughly correspond to specimens from Austrian sites Windener Bärenhöhle (approx. 35,000 BP), Gamssulzenhöhle (approx. 40,000–25,000 BP) and Ramesch-Knochenhöhle (approx. 60,000–30,000 BP). In contrast, male-ascribed metacarpals are on average slightly plumper and, as such, closer to those from Potočka zijalka (approx. 35,000–26,000 BP; Withalm 2001; 2004).

Even more dubious than calculating the index of plumpness with samples of unsexed metapodials is the use of the K index[15] (e.g., Gužvica, Radanović-Gužvica 2000; Withalm 2001; 2004). Because a linear measurement (gL) is expressed in the denominator, while the numerator is a product of two linear measurements (pB*pH), the increase in the value of the denominator is essentially slower than the increase in the value of the numerator, even in (hypothetical) cases when the values of all three dimensions (pB, pH and gL) are increasing evenly. The use of the K-index in morphometric studies is thus inappropriate even when the ratio between the sexes is known (see Atchley, Anderson 1978).

A significant deficiency of "classical" approaches to morphometric analysis of the shape of skeletal elements is also that they do not as a rule allow reliable differentiation between shape and size (as an exception see, e.g., Grandal d'Anglade (1993b) and Grandal d'Anglade, López-Gonzáles (2005)). An attempt was made in this study to overcome this problem by using principal components analysis, whereby size information was extracted from the original data set by the Burnaby's size-out method. If such a modified (= size-free) data set is reintroduced into the PCA in the form of a correlation matrix, in principle all the statistically significant differences in the values of the individual PC found between the compared samples can be interpreted as a reflection of differences in shape.

Within the framework of the shape analysis presented here, both metacarpal bones of one or other sex of the same geological age (e.g., male- and female-ascribed Mc III from sample Db–A) and specimens ascribed to the same sex from two different periods (*e.g.* male-ascribed Mc II from samples Db–A and Db–C) were compared. Since individual PCs explain relatively equal shares of variance,[16] the values of the first four to six PCs were taken into account in each individual comparison. Such a decision made it possible to operate with at least 84 percent of the variability in the size-free data set (full range: 84 % to 95 %; Me = 88.5 %).

Statistically significant differences in PC scores were found in only three (of a total of 25) bilateral comparisons (Mann-Whitney U-test: $p < 0.05$). This indicates an absence of major differences in morphology between the metacarpals of one and the other sex of the same geological age, and between specimens of the same sex ascribed to different geological ages. The only exceptions are female-ascribed fourth metacarpals, in which there is a statistically significant difference in the morphology of the proximal epiphysis between specimens from Db-A and those from Db-C (Mann-Whitney U-test: $p = 0.002$), and male-ascribed third metacarpals (*Fig. 17.8*), in which specimens from the two samples differ in the shape of the proximal epiphysis ($p = 0.003$) and diaphysis ($p = 0.020$).

Plantigrady in cave bear was presumably more pronounced than is the case for brown bear (Couturier 1954; Chagneau 1985; Krklec 1997). Because of this, a fan-shaped enlargement of metapodials due to the enlargement of distal parts of diaphyses and distal epiphysis (e.g., Ewer 1973; Kurtén, Poulianos 1977) has been reported for cave bears. Differences in the morphology of metacarpals or metatarsals of different geological age from Divje babe I are thus to some extent surprising. In terms of the hypothesis of the progressively increasing plantigrady in cave bears and their specialised use of the forepaws in excavating the underground parts of plants (but see also Pinto Llona, Andrews (2001)), differences in the shape of distal parts of metapodials are to be expected (e.g., Kurtén 1969; Viranta 1994; Krklec 1997). It is true that Chagneau (1985) noticed some specific morphological modifications of the *os scapholunare,* which he related to a plantigrad way of walking and/or use of the forepaws for digging (because the cited carpal bone articulates with the fourth metacarpal, certain adaptations could also be expected in the design of its proximal epiphysis). Nevertheless, no straightforward explanation exists for why something similar was not observed at the proximal epiphysis of any of other metacarpals from Divje babe I, although Chagneau (1985) highlighted a range of adaptations to plan-

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[14] Index of plumpness (I_z) is defined as the quotient of the greatest medio-lateral breadth of the distal epiphysis (gdB) and the greatest length of the metapodial (gL), expressed as a percentage.

[15] The K-index is defined as (pB*pH)/gL, where gL is the greatest length of the metapodial, and pB/pH the medio-lateral/antero-posterior breadth of the proximal end.

[16] This is an expected consequence of Burnaby's out-size method.

tigrady in other carpal bones, too. Similarly, the question of why the observed morphological modifications only occurred in one of the two sexes still remains unanswered.

CONCLUSION

The treatment of cave bear metapodials from Divje babe I by the use of multivariate statistical methods revealed some weaknesses in "classical" morphometry research. In addition, it effectively proved that cave bear metacarpals and metatarsals can be grouped by sex (see Withalm 2001).[17] The estimated sex ratio is slightly different from that based on metric data of canines (Debeljak 2002a), but fully corresponds to the results of metric analysis of long bones (Chapter 6 in this volume; *Fig. 16.3a, b*). The results presented thus simultaneously show that, although a very popular method, assessing the sex ratio on the basis of metric data of canines is not always reliable (see Turk *et al.* 1989).

The purpose of the present contribution is not just to draw attention to methodological deficiencies of "classical" morphometric research. The data obtained also offer an interesting starting point for in-depth examination of the life of cave bear and its response to climatic oscillations. The results of sedimentological, palaeontological, palinological and anthracotomical research show that the climate in OIS 3 was significantly colder, damper and less stable than in OIS 5a-5d (Šercelj, Culiberg 1991; Turk *et al.* 2002b; Chapters 6, 8, 10 and 11 in this volume). Taking the biology of recent bears into account, it seems that the observed sex profile of cave bear from Divje babe I also accords with such a climatic picture. A choice of lair by fossil and recent species of the genus *Ursus* is thought to be greatly dependent on the size of the cave, its altitude, inclination and location of the slope, vegetation in the surroundings and distance from various disturbance points (Slobodyan 1976; Rogers 1981; Camarra 1983; Groff *et al.* 1998; Stiner *et al.* 1998; Reisinger, Hohenegger 1998). However, climate also has a very important role in this. As studies of recent bears show, their physiological readiness for entering hibernation is determined by circannual rhythm tied to the seasonal cycle of vegetation (Ewer 1973). This is responsible for an approximate timing of the beginning of hibernation, while the actual transition to the lethargic state is thought to be triggered by an interaction of certain climatic factors (amount and frequency of precipitation, dense clouds, general deterioration of weather) and smaller quantities of available food (Johnson, Pelton, 1980). As far as choice of lair is concerned, present-day pregnant female black and brown bears are known to be the first to occupy a lair in good climatic conditions, followed by subadult individuals and finally by males (Slobodyan 1976; Pasitschniak-Arts 1993). Postponement (in males sometimes even a complete absence) of the beginning of hibernation can be caused by abundant crops of beech-nuts, acorns and the like (Johnson, Pelton 1980; Germonpré, Sablin 2001). In view of the above, it might be inferred that females have a wider choice of appropriate lair in mild winters and/or periods of relatively large amounts of available food. A different picture emerges at the onset of severe climatic conditions and/or shortage of food. In these circumstances, males enter the hibernation approximately contemporaneously to subadult individuals and pregnant females (Slobodyan 1976; Pasitschniak-Arts 1993), thus significantly increasing intersexual competition for appropriate lairs (Johnson, Pelton 1980; Stiner 1998b). Since pregnant females and females with subadult young usually avoid solitary males when choosing a lair (Slobodyan 1976; Wielgus, Bunnell 1994), the onset of climatically severe conditions undoubtedly favours males.

Cave bear probably behaved similarly, as is indicated by the increased $\delta^{15}N$ values in males from the cold phases of Würm (Fernández Mosquera *et al.* 2000; 2001). The increased $\delta^{15}N$ values are thought to be tied to the earlier beginning (and thereby longer duration) of hibernation, during which urea recycling in amino acid synthesis occurs. This realisation is important in the context of the observed sex ratio of cave bears from Divje babe I. There is, in fact, no doubt that the climatic conditions in OIS 5a-5d south of the Alpine glaciation were significantly more favourable and more stable than those in OIS 3. It is therefore to be expected that pregnant females and females with subadult young went into hibernation before males in OIS 5a-5d. This provided them with much more freedom in choosing a lair, since although in recent bears females tend to avoid males when looking for a lair, males do not usually occupy an already occupied cave, even when inhabited by a female (Slobodyan 1976; Wielgus, Bunnell 1994). An approximately equal representation of the two sexes in the Db-C sample from Divje babe I could thus be efficiently explained by the wider choice for females in looking for a lair. A colder and more humid climate in OIS 3 certainly contributed to a more pronounced seasonal availability of vegetable food. The winters of that period are thought to have been longer, with substantially more abundant snowfall (Turk *et al.* 2002), leading to a more or less synchronous autumnal occupation of caves by bears of both sexes. Pregnant females or females with subadult young probably avoided solitary males in choosing their lairs and the latter probably also often occupied caves that had formerly been occupied by females in the warmer and less humid OIS 5a-5d. The increased share of males choosing Divje babe I as their lair in OIS 3 does not therefore seem problematic.

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[17] The findings given by Krklec (1997) and Quiles, Monchot (2004) are also in line with this.

Such a thesis is corroborated by the fact that the sex ratio in metapodials from the only two relatively warm and/or arid phases of OIS 3[18] does not show a majority share of males, as is characteristic of the rest of the material from OIS 3. Instead, the share of males in the material from the aforementioned two phases is practically equal to the share of females, just as in the Db-C sample from the relatively warm OIS 5a-5d (*Fig. 17.9*; see also *Fig. 17.2* and *Fig. 17.4*).

An alternative explanation to sexual dimorphism as the cause of size differences in cave bear metapodials in the Upper Pleistocene sites of Italy, Austria, Germany, Slovenia and Croatia is given by Withalm (2004; 2005) and Hofreiter *et al.* (2004). In the view of these authors, the increased share of larger and bulkier metapodials at some sites is a result of the immigration of a more robust cave bear, which they treat as an independent species *Ursus ingressus* Rabeder *et al.*, 2004 (Rabeder *et al.* 2004b,c). After the immigration into the Alpine space approximately 50,000 BP, this species is claimed to have completely replaced *U. spelaeus* in this region (Rabeder, Hofreiter 2004).[19] However, the absence of statistically significant differences in the shape of metapodials of different geological ages from Divje babe I contradicts such an interpretation in our case, given that Withalm (2004; 2005), Hofreiter *et al.* (2004) and Rabeder *et al.* (2004c) clearly state that *U. spelaeus* and *U. ingressus* also differ in the morphology of the metapodials (Toškan 2007). Similarly noteworthy is the absence of statistically significant differences in the values of the index of plumpness between first metacarpals from sample Db-A and those from Db-C, although this is supposed to be one of the better diagnostic signs for distinguishing between the two species of cave bear (Rabeder *et al.* 2004c). Metapodials from facies C are dated to OIS 5 and are therefore (in contrast to those from facies A) older than 50,000 years, when *U. ingressus* is supposed first to have appeared in the Alps. In view of this, it seems that different sizes of cave bear metapodials in Divje babe I are more thoroughly connected with sexual dimorphism within one species (*U. spelaeus*), than with differences between bears of two distinct species (*U. spelaeus* and *U. ingressus*).

The change of climate at the end of the Early Glacial would have been reflected at the micro-location of Divje babe I mainly in more abundant and longer lasting snow cover and, consequently, explicitly seasonable availability of plant food. The worsening climatic conditions presumably required the herbivorous cave bear (Bocherens *et al.* 1994; 1997; Nelson *et al.* 1998) to deposit more abundant energy stocks in the form of adipose tissue (see Searcy 1980). With larger animals of the given species, fat represents a higher percentage of body weight than with smaller animals of the same species (Lindsedt, Boyce 1985), so larger individuals would be favoured over smaller ones (Millar, Hickling 1990) in circumstances of explicitly seasonal availability of food. The finding that statistically significantly larger bears hibernated in Divje babe I in OIS 3 than in OIS 5a-5d (*Tab. 17.3*; *Fig. 17.7*) is therefore entirely to be expected from this point of view. It is true that an abundance of other factors appears to affect the oscillation of weight of recent bears (e.g., population density, energy value of available food, age of females at first whelping). In circumstances of relatively low primary production and explicitly seasonal availability of food, however, precisely more abundant energy stocks prior to the beginning of hibernation would nevertheless have been decisive for increased body weight (Ferguson, McLoughlin 2000).

Unfortunately, the hypothesis of the increased body weight of bears because of the onset of harsher climatic conditions cannot be tested on fossil metapodials from neighbouring sites, because of the lack of appropriately published data. Interesting, though isolated, data is provided by Torres *et al.* (2000). In the case of Riss (= OIS 6) cave bears from the then presumably colder central part of Spain, they noticed a significantly larger dimension of teeth than with specimens from contemporary coastal sites in the northern part of the country, where the climate is thought to have been milder. The same authors add that all the aforementioned specimens were at the same time smaller on average than those from bears that settled the coastal belt in the even colder Pleniglacial I (= OIS 4).[20] Although the size of cave bears from Divje babe I could also be explained by specific genetic and/or epigenetic factors, such an explanation does not seem as credible as the one presented above. The research on recent brown bears, namely, shows that the predominant part of intraspecific variability in size can be effectively explained by variable ecological factors alone (e.g., Rausch 1962; Rogers 1976; Herrero 1978).

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[18] Complex of layers 2 to 5 (without Layer 5a) and Layer 6 to 7 would have been deposited under such conditions. Unfortunately, because of cryoturbation, the complex of layers 2 to 5 is folded, so that individual finds cannot be reliably distinguished from those from Layer 5a, which was deposited in a period of cold and relatively damp climate. Nevertheless, it is interesting that the number of male-ascribed metacarpals which were provisionally ascribed to Layer 5a is highly statistically significantly greater than the number of female-ascribed metacarpals which were conditionally placed in the same layer (χ^2 test: $p = 0.000$). This contrasts with remaining metacarpals from the group of layers 2 to 5, where the difference in the number of specimens of each of the two sexes is not statistically significant (χ^2 test: $p = 0.144$).

[19] The existence of contemporary but presumably reproductively isolated populations of cave bear (Hofreiter *et al.* 2004; but see also Orlando *et al.* 2002) accords with such thinking.

[20] Teeth are subject to specific selection pressure, so an evolutionary pattern found with them cannot *a priori* be generalised to remaining skeletal elements (Patterson 1983; Dayan *et al.* 2002).

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PRILOGE / ANNEXES

Pril. 17A: Seznam analiziranih prvih dlančnic s pripadajočimi metričnimi podatki. Za globine režnjev glej poglavje 1 v tem zborniku, opomba 5. Za korelacijo sedimentacijskih nivojev in kvadratov/režnjev glej *tabeli 1.1a* in *1.1b* prav tam. Globine sedimentacijskih nivojev so navedene prav tam.
Annex 17A: List of analysed first metacarpals with relevant metric data. For depth of cut see Chapter 1 in this volume, note 5. For a correlation of sedimentation levels and quadrats/cuts see *Table 1.1a* and *1.1b* ibid. Depths of sedimentation levels are also given there.

Facies	**Sediment. level (cm)**	**Square / cut**	**gL**	**sDB**	**sDH**	**pB**	**pH**	**gdB**	**dB**	**dH**
A	-44	34a/3	67.7	16.5	11.4	26.3	24.2	20.9	18.3	17.1
A	-44	41b/4	65.6	13.8	10.2	22.5	22.4	18.2	17.2	16.9
A	-56	41c/5	65.8	15.1	12.2	27.8	22.2	20.7	19.7	19.0
A	-56	36/2	67.0	11.6	9.2	25.1	20.9	19.4	17.7	18.0
A	-68	31/2	58.7	12.6	9.9	21.5	18.5	16.3	15.3	17.5
A	-81	40/3	60.6	12.3	9.1	22.6	20.3	18.2	16.6	16.3
A	-81	19/4	56.9	12.8	10.1	21.6	17.0	17.5	17.5	15.6
A	-81	20/4	70.4	15.6	11.4	26.4	26.0	22.0	19.7	20.1
A	-81	16/5	52.5	10.1	8.8	21.9	21.0	15.1	14.3	14.7
A	-81	41c/7	61.3	12.4	9.5	22.9	18.3	16.9	16.0	16.2
A	-81	48b/7	68.3	15.2	11.9	26.8	22.0	21.4	21.4	20.4
A	-81	48c/7	67.9	13.7	10.8	26.0	22.1	20.3	18.5	18.6
A	-81	55c/7	64.7	14.2	11.3	26.4	22.6	21.1	17.8	18.6
A	-94	35/6	64.4	10.3	7.9	21.7	21.7	16.6	15.2	13.6
A	-106	31/5	61.2	13.2	9.1	23.9	20.9	18.3	16.6	16.8
A	-106	34/7	63.1	14.3	10.8	23.6	21.8	18.5	16.9	17.0
A	-117	25/7	59.9	11.2	9.8	20.6	17.5	16.5	14.9	15.5
A	-117	34c/10	68.3	16.1	11.9	27.5	23.1	22.0	20.5	19.3
A	-117	34c/10	56.1	12.7	10.8	24.6	25.2	18.6	18.3	16.9
A	-117	48b/10	61.0	14.6	11.4	28.3	23.8	20.4	18.5	18.2
A	-129	25/7	65.9	14.7	11.4	26.7	23.6	21.1	19.8	18.7
A	-129	17/9	71.0	13.7	10.6	26.9	22.9	21.6	20.2	20.7
A	-129	62a/10	65.1	14.8	11.5	26.2	23.1	21.2	19.8	19.2
A	-129	55c/11	68.0	16.5	11.8	29.2	24.6	22.9	22.0	19.3
A	-129	55c/11	66.8	13.9	10.3	26.5	21.8	20.4	19.9	18.8
A	-141	31/8	65.7	13.4	11.1	23.2	21.3	17.7	15.9	16.6
A	-141	32/8	66.2	14.1	9.8	26.4	23.3	20.2	19.0	19.2
A	-141	14/10	65.0	14.3	11.5	28.4	22.2	20.2	17.9	17.2
A	-141	34c/12	59.0	11.5	9.3	19.8	17.5	16.8	16.5	16.5
A	-153	41c/13	64.9	13.7	10.8	26.1	19.8	19.4	16.6	16.8
A	-153	48c/13	66.2	16.0	12.8	27.4	22.9	19.6	18.2	19.7
A	-165	48a/13	67.0	13.2	10.3	25.2	18.8	19.8	19.9	17.1
A	-177	32/11	55.2	11.4	8.7	19.4	18.5	16.0	14.8	15.4
A	-177	39/11	72.9	14.6	11.6	26.8	24.2	21.4	18.6	17.5
A	-177	34a/14	69.8	15.9	12.9	30.7	26.2	22.9	21.9	19.6
A	-201	34a/16	66.5	15.7	11.4	28.9	22.3	20.3	19.0	18.1
A	-225	41a/17	69.2	14.1	11.7	25.1	21.5	20.8	19.9	19.0
A	-225	20/16	60.3	14.1	9.3	23.6	20.4	19.0	17.7	15.5
A	-225	26/16	55.9	12.9	10.3	21.2	18.4	16.1	14.8	15.5
A	-225	26/16	68.3	15.2	11.3	25.2	20.6	19.8	18.5	17.2
A	-225	17/17	65.3	14.0	10.5	27.9	21.0	20.6	18.9	17.2
B	-237	31/16	65.0	13.9	11.2	24.9	22.2	19.6	18.1	17.6
B	-237	19/17	59.0	12.1	9.6	21.7	19.4	16.3	15.2	15.1
B	-237	23/17	60.1	12.3	10.3	21.7	19.3	19.8	17.8	17.6
B	-237	26/17	66.0	14.2	10.2	25.3	22.4	19.6	18.0	17.8
B	-249	34a/19	61.7	13.2	9.9	23.1	21.6	18.9	18.2	17.4
B	-249	55b/20	69.0	14.4	12.0	26.0	23.4	21.6	20.6	19.4
B	-249	28/17	66.2	15.0	10.8	27.1	24.0	20.6	18.6	18.9
B	-249	29/17	61.7	13.0	10.2	22.2	18.7	18.8	17.5	17.3
B	-249	31/17	61.9	13.5	10.0	22.9	19.2	19.1	18.5	18.0
B	-249	31/17	64.2	13.9	11.4	26.8	28.2	19.4	18.3	18.5
B	-249	26/18	51.3	10.9	8.6	20.9	20.7	15.5	14.6	14.2
B	-249	36/18	57.6	11.9	8.2	21.8	17.1	16.9	17.7	15.6
B	-249	13/19	66.3	17.4	13.9	26.6	23.5	23.8	22.9	21.3
B	-261	39/18	59.0	14.7	12.9	25.5	24.7	20.5	18.2	17.8
B	-261	22/19	58.7	13.6	11.1	22.8	19.2	17.8	16.3	17.6
B	-261	22/19	62.0	12.7	9.9	22.3	18.7	17.5	17.9	17.0
B	-261	26/19	56.0	12.4	8.9	22.8	23.7	16.6	15.6	15.6
B	-261	37/19	64.1	13.8	12.4	26.5	22.1	20.3	19.5	19.3
B	-261	38/19	57.1	13.1	9.6	23.9	20.8	17.9	17.3	15.9

continued....

Pril. 17A / Annex 17A (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-261	38/19	63.3	14.1	11.0	26.1	23.2	18.9	18.8	18.3
B	-273	22/20	66.1	16.0	11.1	28.0	23.7	20.5	19.6	19.8
B	-273	25/20	64.4	12.5	9.8	23.2	21.8	19.2	16.7	16.6
B	-273	16/21	64.8	15.0	11.2	26.6	23.5	23.0	21.8	18.7
B	-285	28/20	58.2	13.1	9.3	23.3	20.5	18.1	16.4	16.4
B	-285	32/20	63.1	13.6	11.7	25.5	22.7	21.3	20.8	18.9
B	-285	19/21	65.1	13.7	10.0	24.8	21.8	19.7	18.1	17.5
B	-285	37/21	70.3	16.2	12.1	26.8	23.4	21.5	20.0	19.6
B	-285	16/22	64.3	14.3	10.1	25.7	21.7	20.9	18.1	17.0
B	-285	34/22	56.0	12.5	9.6	23.3	20.7	19.7	17.8	16.6
B	-297	25/22	66.9	14.1	11.5	26.9	23.8	19.2	18.2	18.9
B	-297	26/22	67.5	15.1	12.4	29.0	25.8	21.9	22.4	19.8
B	-297	22/23	67.1	14.9	11.0	27.8	22.8	21.5	19.0	19.0
B	-297	34/23	70.7	14.5	12.6	29.3	23.3	22.8	22.5	21.0
B	-309	29/22	66.6	13.5	10.8	25.6	23.8	20.2	18.8	18.2
B	-321	32/23	58.6	11.4	9.0	20.5	18.6	17.5	16.4	14.4
B	-321	32/23	62.3	13.9	10.6	25.2	22.5	19.7	17.5	17.3
B	-321	23/24	65.3	14.6	11.1	25.6	22.6	19.8	17.9	17.5
B	-321	25/24	63.4	14.5	10.0	26.9	21.2	20.6	20.0	18.6
B	-321	26/24	62.6	13.3	10.1	23.5	22.0	17.3	16.3	16.8
B	-321	26/24	58.1	11.4	9.0	22.1	16.8	17.6	17.0	15.8
B	-321	36/24	67.6	14.8	10.1	25.0	21.0	16.9	14.6	16.1
B	-321	13/25	67.0	16.3	11.7	29.5	21.8	20.8	19.1	17.9
B	-321	17/25	61.0	12.9	9.2	23.7	20.3	18.9	18.2	16.5
B	-333	29/24	66.5	15.6	11.5	28.5	21.9	22.7	20.9	19.4
B	-333	32/24	64.1	13.6	9.8	25.9	22.7	21.2	19.9	18.8
B	-333	19/25	67.4	15.9	12.0	27.3	23.0	20.2	18.2	19.2
B	-333	20/25	64.1	14.7	10.0	26.1	22.4	20.5	19.0	18.1
B	-333	23/25	73.3	14.0	11.8	28.4	23.3	21.8	20.5	20.1
B	-333	26/25	68.4	15.6	11.1	26.6	24.4	21.4	20.0	19.1
B	-333	26/25	57.6	11.8	9.4	21.4	17.6	16.6	15.5	14.8
B	-333	26/25	66.4	17.2	12.8	28.5	26.9	23.3	21.9	20.4
B	-333	37/25	60.3	14.2	10.5	24.6	23.4	18.9	17.0	17.0
B	-345	31/25	67.8	15.0	11.7	25.9	22.3	20.8	18.6	17.8
B	-345	32/25	57.4	11.3	9.8	21.8	24.4	17.2	14.1	15.1
B	-345	40/25	68.9	16.3	13.0	29.7	24.1	22.2	21.9	20.5
B	-345	19/26	62.3	13.1	10.5	23.8	20.5	19.0	18.1	17.7
B	-345	22/26	63.5	14.8	11.1	25.1	22.4	20.1	18.8	17.1
B	-345	13/27	64.1	14.5	10.7	23.7	21.8	19.2	17.9	17.3
B	-357	40/26	71.8	15.3	10.6	26.3	21.7	20.7	20.1	19.1
B	-357	40/26	58.9	11.9	9.7	22.9	19.5	16.9	16.2	15.8
B	-357	40/26	66.6	14.2	11.5	24.1	27.1	19.8	19.4	17.5
B	-357	40/26	57.7	11.7	9.3	21.2	18.8	16.6	16.1	15.2
B	-357	22/27	58.6	10.4	8.5	20.1	16.7	15.9	15.0	15.0
B	-357	25/27	65.0	13.1	10.1	25.6	22.2	20.4	19.5	18.0
B	-357	37/27	64.5	12.9	10.4	26.4	19.8	18.6	17.9	16.7
B	-357	16/28	62.7	11.0	10.0	22.3	21.3	17.1	16.1	16.4
B	-357	34/28	67.2	14.9	10.4	27.1	21.3	20.6	18.6	17.6
B	-369	29/27	61.1	13.0	8.9	24.5	18.7	19.0	19.7	17.7
B	-369	39/27	59.4	13.1	10.3	23.1	21.0	18.4	16.4	16.0
B	-369	40/27	60.4	13.0	9.2	22.6	18.9	18.7	15.7	17.7
B	-369	40/27	64.9	12.5	10.0	24.5	22.4	19.2	16.9	17.3
B	-369	22/28	68.4	14.5	10.1	25.1	22.5	20.4	18.4	19.5
B	-369	36/28	63.4	13.1	10.3	25.0	23.4	20.5	19.2	18.7
B	-369	36/28	65.6	14.7	10.7	27.7	23.3	21.1	20.2	18.5
B	-369	17/29	58.7	11.8	8.9	22.9	18.7	16.8	14.9	15.3
B	-369	35/29	68.9	14.2	10.9	26.0	21.8	20.7	19.6	18.5
B	-369	35/29	55.1	11.6	9.6	20.8	18.1	16.7	15.7	16.8
B	-381	32/28	61.4	13.0	10.7	24.0	21.2	19.7	18.3	16.6
B	-381	40/28	67.1	14.1	10.8	25.2	22.6	20.2	19.8	19.7
B	-381	20/29	58.5	12.2	9.4	22.1	18.8	17.0	15.4	15.1
B	-381	26/29	64.9	15.4	11.6	26.5	22.3	21.1	17.6	19.3
B	-381	36/29	60.3	12.7	9.0	22.1	18.9	18.0	16.5	15.2
B	-381	37/29	65.4	14.0	10.4	25.5	20.4	19.5	17.9	15.9
B	-381	14/30	61.9	14.2	10.8	26.4	19.7	19.7	18.6	17.7
B	-393	13/31	59.3	11.6	8.0	21.8	18.6	17.0	16.8	17.1

continued....

Pril. 17A / Annex 17A (nadaljevanje / cont.)

Facies	**Sediment. level (cm)**	**Square / cut**	**gL**	**sDB**	**sDH**	**pB**	**pH**	**gdB**	**dB**	**dH**
B	-393	35/31	58.9	11.7	9.4	22.2	16.4	17.2	14.9	14.9
B	-405	19/31	66.7	13.2	10.0	26.0	23.2	20.0	19.5	18.0
B	-405	26/31	62.0	14.1	10.8	25.7	21.8	19.6	18.7	19.0
B	-405	14/32	59.2	13.2	9.7	22.8	18.3	18.6	15.2	16.3
B	-405	14/32	63.3	14.3	10.4	25.5	22.1	19.8	17.6	18.3
B	-405	16/32	55.0	12.4	10.7	21.7	24.6	18.9	17.8	16.8
B	-405	17/32	62.0	14.4	10.4	26.2	24.6	21.2	19.5	18.4
B	-405	34/32	57.3	11.5	8.6	21.3	15.6	17.1	16.5	15.3
B	-417	29/31	60.7	12.4	9.7	23.4	18.5	19.2	17.4	16.9
B	-417	17/33	57.1	11.6	9.3	21.4	17.0	16.9	15.3	15.8
B	-417	17/33	62.1	13.6	9.4	25.2	21.7	20.0	18.2	16.3
B	-429	19/33	65.0	15.8	11.1	29.5	21.5	21.4	18.2	18.9
B	-429	25/33	59.4	13.3	10.5	22.4	19.2	18.4	18.3	16.9
B	-429	36/33	67.9	15.1	11.2	24.8	23.1	17.9	16.2	17.2
B	-429	13/34	69.4	15.8	10.2	27.2	23.4	21.3	19.8	19.1
B	-429	17/34	55.4	11.8	8.5	19.9	16.9	16.3	14.9	14.7
B	-429	17/34	64.7	14.3	10.4	24.7	20.0	18.9	18.2	17.4
B	-429	34/34	62.6	13.7	10.1	24.3	19.8	19.9	18.8	17.5
B	-429	35/34	65.5	14.4	11.4	25.2	20.8	19.7	17.4	18.1
C	-441	19/34	57.5	13.6	9.7	22.5	19.4	17.5	16.3	15.8
C	-441	36/34	59.0	11.1	8.1	20.9	17.1	16.9	15.9	14.4
C	-441	36/34	58.5	11.3	10.0	21.9	16.7	15.3	14.7	15.5
C	-441	34/35	56.5	11.4	8.7	20.9	17.0	16.6	15.5	14.7
C	-441	34/36	57.0	11.6	8.5	21.1	18.8	17.3	17.5	15.3
C	-465	19/36	60.6	13.6	10.4	22.1	20.0	17.5	16.5	16.9
C	–	155-157/13	59.8	13.0	9.2	21.6	19.9	18.2	16.1	15.6
C	–	164/13	59.3	12.8	10.5	23.6	21.0	18.5	18.5	18.3
C	–	169/13	54.9	12.1	10.1	20.3	17.2	16.4	14.5	14.1
C	–	179/13	56.4	13.4	10.0	21.1	17.5	16.8	16.2	14.7
C	–	181/13	58.1	10.8	8.3	19.2	16.0	15.7	14.9	13.9
C	–	182/13	63.0	14.8	12.1	25.5	21.0	18.9	17.1	16.4
C	–	182/13	59.6	12.2	9.7	22.5	16.7	16.6	16.1	15.9
C	–	184/13	63.2	13.6	10.8	27.0	20.2	20.6	20.1	18.1
C	–	188/13	59.4	12.5	9.8	22.0	18.4	17.3	14.1	15.4
C	–	190/13	56.6	11.0	8.1	20.8	16.4	16.0	15.2	15.4
C	–	191/13	61.4	11.6	9.1	23.4	17.9	17.6	14.9	15.9
C	–	192/13	61.1	11.8	9.2	22.3	17.2	17.9	17.2	16.7
C	–	202/13-14	55.3	12.7	10.0	22.5	16.8	17.1	15.4	14.4
C	–	203/13-14	56.6	11.6	9.0	22.1	16.9	17.4	14.8	14.4
C	–	168/14	59.4	11.6	9.3	21.0	17.0	17.3	16.1	14.2
C	–	171/14	66.8	13.9	10.1	26.2	20.8	19.8	17.1	18.7
C	–	171/14	61.0	11.8	9.2	20.4	17.1	17.1	15.7	16.3
C	–	178/14	66.1	13.8	11.2	25.5	20.6	20.2	19.5	19.1
C	–	179/14	58.4	12.1	9.3	22.7	15.7	18.6	17.3	15.9
C	–	180/14	63.4	15.0	9.8	28.7	19.0	20.9	17.4	16.9
C	–	181/14	56.5	11.4	8.6	21.0	16.1	16.5	16.0	14.9
C	–	182/14	67.5	14.6	13.1	26.2	23.1	21.3	19.3	17.9
C	–	184/14	59.4	13.8	9.7	21.9	17.6	18.3	16.3	14.8
C	–	187/14	56.6	11.8	9.2	21.0	17.9	16.4	14.7	14.6
C	–	188/14	67.0	13.9	10.4	28.3	22.0	21.3	19.3	19.1
C	–	191/14	68.4	13.7	10.4	24.8	20.8	21.0	20.1	19.5
Σ sample A			x = 64.27 SD = 4.72	x = 13.80 SD = 1.61	x = 10.63 SD = 1.56	x = 25.08 SD = 2.76	x = 21.61 SD = 2.30	x = 19.42 SD = 2.02	x = 18.06 SD = 1.99	x = 17.58 SD = 1.65
Σ sample B			x = 62.99 SD = 4.20	x = 13.65 SD = 1.44	x = 10.41 SD = 1.11	x = 24.68 SD = 2.32	x = 21.41 SD = 2.41	x = 19.38 SD = 7.19	x = 18.05 SD = 1.88	x = 17.51 SD = 1.55
Σ sample C			x = 60.12 SD = 3.77	x = 12.62 SD = 1.21	x = 9.73 SD = 1.09	x = 22.84 SD = 2.42	x = 18.42 SD = 1.96	x = 17.95 SD = 1.70	x = 16.56 SD = 1.69	x = 16.04 SD = 1.63
Σ all samples (A+B+C)			x = 62.8 SD = 4.4	x = 13.5 SD = 1.5	x = 10.3 SD = 1.2	x = 24.4 SD = 2.6	x = 20.9 SD = 2.6	x = 19.1 SD = 1.9	x = 17.8 SD = 2.0	x = 17.3 SD = 1.7

Pril. 17B: Seznam analiziranih drugih dlančnic s pripadajočimi metričnimi podatki.
Annex 17B: List of analysed second metacarpals with relevant metric data.

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
A	-44	48b//4	82.80	19.1	14.86	21.95	28.54	26.53	21.89	20.49
A	-68	37//3	78.81	20.41	15.17	21.10	30.12	28	24.47	22.04
A	-68	19//3	77.28	20.29	11.61	18.82	27.3	26.53	21.87	20.56
A	-68	14//4	77.40	20.32	14.3	20.29	29.03	27.37	23.61	20.98
A	-68	28//2	80.14	20.59	16.03	19.51	29.61	27.16	22.53	19.66
A	-68	28//2	80.95	19.58	14.35	23.40	32.45	27.99	24.09	21.65
A	-68	17//4	81.13	19.98	15.2	19.99	32.26	29.46	25.9	21.75
A	-81	20//4	72.69	17.03	12.53	19.58	26.62	23.88	20.79	19.16
A	-81	37//4	76.09	19.46	15.03	20.22	27.8	26.36	22.88	19.53
A	-81	39//3	78.36	18.79	14.13	19.31	26.49	26.67	23.45	21.35
A	-81	22//4	78.93	19.51	14.52	20.21	29.55	27.57	21.27	20.19
A	-81	36//4	83.55	19.38	14.69	20.08	31.06	26.88	22.61	20.38
A	-94	29//3	80.28	20.5	14.96	22.02	29.9	27.38	23.08	21.43
A	-94	36//5	75.61	18.47	13.18	18.22	29.17	27.19	22.96	19.43
A	-94	37//5	79.01	19.56	14.99	22.25	31.16	28.93	24.82	22.96
A	-94	32//4	79.99	18.86	15.05	21.26	31.18	26.78	23.46	21.72
A	-106	38//6	68.18	15.16	10.37	17.13	24.28	21.96	18.24	17.72
A	-106	55b//9	74.72	15.25	11.65	18.06	26.54	24.19	19.68	18.7
A	-106	55c//9	78.05	19.18	14.34	22.26	27.35	26.23	19.96	19.48
A	-106	55c//9	81.57	20.48	16.57	22.40	31.97	28.56	22.29	22.92
A	-106	41c//9	83.38	19.65	14.74	21.97	30.11	26.51	22.79	22.33
A	-117	48a//9	76.16	19.68	14.33	22.17	31.17	27.8	23.36	21.84
A	-117	34a//9	79.52	19.64	13.45	19.42	28.39	28.19	23.07	20.83
A	-129	16//9	79.57	20.51	13.16	20.00	27.7	26.71	22.38	20.1
A	-129	55b//11	77.44	19.53	15.47	20.01	30.16	28.58	23.19	21.97
A	-129	48a//10	82.17	20.41	15.02	20.41	27.1	28.27	23.88	20.5
A	-129	41a//10	83.13	20.23	13.8	20.07	30.44	28.95	23.39	21.35
A	-141	38//9	67.77	18.03	12.49	16.20	25	23.55	19.56	18.41
A	-141	48c//12	72.90	17.83	12.7	16.56	23.5	23.56	19.69	18.05
A	-141	48b//12	80.51	19.63	12.7	19.30	30.21	27.22	23.7	21.54
A	-141	40//8	81.21	20.24	14.61	20.15	29.49	28.67	23.11	20.7
A	-153	26//10	81.85	20.35	13.54	21.61	29.54	28.04	23.81	21.58
A	-153	39//9	82.73	20.49	14.85	21.94	30.9	29.08	25.26	21.75
A	-153	36//10	82.87	19.28	13.99	21.85	27	27.39	21.74	20.1
A	-153	55b//13	80.69	19.89	14.83	18.83	29.28	27.22	22.59	19.12
A	-153	62a//12	80.80	20.54	15.9	20.67	29.1	27.5	21.54	20.3
A	-153	62a//12	82.90	20.81	14.93	22.09	29.51	29.06	24.34	22.02
A	-165	62c//14	80.08	20.78	13.7	21.38	30.03	28.27	23.19	20.72
A	-165	48c//14	82.14	21.41	14.52	22.80	29.94	28.71	25.1	21.9
A	-177	34b//15	68.07	15.83	10.94	18.08	24.75	22.46	19.8	17.75
A	-177	34b//15	80.16	19.16	14.62	21.61	29.49	27.33	23.61	21.38
A	-177	55b//15	85.38	21.92	15.77	24.79	30.99	29.48	24.06	20.83
A	-201	34b//17	86.51	20.89	15.47	21.44	32.87	28.26	24.76	22.37
A	-233	37//15	65.88	16.46	11.34	17.92	24.9	23.2	20.66	18.59
A	-233	26//15	67.99	16.09	11.46	15.33	22.37	22.25	17.65	16.6
A	-233	16//16	74.54	16.81	12.21	18.32	25.64	24.08	19.49	17.96
A	-233	22//15	75.74	19.6	14.87	19.52	29.11	27.61	23.82	20.28
A	-233	22//15	76.86	17	13.55	19.09	24.66	24.12	20.52	18.7
A	-233	29//14	77.08	19.59	13.98	20.36	30.38	27.73	25.19	21.57
A	-233	26//15	81.88	20.05	13.84	20.03	29.06	26.77	22.45	20.16
A	-225	23//16	64.20	15.42	10.86	15.42	21.15	20.71	16.88	16.1
A	-225	16//17	71.49	17.66	12.72	17.84	24.47	25.58	20.64	18.4
A	-225	23//16	77.79	20.09	15.91	21.21	30.5	29.28	24.98	20.51
A	-225	31//15	78.77	18.9	13.19	20.68	26.8	25.89	21.42	19.38
B	-237	41b//19	76.41	18.34	14.5	19.78	27.89	25.54	20.94	19.6
B	-237	41a//18	82.83	21.4	15.03	20.29	28.73	27.56	22.35	20.4
B	-237	25//17	68.03	16.39	10.91	15.65	22.7	22.97	18.46	16.9
B	-237	28//16	70.28	17.32	12.83	17.31	22.14	22.3	18.35	16.3
B	-237	26//17	71.94	17.47	12.29	19.76	26.81	25.42	21.86	19.51
B	-237	13//18	72.09	16.94	12.04	15.92	22.96	22.3	18.55	16.42
B	-237	25//17	73.39	18.54	11.62	19.66	27.94	24.71	21.39	19.28
B	-237	25//17	73.63	16.46	11.49	16.5	24.87	21.24	17.95	17.37
B	-249	28//17	64.85	15.82	11.4	16	23.65	22.06	18.27	17.01
B	-249	23//18	70.00	16.93	11.29	16.98	25.31	23.31	20.07	16.67
B	-249	32//17	79.00	20.5	14.5	19.6	28.7	26.6	22.4	20.2
B	-249	28//17	71.06	14.48	11.73	16.02	20.54	21.65	17.52	16.1
B	-249	28//17	71.43	15.5	10.99	16.49	23.38	22.06	19.42	17.4

continued....

Pril. 17B / Annex 17B (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-249	37//18	72.43	16.55	13.87	16.67	23.3	22.2	19.17	17.4
B	-249	23//18	72.56	16.37	12.76	16.67	23.77	22.12	20.14	17.7
B	-261	23//19	75.12	17.32	12.27	19.3	24.59	24.45	20.81	18.6
B	-261	28//18	80.09	20.6	13.72	22.07	28.24	27.25	23.56	19.24
B	-261	31//18	81.34	20.92	15.4	22.05	31.16	30.5	25.51	22.44
B	-261	25//19	87.17	21.38	15.83	21.29	31.77	28.99	24.07	22.53
B	-273	17//21	81.55	20.13	14.61	21.86	29.66	27.8	24.39	23.23
B	-273	26//21	70.33	18.74	14.7	20.11	27.76	26.43	22.73	20.83
B	-285	16//22	68.36	16.02	11.13	18.14	25.99	23.16	20.38	18.43
B	-285	13//22	71.23	15.68	11.28	16	23.29	23.92	19.92	18.07
B	-285	35//22	77.39	20.11	14.28	20.78	32.43	26.99	23.67	21.41
B	-285	32//20	78.55	18.66	13.95	22.3	30.51	26.66	22.8	21.18
B	-297	39//21	80.47	18.71	14	22.32	31.3	26.93	24.17	22
B	-309	36//23	82.36	21	15.34	22.02	31.82	30.23	26.52	22.97
B	-321	17//25	69.60	17.21	11.85	19.37	25.02	24.04	20.58	17.97
B	-321	19//24	70.59	20.82	14.58	19.55	28.13	28.05	23.4	21.21
B	-321	14//25	72.41	18.48	12.67	17.95	26.82	26.37	20.43	18.96
B	-321	40//23	72.80	19.22	14.14	18.33	27.14	25.47	21.8	19.11
B	-321	40//23	77.19	18.94	14.5	19.79	28.27	26.57	23.36	19.95
B	-321	23//24	77.62	19.32	14.52	20.69	30.27	26.95	22.71	20.84
B	-333	31//24	72.06	18.04	12.51	18.14	27.69	26.56	21.73	20.35
B	-333	22//25	73.94	20.34	14.71	20.93	28.06	27.25	22.79	20.28
B	-333	31//24	76.09	18.37	12.72	18.49	28.11	24.37	19.85	19.2
B	-345	40//25	65.97	16.37	11.57	17.2	23.88	21.87	18.55	17.55
B	-345	34//27	66.74	18.19	11.76	17.12	25.31	23.31	19.72	18.68
B	-345	23//26	73.04	15.58	10.94	15.94	22.44	21.89	19.72	17.8
B	-345	16//27	75.26	20.08	14.15	19.4	27.2	27.89	24.1	20.03
B	-345	36//26	76.56	20.05	13.74	21.15	29.2	26.66	23.76	22.09
B	-345	26//26	77.74	20.5	15.54	22.43	29.71	29.52	24.41	22.05
B	-345	31//25	78.78	17.72	13.8	19.98	26.66	25.15	22.19	19.7
B	-345	31//25	82.22	20.39	14.98	21.97	31.29	28.11	24.16	22.35
B	-357	39//26	69.47	16.04	11.59	17.06	24.91	22.51	20.86	17.45
B	-357	36//27	69.99	16.37	10.01	17.83	24	23.1	19.25	17.89
B	-357	40//26	75.50	18.05	13.32	19.72	27.11	26.13	21.64	19.75
B	-357	13//28	76.01	19.05	14.21	21.25	28.9	27.24	22.99	21.17
B	-357	31//26	76.95	20.48	14.78	21.76	35.11	27.25	23.57	21.17
B	-357	28//26	80.12	18.32	13.72	22.33	29.16	26.82	23.83	20.68
B	-357	40//26	82.72	19.18	14.59	22.57	31.62	28.88	25.37	21.66
B	-369	40//27	66.34	15.9	10.67	17.51	23.16	21.96	18.38	17.5
B	-369	39//27	72.17	17.21	12.86	18.75	26.5	24.36	20.62	19.69
B	-369	39//27	80.65	18.8	14.88	20.91	29.82	27.35	21.52	21.15
B	-381	37//29	68.03	17.19	12.32	17.72	24.32	23.67	20.72	18.89
B	-381	32//28	70.02	15.15	11.21	19.32	24.03	22.05	19.66	17.93
B	-381	20//29	70.74	15.56	11.59	15.86	23.2	21.82	18.03	16.31
B	-381	26//29	73.54	14.59	12.21	18.53	23.32	21.32	18.26	17.96
B	-381	34//30	82.51	19.61	14.68	21.25	31.4	27.7	23.86	22.17
B	-381	38//29	82.62	21.62	14.44	21.86	30.14	29.17	24.82	22.19
B	-381	40//28	84.21	19.41	15.83	22.13	29.17	28.32	24.14	22.34
B	-393	13//31	70.60	15.76	9.74	17.01	22.3	21.02	18.65	16.9
B	-393	34//31	79.57	18.46	13.75	20.53	28.71	26.64	23.16	20.76
B	-405	17//32	76.01	17.81	14.78	20.61	27.99	26.26	22.29	20.61
B	-417	35//33	68.14	15.81	11.32	15.99	21.68	22.31	18.67	16.36
B	-417	35//33	68.89	15.69	10.77	14.85	21.53	21.85	18.73	16.5
B	-417	22//32	70.10	15.61	11.39	17.43	23.53	22.36	18.87	17.34
B	-417	19//32	79.17	18.59	13.98	19.9	27.65	26.83	23.09	20.16
B	-417	37//32	79.52	19.24	15.12	21.64	29.81	27.19	23.17	19.03
B	-417	34//33	82.18	18.89	13.38	20.76	27.66	27.34	22.29	20.37
B	-429	22//33	70.75	15.07	11.7	17.53	23.8	22.67	19.12	18.05
B	-429	22//33	71.51	16.77	12.9	19.28	25.21	24.33	21.1	19.04
B	-429	19//33	72.00	17.01	11.98	17.16	24.35	23.57	20.19	18.1
B	-429	35//34	74.59	18.96	12.49	20.92	28.28	25.62	22.99	21.24
B	-429	14//34	78.34	16.47	12.98	20.83	27.78	25.8	21.63	19.92
C	-441	14//35	66.96	14.94	10.06	16.09	23.1	21.74	17.39	17.07
C	-441	36//34	67.27	15.83	11.22	16.50	20.77	21.92	18.76	15.88
C	-441	14//35	71.70	15.75	10.85	17.70	25.4	22.6	19.49	17.97
C	-441	23//34	72.65	15.69	11.9	18.45	25.84	24.77	20.56	19.8

continued....

Pril. 17B / Annex 17B (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
C	-441	19//34	74.03	19.6	14.73	18.93	28.79	28.25	22.58	20.73
C	-441	14//35	74.85	18.52	13.78	18.62	26.9	26.72	21.69	19.6
C	-441	34//35	76.84	18.78	14.03	19.64	28.32	27.56	22.7	20.54
C	-453	36//35	71.78	17.74	11.23	16.61	23.59	23.39	19	17.02
C	-453	13//36	77.66	17.11	12.48	19.44	26.26	25.33	20.66	19.2
C	–	187//14	65.28	15.1	10.86	14.84	23.47	21.28	17.32	16.58
C	–	171//14	66.68	16.18	10.67	14.99	21.54	21.91	17.91	16.11
C	–	173//14	67.31	16.06	11.68	16.99	22.25	22.64	18.94	17.48
C	–	192//13	67.53	16.4	10.62	15.35	24	21.49	17.75	16.32
C	–	165//13	67.88	15.81	10.34	16.61	24.01	22.93	19.22	17.46
C	–	181//14	68.24	15.82	10.91	16.32	23.86	22.3	18.97	18.05
C	–	163//13	68.57	16.01	11.31	18.37	23.96	23.69	19.6	17.71
C	–	181//14	68.66	16.12	10.57	15.88	22.59	22.84	19.32	17.27
C	–	180//13	69.19	15.54	11.81	18.06	22.18	22.42	19.53	17.6
C	–	173//14	69.37	15.92	11.01	16.78	24.52	22.81	18.56	16.33
C	–	184//13	70.10	17.81	13.69	16.79	25.14	23.17	20.57	17.72
C	–	187//14	70.73	16.45	11.68	17.54	24.02	23.4	17.53	17
C	–	171//14	70.90	17.36	11.3	17.20	23.11	23.62	19.74	17.99
C	–	193//13	70.92	15.69	10.82	15.93	23.13	22.34	18.77	17.45
C	–	183//14	71.79	17.17	10.91	17.47	25.47	23.29	20.18	18.11
C	–	203//13-14	75.12	17.63	12.96	17.24	24.28	25.15	20.69	18.32
C	–	204//13-14	75.46	16.91	12.66	18.79	26.95	24.29	20.52	19.23
C	–	167//14	75.47	18.68	14.25	17.73	25.49	26.78	22.58	19.11
C	–	203//13-14	77.62	20.14	13.97	18.52	26.9	26.64	20.17	19.2
C	–	203//13-14	77.84	17.33	13.58	20.68	28.72	26.35	22.39	20.7
C	–	191//13	77.85	18.71	16.47	19.63	28.02	28.32	22.81	21.23
C	–	168//13	78.00	20.32	14.51	20.90	31.76	27.42	23.44	21.39
C	–	167//14	78.04	16.99	13.78	19.59	30.16	29.2	23.33	20.47
C	–	188//14	78.55	19.36	14.74	20.88	28.16	27.41	23.95	21.23
C	–	180//14	79.08	21.14	16.29	19.33	27.04	27.9	22.79	19.7
C	–	173+179/1	80.51	17.77	13.09	19.43	28.99	27.35	22.53	20.84
C	–	165//13	80.64	20.45	15.44	21.67	29.55	29.9	24	21.7
C	–	184//14	80.71	18.88	13.02	19.99	28.21	26.22	21.32	20
C	–	167//14	80.95	19.17	14.22	19.96	28.63	27.3	22.62	20.34
C	–	202//13-14	84.85	19.66	14.21	19.60	29.61	27.28	21.54	20.52
Σ sample A			x = 78.1 SD = 5.03	x = 19.2 SD = 1.63	x = 13.9 SD = 1.46	x = 20.1 SD = 1.97	x = 28.5 SD = 2.65	x = 26.7 SD = 2.12	x = 22.4 SD = 2.02	x = 20.3 SD = 1.57
Σ sample B			x = 74.7 SD = 5.11	x = 18.0 SD = 1.88	x = 13.1 SD = 1.55	x = 19.2 SD = 2.15	x = 26.8 SD = 3.15	x = 25.2 SD = 2.52	x = 21.5 SD = 2.21	x = 19.4 SD = 1.93
Σ sample C			x = 73.5 SD = 5.09	x = 17.4 SD = 1.68	x = 12.6 SD = 1.76	x = 18.1 SD = 1.75	x = 25.8 SD = 2.71	x = 24.9 SD = 2.49	x = 20.5 SD = 1.96	x = 18.7 SD = 1.70
Σ all samples (A+B+C)			x = 75.5 SD = 5.37	x = 183 SD = 1.87	x = 13.2 SD = 1.65	x = 19.2 SD = 2.13	x = 27.1 SD = 3.06	x = 25.6 SD = 2.51	x = 21.6 SD = 2.20	x = 19.6 SD = 1.86

Pril. 17C: Seznam analiziranih tretjih dlančnic s pripadajočimi metričnimi podatki.
Annex 17C: List of analysed third metacarpals with relevant metric data.

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
A	-56	41b/5	76.8	17.5	14.0	21.1	28.7	24.6	21.4	20.7
A	-56	19/2	79.4	16.5	12.4	19.6	27.6	24.4	21.1	19.6
A	-56	37/2	85.7	18.1	15.7	23.4	32.4	28.5	22.7	21.6
A	-56	38/2	88.1	19.1	14.1	22.7	33.0	28.1	23.8	23.3
A	-56	17/3	81.6	19.0	14.0	20.2	30.9	27.0	22.6	22.4
A	-68	39/2	89.3	19.7	15.8	22.4	32.9	28.9	24.8	22.7
A	-68	19/3	83.6	18.5	15.0	20.5	30.3	27.7	23.3	22.4
A	-68	22/3	80.7	17.3	14.2	19.2	27.4	24.9	18.8	20.7
A	-68	36/3	83.5	21.2	13.8	23.7	32.8	28.7	24.8	22.6
A	-68	35/4	83.3	20.7	15.2	23.6	31.7	26.0	22.8	20.4
A	-68	35/4	80.8	16.3	12.7	19.7	27.2	26.2	21.9	19.8
A	-68	34a/5	90.9	20.1	17.6	23.2	34.5	30.2	26.1	24.9
A	-81	19/4	77.2	16.4	12.7	17.8	26.5	24.7	20.6	19.6
A	-81	20/4	82.4	19.4	13.8	19.5	29.9	27.3	24.0	21.7
A	-81	25/4	75.2	17.7	12.5	19.1	27.8	24.4	21.1	20.9
A	-81	25/4	75.5	15.0	11.3	19.9	26.5	23.0	18.9	19.0
A	-81	26/4	85.2	18.2	14.2	22.3	31.4	27.6	23.8	23.0
A	-81	35/5	85.4	20.2	15.7	23.2	31.9	29.3	25.2	22.3
A	-81	34a/6	90.0	18.4	13.8	21.6	30.7	27.8	24.8	22.4
A	-81	41c/7	77.5	15.2	13.0	18.3	26.6	24.0	19.5	20.7
A	-94	37/5	80.5	18.3	14.1	21.4	29.8	25.6	22.6	20.7
A	-94	34/6	80.6	18.6	15.0	21.9	29.2	27.9	23.2	21.9
A	-94	35/6	81.3	19.3	16.3	21.9	30.3	28.6	24.2	22.8
A	-106	38/6	85.5	19.1	17.0	20.6	32.0	26.4	22.7	22.4
A	-106	48a/8	83.9	18.6	15.2	21.8	29.4	29.5	24.7	22.8
A	-106	41c/9	84.1	20.3	15.3	21.2	30.2	27.5	24.0	23.4
A	-117	55a/9	87.8	19.0	14.6	21.9	32.0	28.9	23.7	23.7
A	-117	55a/9	72.2	16.6	13.1	18.5	24.4	23.8	20.4	19.2
A	-117	55b/10	85.9	19.9	15.8	21.2	30.9	28.3	23.5	23.1
A	-129	36/8	82.3	19.0	14.2	21.1	30.5	28.8	24.8	22.2
A	-129	38/8	82.5	18.0	14.5	20.5	29.9	26.4	23.0	21.7
A	-129	34c/11	84.5	18.0	14.1	22.2	30.4	27.9	23.7	22.1
A	-129	55c/11	82.6	20.0	15.2	22.2	31.4	29.6	23.4	23.5
A	-141	23/9	83.4	18.0	15.0	20.5	31.3	26.6	21.8	22.4
A	-141	55a/11	71.1	13.1	10.0	16.7	23.1	21.2	17.2	18.0
A	-153	16/11	77.5	15.2	11.8	17.9	25.9	23.4	19.8	18.8
A	-165	40/10	82.2	18.5	14.1	22.5	31.6	28.8	23.9	22.4
A	-165	14/12	81.0	18.9	14.7	20.0	30.6	25.9	21.9	21.2
A	-165	16/12	72.4	15.3	11.2	17.8	24.7	22.9	19.6	18.8
A	-165	62b/14	87.1	18.9	15.0	19.7	30.8	26.5	23.4	22.2
A	-165	62c/14	85.2	20.2	15.9	21.9	33.7	28.7	24.9	23.1
A	-177	41c/15	83.0	18.8	14.1	22.7	32.9	29.3	24.1	22.4
A	-201	38/14	86.1	19.8	15.1	21.7	32.3	29.4	25.6	23.5
A	-213	29/14	79.2	18.2	13.5	20.2	26.8	23.8	20.3	19.7
A	-213	29/14	81.7	19.6	15.5	21.3	29.5	28.6	24.7	22.7
A	-213	37/15	72.5	15.8	12.1	18.4	27.3	23.8	20.3	19.4
A	-225	41b/18	85.8	18.6	14.4	20.8	31.6	28.3	21.2	22.7
A	-225	48b/18	72.3	15.4	11.2	18.8	25.1	23.8	20.0	19.3
A	-225	19/16	84.7	19.9	14.2	20.6	30.7	27.8	22.9	20.4
A	-225	22/16	74.0	16.2	12.3	18.7	24.0	24.3	19.5	19.9
A	-225	26/16	73.7	16.1	11.2	18.5	26.0	24.1	19.0	19.5
A	-225	16/17	76.4	16.1	11.7	18.1	26.4	22.3	18.4	19.0
B	-237	28/16	72.9	15.3	12.1	18.0	25.8	23.6	18.8	17.8
B	-237	28/16	74.8	17.2	11.5	19.5	22.5	23.1	19.4	17.9
B	-237	31/16	71.8	13.0	11.1	17.0	23.9	21.5	18.4	18.7
B	-237	32/16	87.0	20.2	14.4	23.0	33.0	28.9	23.1	22.2
B	-237	22/17	82.1	18.0	15.7	21.7	27.6	26.6	21.3	21.2
B	-237	22/17	69.6	15.3	12.2	16.9	19.6	21.6	17.6	17.3
B	-237	26/17	74.1	17.3	12.8	18.9	25.5	23.7	19.2	19.2
B	-237	14/18	79.7	17.1	13.1	19.0	27.7	24.9	19.1	19.8
B	-249	28/17	84.7	18.8	14.0	21.2	28.0	25.2	21.5	20.7
B	-249	28/17	77.7	16.2	11.3	18.6	25.3	24.2	19.8	18.8
B	-249	28/17	76.4	15.4	12.2	18.1	24.1	22.2	18.5	18.2
B	-249	29/17	74.5	14.9	12.2	15.6	21.8	21.1	17.1	16.3
B	-249	32/17	85.9	19.4	14.3	22.6	28.9	27.9	23.2	21.6
B	-249	32/17	78.9	16.5	12.8	18.4	23.1	23.1	20.0	18.9
B	-249	39/17	71.4	15.0	11.7	15.1	22.2	20.4	16.5	16.9
B	-249	40/17	72.5	16.4	12.6	18.3	23.6	23.0	18.9	18.6

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Pril. 17C / Annex 17C (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-249	23/18	84.8	18.2	14.5	22.3	29.3	27.1	21.9	21.9
B	-249	23/18	70.4	15.8	11.1	18.2	23.8	23.1	19.5	18.3
B	-249	38/18	84.8	19.3	15.3	20.2	32.9	28.0	24.6	23.8
B	-261	28/18	75.5	15.8	13.3	20.0	26.3	27.0	20.9	20.2
B	-261	22/19	81.2	18.0	14.9	20.0	30.4	28.3	23.1	22.7
B	-261	34/20	73.0	16.6	12.3	17.8	22.9	20.7	18.8	18.2
B	-273	22/20	79.4	18.9	14.1	22.5	30.4	28.4	24.8	21.7
B	-273	13/21	77.5	16.6	12.9	19.5	26.1	24.7	21.5	20.0
B	-273	34/21	69.1	15.3	11.6	18.0	26.6	24.1	19.9	18.6
B	-285	16/22	82.0	20.0	15.9	21.8	30.7	29.4	24.0	23.5
B	-285	16/22	84.7	19.1	14.8	22.0	29.3	28.3	23.1	20.9
B	-285	35/22	84.4	19.1	15.0	22.1	32.7	29.3	23.9	23.3
B	-297	31/21	80.0	18.1	14.9	21.4	28.8	27.2	22.8	21.2
B	-297	39/21	78.7	17.3	14.6	20.0	29.3	26.3	22.0	21.3
B	-297	39/21	77.2	17.6	14.8	20.0	27.0	25.8	22.0	21.2
B	-297	40/21	78.9	17.0	14.4	20.6	29.3	26.4	21.8	20.9
B	-297	20/22	85.7	19.4	16.8	23.8	35.2	29.6	25.1	23.7
B	-297	20/22	79.3	17.7	14.7	21.3	29.9	29.3	23.5	22.2
B	-309	28/22	79.7	17.7	15.4	21.1	32.0	27.7	22.8	22.2
B	-309	32/22	77.8	17.8	15.0	21.4	30.5	28.0	23.7	22.5
B	-309	26/23	76.6	17.6	14.6	20.1	28.7	25.3	22.1	21.0
B	-309	13/24	78.3	17.6	14.7	21.4	29.7	27.8	22.4	21.3
B	-309	14/24	70.7	15.2	12.4	19.3	24.7	22.5	18.4	19.2
B	-309	16/24	72.9	18.1	13.4	19.6	28.4	25.1	22.0	20.1
B	-309	35/24	83.2	21.4	15.7	23.6	33.0	28.4	25.4	23.6
B	-321	31/23	77.3	15.9	12.9	19.5	28.3	25.6	22.1	21.0
B	-321	40/23	78.8	17.4	15.7	20.0	30.5	27.4	22.1	21.6
B	-321	22/24	84.0	18.1	13.0	22.1	30.5	28.1	24.7	22.1
B	-321	23/24	69.9	16.4	12.1	16.3	26.4	23.5	19.6	18.6
B	-321	25/24	71.1	14.8	11.6	17.6	26.3	23.1	19.6	18.4
B	-321	26/24	69.0	16.3	12.2	17.9	25.7	23.6	19.8	18.9
B	-321	38/24	73.5	15.0	10.9	18.5	23.9	22.5	18.9	18.5
B	-321	13/25	82.4	17.2	14.6	22.1	31.1	26.8	22.6	20.9
B	-321	14/25	85.1	19.1	15.4	22.8	31.4	30.5	25.8	23.8
B	-321	34/25	87.3	18.0	15.0	22.0	28.9	29.6	25.2	22.7
B	-321	34/25	82.8	19.6	14.5	21.1	27.5	27.8	21.7	20.9
B	-321	35/25	81.5	18.5	14.0	19.3	31.4	27.9	23.2	21.4
B	-333	28/24	78.8	18.3	12.9	20.1	26.6	26.0	22.0	20.1
B	-333	39/24	81.0	17.6	14.6	22.3	29.3	26.0	22.2	19.6
B	-333	40/24	81.1	18.6	14.2	21.5	30.0	26.9	22.9	22.9
B	-333	37/25	85.4	19.0	14.5	22.2	30.2	26.6	22.0	21.7
B	-333	16/26	81.3	19.1	16.1	22.9	32.0	29.0	24.8	22.4
B	-333	16/26	87.0	18.1	14.2	22.1	32.7	27.8	23.7	23.1
B	-345	31/25	87.7	18.4	14.4	22.8	33.8	29.3	25.9	23.4
B	-345	13/27	84.0	17.8	14.7	21.6	30.3	27.0	22.9	22.1
B	-345	14/27	83.2	18.2	14.1	20.0	28.7	26.7	21.7	23.3
B	-357	20/27	81.8	18.3	16.3	22.3	28.8	29.2	23.2	23.1
B	-357	25/27	76.1	16.9	12.8	20.9	27.3	23.6	20.7	19.5
B	-357	16/28	80.7	18.4	14.3	21.6	29.4	26.7	22.4	21.4
B	-357	16/28	75.1	15.7	11.8	18.9	24.4	24.7	19.8	21.1
B	-357	35/28	72.7	16.8	11.9	18.1	25.1	22.5	18.5	17.9
B	-369	39/27	69.5	14.7	10.6	17.3	24.8	22.2	19.4	18.3
B	-369	40/27	76.4	15.2	11.5	20.0	23.8	24.2	20.2	19.7
B	-369	19/28	74.9	15.5	11.3	19.2	26.4	24.0	17.8	19.1
B	-369	19/28	69.5	15.3	11.8	16.9	23.7	22.2	19.2	18.1
B	-369	19/28	78.9	16.2	13.9	20.1	28.3	24.2	21.4	20.9
B	-369	13/29	84.3	18.3	14.2	21.4	30.5	27.2	23.2	22.2
B	-369	17/29	85.7	17.0	14.0	23.1	29.1	26.7	21.5	21.4
B	-369	35/29	73.4	15.3	12.4	18.2	22.9	23.6	19.3	19.2
B	-381	32/28	82.9	19.2	15.0	23.6	31.7	29.1	24.6	22.7
B	-381	22/29	83.3	16.4	13.4	20.8	29.3	26.7	22.5	21.4
B	-381	22/29	74.6	17.4	12.8	19.4	24.6	23.1	19.2	18.4
B	-381	22/29	81.8	18.6	14.8	20.6	25.8	24.9	19.8	20.4
B	-381	38/29	81.1	18.5	14.6	20.2	30.6	28.5	23.8	21.5
B	-381	13/30	73.6	14.8	11.8	17.7	25.2	22.5	18.1	18.7
B	-381	14/30	68.9	13.8	10.6	17.0	23.3	21.4	18.3	16.4
B	-381	35/30	67.5	15.5	11.2	17.0	23.5	23.1	18.6	18.6

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Pril. 17C / Annex 17C (nadaljevanje / cont.)

Facies	**Sediment. level (cm)**	**Square / cut**	**gL**	**sDB**	**sDH**	**pB**	**pH**	**gdB**	**dB**	**dH**
B	-393	19/30	75.9	15.4	12.1	18.3	24.4	23.1	18.4	19.4
B	-393	17/31	77.2	17.7	11.1	18.0	25.4	24.0	20.7	20.3
B	-405	14/32	84.8	17.2	13.9	20.8	28.4	24.4	21.2	20.3
B	-417	25/32	78.7	15.9	12.1	20.0	27.0	25.3	21.6	20.6
B	-417	36/32	73.0	15.3	11.9	16.8	25.0	22.9	18.5	18.5
B	-417	17/33	76.6	16.9	12.4	21.0	28.7	23.3	20.9	19.5
B	-417	35/33	79.2	18.3	14.8	21.1	25.4	25.9	21.4	20.9
B	-429	19/33	82.4	15.7	14.6	21.4	29.4	26.8	22.0	21.2
B	-429	19/33	83.3	16.8	13.1	21.6	26.4	25.5	20.8	20.4
B	-429	19/33	74.0	17.0	12.7	19.2	26.7	25.0	20.1	19.5
B	-429	22/33	75.6	14.6	11.5	20.7	24.5	23.4	19.4	18.3
B	-429	22/33	74.3	14.5	11.8	19.1	26.1	23.3	20.0	19.5
B	-429	22/33	74.2	15.2	10.4	19.6	22.1	23.3	19.0	19.1
B	-429	22/33	76.0	15.9	12.5	20.7	26.7	25.0	20.3	19.4
B	-429	36/33	76.5	15.0	11.3	20.1	25.5	23.2	19.9	19.0
B	-429	37/33	74.4	16.1	11.2	18.9	25.4	23.3	19.2	19.3
B	-429	13/34	85.5	16.9	11.9	22.2	27.7	25.4	21.0	20.2
B	-429	16/34	82.2	17.0	14.0	21.8	30.5	27.8	22.8	22.0
B	-429	35/34	80.8	18.3	14.5	20.2	27.6	27.1	21.1	21.9
B	-429	35/34	74.8	16.2	12.5	18.2	24.1	23.0	19.7	19.1
C	-441	36/34	79.0	16.3	12.4	20.5	26.6	23.6	21.6	20.7
C	-441	13/35	75.7	16.3	12.2	19.6	27.1	25.2	20.9	20.0
C	-441	17/35	68.8	13.3	10.8	16.9	22.1	21.7	18.6	17.6
C	-441	34/35	81.8	19.3	14.1	21.7	31.6	28.7	23.6	22.4
C	-441	16/36	83.1	17.8	11.9	22.1	28.2	26.1	21.5	21.9
C	-453	19/35	75.3	16.2	11.1	18.1	23.6	22.2	18.3	17.1
C	–	165/13	82.8	20.0	15.9	21.7	30.5	27.7	22.7	21.5
C	–	169/13	67.8	14.5	10.7	16.1	20.5	21.1	16.5	16.3
C	–	170/13	74.1	15.7	12.1	18.0	24.2	22.2	18.9	19.0
C	–	173+179/1	81.9	18.6	14.4	21.2	30.2	27.7	22.7	21.5
C	–	178/13	77.4	17.8	11.9	19.3	26.3	23.8	20.4	18.4
C	–	179/13	76.5	16.7	13.9	19.3	25.9	23.8	19.4	18.4
C	–	180/13	80.5	16.7	13.0	22.1	27.2	24.9	20.4	20.5
C	–	181/13	73.1	14.6	11.1	17.6	24.1	22.8	18.6	16.8
C	–	183/13	71.0	14.2	12.0	16.9	22.0	21.9	17.7	17.3
C	–	184a/13	71.4	14.3	10.0	18.3	20.9	20.0	16.2	16.2
C	–	188/13	89.5	17.9	13.9	22.0	27.3	23.6	20.2	19.5
C	–	191/13	80.3	17.8	14.8	23.5	29.6	28.6	24.1	21.9
C	–	177/13-14	80.3	17.2	12.8	20.8	28.6	25.7	21.0	20.2
C	–	203/13-14	83.2	19.6	15.3	21.1	29.9	27.7	22.7	21.3
C	–	203/13-14	87.8	18.0	13.4	23.1	30.8	26.5	22.2	20.8
C	–	168/14	88.0	17.2	12.7	22.5	29.4	28.0	23.2	19.7
C	–	171/14	74.8	18.6	13.1	20.8	27.5	26.4	21.6	19.8
C	–	172/14	73.9	15.7	11.8	17.7	24.0	22.0	19.0	18.5
C	–	174/14	81.6	18.6	14.1	20.3	29.4	27.2	22.6	21.8
C	–	178/14	72.7	14.2	10.2	17.1	23.9	21.5	17.1	17.4
C	–	182/14	86.3	19.3	15.5	22.9	33.3	30.4	24.8	22.9
C	–	182/14	80.8	16.7	13.1	20.9	27.2	25.2	21.0	19.9
C	–	189/14	84.1	16.8	13.8	21.4	28.7	25.5	20.6	20.0
C	–	189/14	83.3	18.8	12.9	23.2	29.9	27.5	23.7	21.7
C	–	190/14	83.7	18.4	14.8	23.4	34.3	29.3	25.3	22.8
C	–	191/14	82.1	17.7	12.6	20.5	27.7	25.5	20.7	20.6
Σ sample A			x = 81.4 SD = 4.99	x = 18.1 SD = 1.76	x = 14.0 SD = 1.60	x = 20.6 SD = 1.75	x = 29.5 SD = 2.77	x = 26.6 SD = 2.29	x = 22.4 SD = 2.16	x = 21.4 SD = 1.62
Σ sample B			x = 78.3 SD = 5.14	x = 17.0 SD = 1.58	x = 13.3 SD = 1.53	x = 20.1 SD = 1.93	x = 27.5 SD = 3.13	x = 25.5 SD = 2.45	x = 21.2 SD = 2.15	x = 20.4 SD = 1.80
Σ sample C			x = 79.1 SD = 5.69	x = 17.0 SD = 1.77	x = 12.9 SD = 1.54	x = 20.3 SD = 2.17	x = 27.3 SD = 3.45	x = 25.1 SD = 2.73	x = 20.9 SD = 2.38	x = 19.8 SD = 1.95
Σ all samples (A+B+C)			x = 79.3 SD = 5.35	x = 17.3 SD = 1.72	x = 13.4 SD = 1.60	x = 20.3 SD = 1.93	x = 28.0 SD = 3.21	x = 25.7 SD = 2.50	x = 21.5 SD = 2.26	x = 20.6 SD = 1.86

Pril. 17D: Seznam analiziranih četrtih dlančnic s pripadajočimi metričnimi podatki.
Annex 17D: List of analysed fourth metacarpals with relevant metric data.

Facies	**Sediment. level (cm)**	**Square / cut**	**gL**	**sDB**	**sDH**	**pB**	**pH**	**gdB**	**dB**	**dH**
A	-32	62a/2	87.0	21.2	14.5	23.5	33.9	28.6	24.2	21.6
A	-44	17/2	93.1	23.7	17.7	24.9	34.9	34.2	26.1	26.1
A	-44	17/2	75.8	14.8	11.6	19.0	25.8	21.5	19.2	18.0
A	-56	25/2	76.3	16.2	11.5	20.6	30.7	23.1	18.8	18.8
A	-56	16/3	80.5	16.6	12.0	20.9	29.1	24.6	20.6	19.9
A	-68	16/4	72.0	17.6	12.4	19.2	27.7	24.7	20.3	19.1
A	-68	34a/5	76.8	16.4	12.6	20.5	29.0	24.7	20.5	20.2
A	-68	41a/5	85.9	19.7	15.4	23.8	33.5	29.4	24.0	23.6
A	-81	20/4	87.5	22.2	16.7	25.0	35.4	31.2	26.7	22.5
A	-81	55a/6	90.4	19.7	15.5	23.7	32.4	26.0	21.7	23.0
A	-81	34b/7	87.6	20.7	16.0	23.5	32.3	29.2	25.5	22.9
A	-94	37/5	81.4	18.2	13.3	22.3	27.6	24.2	21.2	19.7
A	-106	13/7	75.2	15.7	15.0	20.8	27.5	23.4	20.1	19.5
A	-106	41b/9	87.9	22.5	15.7	24.5	33.8	29.4	25.2	24.6
A	-106	41c/9	82.6	18.2	13.3	20.9	31.8	24.0	21.0	19.9
A	-106	55c/9	85.4	19.2	16.8	23.1	31.7	25.9	20.9	21.2
A	-117	28/6	75.6	19.2	11.1	20.3	27.2	25.5	21.8	20.8
A	-117	34c/10	84.2	21.4	16.0	26.0	33.6	28.5	25.1	22.7
A	-117	41b/10	75.9	18.1	12.1	18.7	28.5	22.7	18.3	20.1
A	-117	55c/10	86.9	21.5	15.7	24.9	34.8	31.0	25.0	24.2
A	-129	41a/10	80.1	17.6	12.6	20.0	28.7	24.6	21.6	21.1
A	-129	55c/11	92.0	21.2	17.3	25.9	37.6	30.1	27.5	24.1
A	-141	32/8	86.4	19.2	14.5	23.6	33.0	28.6	23.9	23.8
A	-177	26/12	93.1	21.6	17.3	24.1	34.5	30.6	24.0	24.5
A	-177	34c/15	93.3	19.8	16.8	22.9	33.7	30.1	24.9	23.0
A	-189	34/14	87.1	20.2	15.0	23.9	33.6	29.6	23.6	24.3
A	-189	41b/16	89.5	20.7	16.1	22.3	34.9	30.3	25.6	23.8
A	-201	38/14	76.0	17.9	11.5	21.0	29.7	24.6	22.5	20.4
A	-201	17/15	90.3	20.1	14.9	22.7	32.9	28.8	24.7	22.2
A	-201	55b/17	94.0	20.6	17.6	25.0	35.1	30.2	25.8	25.7
A	-201	62c/17	88.9	21.5	15.0	25.2	35.3	30.3	23.1	23.4
A	-213	19/15	80.5	19.0	12.9	21.7	32.3	24.2	19.7	19.4
A	-225	29/15	80.0	18.6	13.1	21.1	28.6	25.1	21.4	20.3
A	-225	39/15	88.0	19.1	12.9	21.2	31.1	25.8	21.9	21.0
B	-237	25/17	79.6	17.2	11.7	20.5	27.2	24.7	22.3	20.2
B	-237	26/17	85.5	19.6	15.9	23.0	32.9	27.7	24.1	22.6
B	-237	25/17	77.0	17.6	12.6	20.5	27.2	25.6	20.4	18.2
B	-249	41a/19	80.9	17.6	11.1	18.5	26.4	23.6	21.1	19.2
B	-249	28/17	76.3	17.4	13.8	19.9	26.7	23.0	21.0	19.1
B	-249	31/17	92.4	21.8	18.2	24.6	36.6	29.7	25.3	22.3
B	-249	32/17	75.4	18.0	11.9	19.8	27.1	23.8	18.7	18.6
B	-249	19/18	87.7	21.7	15.1	23.1	31.3	30.8	25.7	21.8
B	-249	20/18	81.4	17.7	11.4	21.2	28.2	26.1	22.6	20.9
B	-249	25/18	78.8	18.9	12.6	19.0	28.6	25.6	20.9	19.9
B	-249	13/19	86.4	19.8	16.8	23.6	32.7	27.8	23.3	23.1
B	-261	34b/21	82.8	21.3	16.6	22.0	31.7	31.8	28.0	22.7
B	-261	28/18	76.1	17.0	11.0	18.4	31.5	23.8	19.6	19.1
B	-261	39/18	91.1	20.7	16.2	22.6	34.8	30.1	23.0	22.9
B	-261	39/18	83.0	20.4	16.5	22.0	31.8	29.0	24.4	21.5
B	-261	22/19	77.2	19.1	13.8	19.9	27.7	26.4	23.9	21.3
B	-261	37/19	85.6	20.1	16.3	21.8	34.9	29.3	26.9	22.1
B	-261	23/20	83.2	19.9	14.3	22.0	34.0	29.0	22.9	21.5
B	-273	36/20	76.0	18.9	12.4	20.2	27.9	24.9	21.0	19.4
B	-273	35/21	82.4	21.1	14.8	20.5	31.3	29.4	24.2	22.1
B	-285	32/20	77.1	18.3	11.7	21.2	28.9	23.2	19.6	18.6
B	-285	16/22	90.5	20.6	16.2	24.7	31.9	28.3	24.5	23.8
B	-297	38/21	81.0	18.6	14.8	23.7	32.5	28.4	24.1	23.1
B	-297	31/21	89.4	20.6	14.7	23.1	31.9	28.5	23.6	22.5
B	-297	40/21	77.7	16.3	10.6	20.1	27.0	23.7	18.6	18.7
B	-297	40/21	81.4	19.1	14.1	20.6	32.0	26.2	21.1	20.2
B	-297	16/23	85.5	21.5	16.5	26.7	33.0	31.4	25.2	23.7
B	-309	29/22	84.7	21.8	15.0	25.0	35.1	28.8	24.2	23.3
B	-309	20/23	77.0	18.5	14.5	21.0	31.3	27.0	23.2	20.6
B	-309	23/23	89.5	20.0	15.8	23.0	33.3	27.8	23.4	23.3
B	-309	25/23	79.6	19.3	14.5	23.3	29.5	26.9	21.2	22.7
B	-321	32/23	79.6	19.6	15.6	22.0	32.8	28.4	23.5	22.5

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Pril. 17D / Annex 17D (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-321	40/23	79.1	20.3	15.9	22.8	32.7	27.8	23.8	22.3
B	-321	25/24	81.4	18.8	14.4	21.6	30.6	28.0	22.9	21.5
B	-321	37/24	88.8	20.2	16.5	22.3	34.5	30.6	27.9	25.0
B	-333	28/24	85.1	20.5	14.7	21.7	34.1	28.3	24.5	22.8
B	-333	28/24	71.2	16.9	12.3	18.1	27.2	23.8	20.6	19.0
B	-333	23/25	75.9	16.6	11.5	18.5	27.8	23.2	19.5	19.6
B	-333	34/26	82.6	21.9	15.7	22.9	32.0	30.6	25.0	21.1
B	-345	29/25	84.2	17.8	13.9	21.3	30.9	26.3	22.1	21.4
B	-345	31/25	82.0	20.0	14.4	21.9	30.7	28.4	23.8	22.0
B	-345	32/25	84.0	19.7	14.1	22.8	30.6	28.0	22.6	21.1
B	-345	39/25	85.5	18.8	14.3	22.7	31.6	28.5	24.5	22.7
B	-345	26/26	75.5	17.6	12.9	19.3	27.7	23.8	20.8	19.6
B	-345	37/26	87.0	20.4	15.1	22.2	32.2	29.7	24.7	23.4
B	-345	14/27	75.4	16.2	21.0	27.6	23.2	18.8	18.3	19.2
B	-357	32/26	86.3	19.6	14.9	23.3	31.6	29.0	22.7	21.1
B	357	32/26	85.3	22.0	17.2	21.1	33.6	31.4	25.7	22.9
B	357	39/26	84.2	18.0	14.3	21.8	30.6	25.6	21.2	22.2
B	357	40/26	92.3	21.2	16.6	26.2	35.8	29.5	25.9	24.3
B	357	20/27	89.0	21.2	15.3	22.1	32.3	29.4	24.5	24.5
B	357	22/27	73.8	16.1	13.4	18.9	28.9	23.4	19.5	19.7
B	357	22/27	88.6	21.1	17.3	22.6	34.8	30.9	28.1	23.2
B	357	37/27	89.5	21.8	17.5	24.1	34.7	30.5	26.9	24.5
B	357	34/28	82.1	19.3	15.0	23.0	30.0	27.4	23.7	22.4
B	-369	40/27	80.6	16.8	12.9	21.0	27.5	23.0	19.7	21.5
B	-369	40/27	83.1	19.2	15.2	22.1	31.8	26.8	24.2	23.4
B	-369	40/27	84.2	19.9	14.7	22.9	33.8	28.7	25.2	23.1
B	-369	40/27	79.0	16.3	12.8	18.9	29.0	24.9	21.3	21.0
B	-369	20/28	84.1	18.9	14.8	20.8	34.6	28.3	25.3	22.9
B	-369	26/28	80.1	16.9	12.2	21.1	28.3	24.1	20.7	19.5
B	-369	13/29	80.0	16.4	12.0	20.3	27.1	24.2	19.8	21.1
B	-369	35/29	83.8	19.5	13.9	23.4	32.9	27.9	24.4	22.0
B	-381	32/28	75.4	15.5	12.6	20.6	26.8	22.6	20.3	19.6
B	-381	22/29	73.1	16.3	12.5	21.0	26.7	25.1	19.8	19.3
B	-381	23/29	78.9	19.0	13.4	22.3	30.8	27.1	22.8	21.0
B	-381	36/29	82.9	17.2	13.4	20.3	29.9	25.9	23.0	21.3
B	-381	16/30	82.5	19.8	14.5	22.0	30.5	26.4	22.4	20.0
B	-393	20/30	79.3	16.5	12.7	20.5	27.6	24.3	20.4	20.6
B	-393	17/31	75.3	17.3	12.3	21.3	28.2	23.2	20.1	18.7
B	-393	34/31	80.8	18.1	13.1	21.0	29.7	25.2	21.4	21.0
B	-393	35/31	78.8	17.7	12.4	19.1	28.0	23.7	20.5	20.1
B	-405	14/32	79.2	16.8	10.9	20.3	28.2	22.7	19.3	20.2
B	-429	22/33	82.7	18.2	13.7	20.3	30.7	27.0	24.0	21.1
B	-429	25/33	82.5	17.2	12.1	21.5	28.3	26.6	22.5	20.9
B	-429	14/34	82.1	20.0	14.8	22.2	30.1	26.6	23.2	20.9
B	-429	17/34	85.4	19.7	17.9	21.6	32.9	26.7	23.8	22.5
B	-429	17/34	87.9	19.4	15.9	23.8	33.5	28.9	24.0	22.8
C	-441	22/34	71.7	15.9	13.3	20.1	27.2	22.6	21.5	20.0
C	-441	14/35	86.8	21.4	16.5	22.7	31.6	29.9	25.3	24.3
C	-441	17/35	77.0	18.8	11.3	19.3	27.1	25.0	20.4	19.8
C	-441	34/36	74.0	15.3	12.4	19.6	26.9	22.5	19.5	18.4
C	-441	34/36	75.0	17.0	11.1	18.1	25.8	23.6	19.8	19.2
C	–	155-157/13	80.2	17.9	14.6	22.4	31.0	28.3	26.1	23.1
C	–	163/13	76.5	16.0	12.2	18.9	26.5	24.5	18.7	18.2
C	–	163/13	86.2	19.8	17.8	23.6	33.2	28.5	25.4	23.6
C	–	164/13	86.7	20.9	14.8	25.3	33.9	30.4	24.1	24.5
C	–	164/13	76.7	16.8	12.7	19.4	25.5	24.2	19.4	18.1
C	–	170/13	74.5	18.3	12.2	18.9	27.0	23.5	19.5	18.3
C	–	178/13	84.1	18.6	15.0	21.8	28.8	26.5	22.1	20.7
C	–	180/13	85.3	16.9	14.1	21.7	24.6	25.5	20.9	21.6
C	–	181/13	91.1	19.4	15.9	23.1	31.4	27.1	22.9	21.6
C	–	181/13	80.6	18.7	14.4	23.3	30.6	26.5	21.7	21.4
C	–	181/13	75.0	14.4	10.1	17.7	26.3	21.5	18.7	17.9
C	–	184a/13	82.2	19.0	12.9	21.4	27.3	24.7	20.7	20.2
C	–	189/13	82.4	18.3	13.4	20.8	31.3	24.8	21.0	18.9
C	–	189/13	74.8	16.4	12.0	19.4	24.6	22.8	19.2	17.3
C	–	189/13	85.1	20.3	13.9	22.9	32.0	27.2	22.4	22.0

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Pril. 17D / Annex 17D (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
C	–	189/13	76.1	16.3	10.7	19.0	25.7	23.1	19.3	19.6
C	–	203/13-14	79.9	19.0	12.8	21.5	29.4	24.6	20.6	19.1
C	–	204/13-14	85.5	19.0	13.9	22.0	30.9	27.7	23.8	21.4
C	–	204/13-14	80.1	18.4	13.1	23.1	30.1	26.8	23.0	21.4
C	–	168/14	87.4	20.2	16.2	23.0	31.5	29.5	27.2	24.0
C	–	173/14	71.2	16.3	11.9	18.6	26.2	23.6	20.7	19.2
C	–	173/14	75.9	15.2	11.9	18.4	25.9	22.9	20.6	17.5
C	–	180/14	77.5	17.7	12.9	20.1	26.0	23.9	19.6	19.8
C	–	182/14	86.3	20.1	14.4	23.4	31.7	27.4	23.1	22.7
C	–	184a/14	94.1	21.1	14.8	25.7	32.1	28.1	23.8	23.2
C	–	184a/14	79.7	17.1	11.6	20.9	26.1	24.4	19.5	19.7
C	–	184a/14	84.6	20.5	16.8	24.4	33.3	29.6	23.6	22.1
C	–	188/14	89.0	20.3	15.3	24.3	33.4	28.4	24.5	23.3
C	–	190/14	82.4	17.8	13.7	20.9	28.5	28.2	22.2	21.2
C	–	191/14	79.0	17.0	13.5	20.2	27.6	25.0	21.3	21.1
C	–	191/14	77.2	18.3	11.2	19.7	27.1	24.7	19.7	17.9
C	–	192/14	83.2	20.3	14.6	20.3	30.3	27.4	23.8	20.1
Σ sample A			x = 84.3 SD = 6.29	x = 19.4 SD = 2.08	x = 14.5 SD = 2.02	x = 22.5 SD = 2.07	x = 31.8 SD = 2.98	x = 27.2 SD = 3.12	x = 22.8 SD = 2.47	x = 21.9 SD = 2.13
Σ sample B			x = 82.1 SD = 4.78	x = 19.0 SD = 1.72	x = 14.3 SD = 1.97	x = 21.7 SD = 1.87	x = 30.7 SD = 2.77	x = 26.8 SD = 2.65	x = 22.8 SD = 2.32	x = 21.4 SD = 1.65
Σ sample C			x = 80.9 SD = 5.56	x = 18.2 SD = 1.82	x = 13.5 SD = 1.81	x = 21.2 SD = 2.12	x = 28.9 SD = 2.82	x = 25.8 SD = 2.40	x = 21.8 SD = 2.25	x = 20.6 SD = 2.06
Σ all samples (A+B+C)			x = 82.3 SD = 5.44	x = 18.9 SD = 1.86	x = 14.1 SD = 1.97	x = 21.8 SD = 2.02	x = 30.5 SD = 3.00	x = 26.7 SD = 2.73	x = 22.5 SD = 2.37	x = 21.3 SD = 1.92

Pril. 17E: Seznam analiziranih petih dlančnic s pripadajočimi metričnimi podatki.
Annex 17E: List of analysed fifth metacarpals with relevant metric data.

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
A	-44	48C/4	78.9	15.5	12.5	24.4	28.6	24.3	22.6	18.4
A	-44	37/1	83.1	22.5	17.1	36.2	34.7	30.4	28.1	22.2
A	-56	48A/4	75.2	17.1	14.4	27.2	32.4	26.3	23.9	19.5
A	-68	19/3	90.1	21.2	15.0	32.9	35.6	29.8	29.3	22.8
A	-81	28/3	86.8	20.3	17.3	32.9	36.1	31.8	28.9	23.0
A	-81	39/3	91.4	19.9	14.5	33.2	36.2	32.0	30.4	24.4
A	-81	39/3	77.8	18.0	13.9	28.9	29.8	26.1	23.6	20.2
A	-81	22/4	90.1	20.6	17.7	32.3	36.1	29.9	28.8	22.8
A	-81	38/4	78.3	16.3	11.6	25.1	27.8	25.2	24.2	19.9
A	-81	34/5	88.5	20.0	15.6	31.7	38.2	31.1	28.4	23.6
A	-81	48A/6	91.8	21.9	17.2	30.4	35.1	30.7	28.0	21.0
A	-81	55C/7	88.1	19.9	15.0	29.1	30.9	28.4	25.5	21.6
A	-94	35/6	91.9	22.3	17.5	36.1	37.3	34.5	32.3	24.8
A	-94	48B/8	84.6	21.2	16.8	34.9	32.9	32.9	27.5	24.0
A	-106	34/7	90.1	21.2	17.1	32.3	34.1	31.7	28.8	22.8
A	-106	35/7	87.7	20.1	15.7	31.1	35.6	31.2	27.7	21.9
A	-117	38/7	79.4	18.4	11.8	29.3	31.7	28.5	24.7	20.6
A	-117	48A/9	91.2	20.8	15.9	31.5	37.7	29.6	25.8	23.2
A	-117	41C/10	88.5	21.4	16.3	33.5	34.3	31.9	25.0	21.3
A	-117	48C/10	85.6	21.3	16.4	29.5	28.9	29.8	25.5	20.4
A	-129	34/9	86.3	21.2	17.4	35.0	40.4	32.7	30.9	23.8
A	-141	32/8	87.0	19.6	15.7	33.2	36.3	31.8	27.2	23.9
A	-141	34B/12	81.4	17.9	12.2	27.4	32.2	26.3	25.8	21.4
A	-141	48B/12	88.2	19.9	15.1	32.2	38.7	28.4	27.0	22.2
A	-153	32/9	76.7	17.9	13.5	29.9	31.1	27.9	23.8	21.4
A	-153	26/10	93.2	20.6	16.2	35.6	38.5	33.9	31.7	25.4
A	-153	48B/13	85.1	22.6	14.5	33.3	31.1	30.9	27.4	21.5
A	-156	16/12	88.0	20.6	15.4	30.3	34.7	30.0	26.6	21.5
A	-201	23/14	83.1	20.7	15.7	31.2	34.1	30.3	27.7	21.4
A	-201	38/14	74.1	16.6	13.6	27.0	31.7	25.6	24.8	19.1
A	-201	34/15	95.0	23.2	16.9	33.6	38.2	32.1	29.5	23.0
A	-201	30/16	82.2	19.9	15.5	30.2	31.7	28.5	25.2	20.7
A	-225	55A/17	84.5	21.6	14.8	33.1	33.8	32.1	28.5	21.8
A	-225	28/15	80.3	16.6	13.3	26.2	28.9	24.7	23.1	19.8
A	-225	29/15	89.2	19.7	16.2	32.9	37.4	31.4	29.2	22.0
A	-225	40/15	80.3	17.5	15.5	28.4	30.7	26.4	25.6	21.0
A	-225	23/16	76.5	17.6	14.2	25.5	30.2	24.9	22.7	18.5

continued...

Pril. 17E / Annex 17E (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-237	19/17	77.3	17.1	12.2	29.9	27.9	26.4	25.7	18.9
B	-237	22/17	90.7	20.5	16.8	32.3	37.6	31.8	30.2	22.7
B	-237	13/18	85.9	21.8	15.4	29.0	34.6	30.3	27.2	22.0
B	-249	29/17	76.0	18.0	12.8	27.7	31.3	26.6	24.0	19.8
B	-249	20/18	87.1	21.2	16.0	32.4	37.6	31.6	29.1	23.0
B	-249	34A/19	87.1	22.4	15.5	32.2	35.7	30.1	28.6	23.3
B	-249	34A/19	96.0	15.1	12.4	26.7	35.0	28.9	27.0	20.0
B	-261	62A/20	73.4	17.4	12.9	27.1	29.5	27.2	24.2	19.5
B	-261	28/18	85.6	17.3	15.4	31.8	31.1	27.4	25.3	18.6
B	-261	39/18	77.4	17.3	12.1	27.2	30.4	26.2	26.2	19.9
B	-273	28/19	84.4	19.9	17.1	31.8	35.9	31.8	27.9	22.9
B	-273	29/19	82.4	22.3	16.8	32.1	37.9	31.7	31.1	23.2
B	-273	31/19	77.0	16.5	12.4	27.5	30.1	26.9	23.8	18.9
B	-273	22/20	87.2	23.0	18.8	35.0	36.7	33.2	29.9	23.3
B	-273	13/21	73.4	17.9	14.0	27.5	32.3	25.7	26.0	20.2
B	-285	17/22	85.7	23.0	17.9	33.1	39.2	35.0	32.0	24.9
B	-285	26/21	88.4	22.6	17.0	31.1	36.2	31.3	28.3	23.2
B	-297	40/21	83.1	20.4	16.3	33.4	37.2	30.0	29.2	22.7
B	-297	40/21	82.6	22.4	18.1	32.1	37.8	32.6	29.1	24.0
B	-297	37/22	84.0	19.7	15.7	31.7	36.2	29.7	28.5	21.6
B	-297	34/23	81.7	23.1	16.4	32.5	38.3	33.0	30.0	22.0
B	-309	32/22	82.2	19.3	16.5	32.7	37.8	31.2	28.4	22.6
B	-309	32/22	76.3	17.1	12.9	26.0	30.9	25.6	24.4	20.6
B	-309	40/22	81.1	21.5	18.1	32.6	37.3	30.3	29.3	22.5
B	-309	20/23	83.8	22.0	20.2	34.1	35.1	33.4	30.4	22.8
B	-321	31/23	73.4	16.4	13.4	26.6	28.4	25.6	24.8	18.5
B	-321	31/23	82.0	19.7	16.1	31.7	34.2	29.7	24.5	20.0
B	-321	39/23	73.1	16.5	11.7	25.1	27.8	24.8	24.0	18.9
B	-321	40/23	80.0	21.4	18.3	30.4	33.0	30.4	28.4	22.4
B	-321	40/23	78.3	22.9	19.4	32.5	33.2	31.5	28.8	21.2
B	-321	13/25	82.4	19.9	15.6	33.0	33.7	29.5	26.3	21.4
B	-321	16/25	83.2	21.5	16.8	33.8	38.0	31.8	30.6	23.4
B	-321	34/25	90.3	24.7	19.2	33.3	36.2	33.6	29.1	24.1
B	-333	39/24	83.7	19.7	14.1	31.5	36.9	30.4	25.7	21.7
B	-333	39/24	87.8	20.3	16.2	32.0	36.4	30.7	27.6	23.6
B	-333	20/25	82.5	20.6	16.3	29.7	34.1	30.0	27.3	21.5
B	-333	23/25	73.1	15.6	12.8	27.7	31.4	25.1	22.0	19.5
B	-345	28/25	72.6	17.0	12.0	27.2	28.1	24.5	23.1	19.5
B	-345	40/25	84.3	19.0	13.4	31.2	30.4	28.9	26.8	20.9
B	-345	40/25	82.0	19.2	14.6	29.0	33.4	28.4	24.9	20.8
B	-345	13/27	79.5	21.4	17.8	32.9	34.5	32.8	27.5	20.6
B	-345	14/27	85.4	18.3	15.4	33.8	33.9	29.3	29.1	22.0
B	-357	39/26	84.1	20.8	17.3	29.4	34.7	30.9	27.6	21.5
B	-357	38/27	77.8	18.4	13.5	27.6	31.6	25.8	21.9	20.5
B	-357	16/28	88.4	20.5	16.4	33.4	39.5	30.8	28.4	23.2
B	-357	16/28	75.9	18.9	12.8	28.9	28.2	26.5	23.8	18.9
B	-369	40/27	79.8	16.0	13.7	26.0	31.8	24.3	20.7	20.7
B	-369	40/27	87.7	19.1	18.8	30.5	34.9	31.0	27.1	22.5
B	-369	16/29	73.6	16.9	14.1	24.6	29.2	23.3	21.2	17.8
B	-381	39/28	76.6	16.4	13.7	26.7	26.4	25.2	24.1	19.1
B	-381	20/29	75.7	18.4	14.0	28.6	29.3	25.0	24.5	19.0
B	-381	13/30	76.8	16.5	12.4	25.7	29.5	24.8	20.9	19.6
B	-381	17/30	79.0	18.0	13.8	26.8	28.9	27.0	25.4	19.5
B	-381	17/30	85.2	20.0	14.7	31.2	33.8	27.7	26.1	21.7
B	-381	35/30	78.2	17.4	10.5	25.3	29.6	26.0	22.7	19.6
B	-393	36/30	74.7	15.3	14.0	24.7	26.5	24.3	22.5	18.4
B	-393	14/31	85.3	18.0	14.1	30.0	31.1	29.0	26.9	21.9
B	-393	34/31	80.5	17.7	13.8	28.5	30.6	27.0	24.3	20.4
B	-393	34/31	78.8	18.2	12.6	27.6	30.3	25.8	22.4	20.2
B	-393	35/31	77.6	16.7	12.1	28.0	31.8	25.9	22.4	19.8
B	-405	17/32	83.8	20.2	14.9	28.7	33.7	31.3	27.7	21.7
B	-417	32/31	86.5	19.8	17.5	32.9	35.0	30.1	28.9	22.6
B	-417	22/32	81.6	17.0	13.1	28.8	30.4	27.3	24.4	21.0
B	-417	36/32	80.7	19.6	15.7	32.0	35.4	29.8	24.3	20.5
B	-417	37/32	79.7	20.6	15.2	29.1	33.5	28.1	26.5	20.4

continued...

Pril. 17E / Annex 17E (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-417	37/32	82.5	18.6	15.6	28.6	31.4	27.6	26.2	20.8
B	-417	14/33	87.8	21.7	17.4	33.7	36.9	32.4	29.2	23.2
B	-417	14/33	83.4	19.4	14.8	31.1	31.5	28.3	26.4	20.5
B	-417	17/33	84.8	21.3	15.7	33.1	35.8	30.7	27.9	21.5
B	-417	35/33	84.1	19.5	14.6	30.3	32.6	28.3	23.9	21.3
B	-429	19/33	86.1	20.9	17.4	32.3	33.2	30.1	27.5	21.1
B	-429	22/33	76.0	16.5	14.3	26.0	27.1	25.8	22.4	19.0
B	-429	22/33	78.6	17.3	13.7	27.3	28.6	26.4	25.5	19.9
B	-429	13/34	79.2	17.8	13.3	29.1	31.6	27.9	23.2	20.2
B	-429	14/34	90.1	19.3	15.9	32.9	33.3	30.2	29.8	21.8
B	-429	14/34	77.4	17.7	14.1	27.7	29.6	27.2	24.4	18.8
B	-429	17/34	91.2	22.1	15.5	33.6	36.3	31.5	29.2	23.4
B	-429	34/34	89.3	22.3	16.3	33.5	34.0	31.9	28.7	22.4
C	-441	23/34	82.0	18.9	15.0	30.9	32.0	29.4	27.8	21.5
C	-441	36/34	76.7	17.1	13.2	25.9	29.2	25.0	22.0	17.8
C	-453	17/36	77.0	16.6	14.3	26.8	28.0	25.9	22.8	19.4
C	–	164/13	77.6	16.4	12.7	26.7	30.0	25.6	23.6	19.1
C	–	165/13	90.4	20.5	14.8	34.3	36.5	31.7	27.4	20.9
C	–	168/13	75.4	16.2	11.8	27.4	30.0	25.8	23.9	20.0
C	–	169/13	87.2	20.6	15.4	33.0	36.2	30.4	25.4	20.1
C	–	169/13	81.0	16.9	12.9	25.6	26.1	22.6	17.6	15.7
C	–	179/13	74.1	15.4	11.2	25.7	25.3	22.0	17.4	16.0
C	–	179/13	73.5	17.6	12.1	26.2	27.0	24.1	20.2	16.9
C	–	180/13	87.3	20.5	15.1	31.9	34.0	30.9	27.7	20.3
C	–	180/13	72.9	16.3	12.5	25.1	26.5	24.5	20.1	16.2
C	–	182/13	75.0	16.8	13.1	27.1	29.3	25.2	21.7	17.3
C	–	184a/13	88.9	19.8	14.5	33.8	34.7	30.3	27.0	20.6
C	–	188/13	76.4	17.0	13.3	24.9	28.1	25.3	23.3	19.1
C	–	189/13	82.3	20.4	14.0	33.1	31.9	28.4	25.0	20.6
C	–	202/13-14	80.8	19.7	14.3	30.8	33.7	29.5	28.6	21.5
C	–	202/13-14	85.3	19.7	16.2	32.7	37.3	31.5	26.5	20.7
C	–	203/13-14	78.2	17.7	14.3	27.1	29.2	25.0	22.4	18.9
C	–	203/13-14	78.9	16.4	11.9	26.8	30.8	26.5	24.7	20.1
C	–	204/13-14	75.3	17.5	12.9	26.0	27.5	24.0	22.7	17.6
C	–	169/14	86.6	20.0	16.7	32.9	35.4	32.1	27.9	21.8
C	–	172/14	77.5	17.7	14.4	28.3	32.1	28.1	26.4	19.4
C	–	173/14	83.2	20.2	14.5	32.3	34.5	29.5	26.4	21.3
C	–	178/14	74.0	14.1	10.6	25.3	28.0	23.4	22.2	18.5
C	–	178/14	74.5	17.0	11.2	25.9	27.7	24.4	21.3	17.5
C	–	180/14	78.0	18.9	11.3	27.0	28.3	25.4	24.3	19.0
C	–	181/14	75.8	15.9	12.3	27.3	28.0	24.6	23.0	17.9
C	–	184/14	75.9	16.4	12.2	26.4	29.3	24.5	20.5	17.8
C	–	188/14	76.6	16.9	12.1	26.1	29.3	26.6	24.6	18.7
C	–	189/14	75.4	18.2	11.6	26.2	29.3	24.7	22.5	17.3
Σ sample A			x = 85.1 SD = 5.52	x = 19.8 SD = 1.96	x = 15.3 SD = 1.65	x = 31.0 SD = 3.13	x = 33.9 SD = 3.30	x = 29.6 SD = 2.76	x = 26.9 SD = 2.53	x = 21.8 SD = 1.71
Σ sample B			x = 81.5 SD = 5.10	x = 19.3 SD = 2.22	x = 15.1 SD = 2.10	x = 30.0 SD = 2.76	x = 33.1 SD = 3.35	x = 28.8 SD = 2.74	x = 26.3 SD = 2.70	x = 21.1 SD = 1.63
Σ sample C			x = 79.1 SD = 4.98	x = 17.8 SD = 1.76	x = 13.3 SD = 1.57	x = 28.4 SD = 3.09	x = 30.5 SD = 3.33	x = 26.7 SD = 2.89	x = 23.8 SD = 2.95	x = 19.0 SD = 1.72
Σ all samples (A+B+C)			x = 82.1 SD = 5.55	x = 19.1 SD = 2.17	x = 14.2 SD = 2.03	x = 29.9 SD = 3.04	x = 32.7 SD = 3.52	x = 28.6 SD = 2.95	x = 25.9 SD = 2.93	x = 20.8 SD = 1.94

Pril. 17F: Seznam analiziranih prvih stopalnic s pripadajočimi metričnimi podatki.
Annex 17F: List of analysed first metatarsals with relevant metric data.

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
A	-44	41b/4	53.8	13.2	11.8	23.8	30.0	18.6	17.4	17.5
A	-56	39/1	54.3	11.7	9.7	23.7	23.7	16.4	16.4	16.8
A	-56	39/1	52.2	10.3	9.6	21.6	21.0	16.2	15.4	14.8
A	-56	19/2	53.1	9.6	9.4	21.0	21.6	16.6	15.5	15.1
A	-56	25/2	53.1	11.7	9.0	23.4	25.2	15.8	15.3	14.3
A	-68	38/3	55.6	12.9	10.0	24.8	23.5	18.8	18.6	15.8
A	-68	38/3	54.5	13.4	9.8	24.0	26.3	18.7	17.4	16.1
A	-68	17/4	54.7	13.1	10.9	25.0	28.9	17.7	15.5	17.0
A	-68	48a/5	54.3	12.1	10.0	23.3	23.6	17.3	15.6	15.6
A	-68	41c/6	57.4	14.1	11.0	24.8	28.7	18.8	16.9	16.9
A	-68	55c/6	59.7	13.6	11.4	25.8	29.2	18.6	18.2	16.8
A	-81	19/4	55.6	14.1	11.7	24.4	27.0	18.8	17.1	17.3
A	-81	22/4	54.6	11.9	11.4	24.2	23.8	18.3	17.9	16.0
A	-81	37/4	55.3	12.3	11.1	24.7	22.8	17.6	16.3	16.1
A	-81	48a/6	57.0	11.8	10.1	21.7	23.5	18.7	16.0	16.7
A	-81	55a/6	52.9	13.3	10.1	26.7	27.7	18.3	16.6	17.1
A	-81	41c/7	55.2	13.1	10.0	23.5	26.8	18.2	17.4	16.2
A	-81	41c/7	50.4	11.2	9.5	20.5	22.6	14.8	13.9	14.3
A	-81	48b/7	53.0	12.4	10.9	25.5	26.8	18.6	17.0	16.1
A	-94	39/4	54.5	12.5	11.8	24.1	28.0	18.1	17.9	16.6
A	-94	37/5	54.3	14.8	10.8	27.0	24.4	20.8	17.9	17.7
A	-94	37/5	53.8	13.5	11.4	23.3	24.1	18.6	17.7	16.3
A	-94	14/6	56.2	13.2	9.6	24.7	25.8	18.6	18.0	16.5
A	-94	13/7	54.4	13.9	11.9	24.5	28.9	20.4	19.8	16.2
A	-106	17/7	47.7	11.5	10.2	20.0	23.5	16.2	15.4	15.9
A	-106	34b/9	57.0	13.8	11.1	24.3	26.7	19.1	17.3	16.9
A	-117	48a/9	54.5	14.1	12.9	24.1	27.5	18.6	18.1	18.5
A	-117	48a/9	54.8	12.4	11.1	24.9	25.9	20.0	18.4	17.3
A	-117	48b/10	54.4	14.6	11.6	25.9	28.3	18.7	17.8	18.5
A	-129	62a/10	53.6	14.6	11.3	24.4	28.9	19.5	17.7	16.9
A	-129	48c/11	59.4	13.9	11.4	27.0	28.8	19.9	18.3	19.0
A	-141	13/10	53.8	13.4	11.5	22.6	25.7	18.2	16.6	16.4
A	-153	31/9	57.3	10.6	10.4	23.4	24.8	18.0	16.5	17.4
A	-153	34c/13	47.8	10.1	9.7	20.0	19.9	15.2	13.3	14.9
A	-165	41a/13	57.2	13.9	12.0	27.7	31.2	20.0	19.6	18.1
A	-177	38/12	54.0	12.6	10.6	22.7	24.1	17.2	15.9	16.4
A	-189	20/13	54.5	14.5	12.5	23.3	27.6	17.8	15.5	16.5
A	-201	25/14	50.6	11.0	9.2	23.5	23.5	15.9	15.4	15.1
A	-201	14/15	61.4	14.1	10.3	24.4	27.9	18.5	15.5	17.1
A	-213	22/15	53.8	13.6	10.5	24.6	29.5	19.6	17.6	16.8
A	-213	26/15	55.0	14.4	11.2	23.9	25.9	17.0	15.2	16.4
A	-213	38/15	48.0	11.7	10.8	21.8	23.0	15.6	12.8	13.6
A	-213	17/16	53.2	13.3	10.3	22.3	25.7	17.6	16.7	16.1
A	-225	48a/17	47.4	11.4	8.6	19.2	20.6	14.5	11.7	13.5
A	-225	29/15	54.9	12.4	11.1	25.0	28.2	19.5	18.0	16.8
A	-255	40/15	51.3	14.5	11.7	23.9	29.1	17.9	15.3	15.9
A	-225	26/16	53.4	12.9	10.8	22.0	26.0	17.6	17.2	16.0
A	-225	26/16	50.8	11.1	9.0	20.8	20.2	15.1	15.0	13.9
A	-225	16/17	49.6	11.2	8.9	20.2	23.2	14.9	13.4	13.8
B	-237	22/17	55.2	12.0	9.6	23.5	28.2	15.8	14.6	15.1
B	-237	23/17	47.8	12.7	9.1	20.9	23.6	15.5	13.9	12.8
B	-237	26/17	48.5	11.1	8.6	20.0	23.4	15.7	13.8	14.6
B	-237	14/18	54.8	14.4	11.1	25.5	28.0	20.3	19.2	16.0
B	-237	34/18	53.0	11.5	9.4	21.2	23.9	16.5	15.2	14.7
B	-249	28/17	58.3	13.5	12.4	25.2	30.7	18.5	18.5	16.7
B	-249	29/17	46.2	10.5	8.5	19.8	19.0	15.2	15.4	13.6
B	-249	31/17	50.5	9.9	9.4	19.0	20.3	16.2	16.1	14.8
B	-249	38/18	53.6	11.9	9.3	19.5	17.5	15.5	15.1	14.4
B	-249	13/19	51.9	12.5	9.0	21.8	22.9	17.0	16.3	15.3
B	-261	28/18	46.8	11.3	8.0	18.2	22.7	13.9	12.6	13.3
B	-261	28/18	48.1	11.1	8.1	18.8	21.5	14.4	14.4	13.5
B	-261	32/18	53.3	12.1	8.7	21.3	22.9	16.4	16.2	15.7
B	-273	34a/21	55.9	14.5	11.9	26.1	29.3	18.5	17.8	16.9
B	-273	28/19	53.2	15.6	10.4	25.7	28.9	19.8	17.7	16.6
B	-273	39/19	53.6	12.5	10.1	24.6	29.2	19.3	18.0	16.4
B	-273	40/19	49.3	11.3	9.6	21.5	21.9	14.7	13.0	14.6

continued...

Pril. 17F / Annex 17F (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-273	23/20	59.1	13.3	11.2	26.3	29.1	19.8	19.1	18.0
B	-273	14/21	52.7	13.3	10.7	24.3	26.1	18.5	18.5	17.1
B	-273	16/21	54.1	14.5	12.0	24.5	29.0	19.9	18.1	16.5
B	-285	26/21	55.0	13.2	10.6	25.5	26.8	18.2	18.0	17.3
B	-285	26/21	55.8	13.9	12.3	24.4	25.5	19.7	18.6	17.4
B	-285	36/21	52.4	13.0	11.3	24.3	26.7	17.7	17.6	15.6
B	-285	37/21	54.5	13.2	10.1	24.9	27.2	18.1	17.1	16.8
B	-285	37/21	47.1	14.3	10.2	24.6	28.3	18.5	17.2	16.2
B	-285	17/22	59.4	13.2	10.0	25.0	24.6	19.2	18.1	17.8
B	-297	28/21	47.3	11.9	9.4	20.0	23.9	16.4	15.4	14.7
B	-297	39/21	58.9	14.3	12.4	26.9	29.4	19.2	19.4	18.5
B	-297	40/21	53.1	13.3	10.9	25.2	29.6	18.2	18.5	16.0
B	-297	34/23	53.1	13.4	10.4	25.0	29.3	19.1	18.8	16.3
B	-309	28/22	53.5	14.3	9.5	25.8	25.7	19.1	18.6	15.9
B	-309	22/23	57.2	12.8	11.5	26.4	27.7	19.5	19.9	18.0
B	-321	32/23	53.3	12.4	11.0	25.1	25.8	17.8	17.9	15.7
B	-321	22/24	54.5	15.1	12.6	24.4	27.7	18.5	16.8	17.0
B	-321	26/24	53.0	12.4	9.8	22.4	26.5	17.3	15.6	16.0
B	-321	13/25	53.9	13.1	11.4	25.7	27.4	19.1	18.1	16.8
B	-333	28/24	52.1	14.0	10.2	24.9	27.1	18.0	17.3	17.5
B	-333	19/25	52.3	12.5	11.4	25.9	27.1	20.2	19.7	16.6
B	-333	19/25	53.0	13.5	12.2	25.3	28.0	17.9	15.6	15.7
B	-333	20/25	57.1	14.1	11.8	25.1	25.8	17.7	16.1	17.1
B	-333	26/25	54.9	12.5	10.0	25.3	27.3	18.9	14.5	16.5
B	-333	13/26	47.8	11.8	9.1	22.5	20.9	15.0	14.3	14.9
B	-333	35/26	54.7	14.3	10.5	23.5	28.9	18.7	16.0	16.3
B	-345	39/25	48.2	11.9	9.4	21.6	21.9	15.5	15.2	14.1
B	-345	22/26	56.8	13.7	10.5	22.8	28.0	18.2	16.3	17.4
B	-345	22/26	54.8	12.6	9.3	23.3	28.0	17.4	16.4	16.0
B	-345	23/26	52.9	13.3	10.2	22.4	27.9	17.3	16.9	16.1
B	-357	31/26	49.9	11.7	10.2	20.9	24.8	16.2	15.6	14.6
B	-357	39/26	54.0	13.8	11.2	24.9	27.5	18.8	18.5	16.2
B	-357	39/26	50.7	13.5	10.7	23.0	26.3	18.6	18.1	15.6
B	-357	23/27	47.6	11.0	9.8	19.1	21.3	14.8	13.5	13.8
B	-357	37/27	50.3	12.7	10.7	23.0	24.8	18.6	16.8	15.5
B	-357	17/28	52.6	14.2	10.6	22.8	26.0	17.0	15.1	14.7
B	-369	13/29	52.0	13.8	9.7	22.6	24.0	18.8	17.3	15.6
B	-369	14/29	45.7	10.6	8.4	18.1	20.5	14.3	12.4	13.5
B	-381	14/30	51.6	12.4	11.8	23.1	25.0	17.4	15.6	15.7
B	-381	16/30	49.4	10.0	9.6	20.3	24.4	14.5	13.6	14.2
B	-381	16/30	50.9	10.1	10.3	20.3	23.4	15.9	15.2	15.1
B	-381	17/30	47.4	10.3	8.4	17.7	22.7	14.9	13.2	14.6
B	-381	34/30	48.6	11.7	10.5	21.7	21.4	16.6	16.7	14.3
B	-381	35/30	46.5	9.9	7.2	19.3	19.6	13.8	12.3	13.5
B	-393	36/30	50.3	12.0	9.0	22.3	22.7	15.8	14.6	14.6
B	-393	34/31	50.1	12.1	8.6	22.1	24.6	16.0	14.2	14.0
B	-405	38/31	58.7	13.9	11.5	22.2	26.4	16.0	14.6	16.8
B	-405	16/32	48.1	10.1	7.8	20.2	21.9	14.0	12.3	13.7
B	-405	17/32	49.9	9.7	8.0	18.7	20.4	13.8	13.4	14.2
B	-405	34/32	50.2	12.0	10.7	21.1	22.8	15.4	13.1	14.1
B	-417	22/32	47.9	12.6	11.0	23.8	23.9	17.1	16.0	15.4
B	-417	36/32	46.8	10.7	9.0	19.7	22.4	15.9	14.7	13.2
B	-417	36/32	49.6	10.9	8.4	20.4	23.5	15.7	14.1	13.8
B	-417	13/33	53.0	13.1	8.1	23.6	23.8	16.6	15.7	15.0
B	-417	14/33	52.6	12.6	10.2	22.2	24.6	17.1	15.6	16.1
B	-417	35/33	52.7	12.3	11.4	23.0	25.6	18.8	17.4	16.3
B	-429	19/33	54.2	12.3	12.3	23.4	26.4	20.5	18.2	17.8
B	-429	14/34	55.0	13.6	10.7	24.6	27.1	17.9	17.3	16.5
B	-429	35/34	55.4	13.3	10.4	24.6	27.3	19.7	17.4	16.0
B	-429	35/34	48.3	10.8	9.8	20.4	23.1	15.5	14.3	15.1
C	-441	19/34	49.4	11.5	9.5	19.7	25.3	15.9	14.7	14.9
C	-441	19/34	47.4	10.2	8.4	19.5	22.0	15.7	14.4	14.1
C	-441	22/34	49.6	12.2	9.7	21.5	23.6	17.4	16.5	15.4
C	-441	13/35	52.3	13.5	9.7	25.5	28.8	19.4	18.1	16.9
C	-441	14/35	44.3	10.8	8.8	18.5	23.4	14.9	13.3	13.3
C	-441	17/35	55.0	12.1	11.1	24.8	25.3	17.6	16.8	17.4

continued...

Pril. 17F / Annex 17F (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
C	-441	34/35	48.8	11.1	9.5	20.6	23.8	15.3	13.3	14.5
C	-441	34/35	55.2	12.7	11.0	23.2	27.0	18.8	18.1	16.9
C	-453	14/36	46.4	10.8	8.8	18.7	22.4	14.8	12.1	13.1
C	-465	20/36	50.8	10.7	10.2	20.1	22.9	15.5	14.3	14.4
C	-465	20/36	48.1	10.4	9.9	20.6	22.5	16.1	14.5	14.3
C	–	165/13	48.0	11.1	7.9	19.1	21.9	14.9	13.7	13.4
C	–	171/13	55.0	13.4	10.5	23.9	23.0	18.0	16.1	15.1
C	–	175/13	54.4	13.0	10.7	23.9	28.5	18.0	16.4	16.8
C	–	173+179/13	51.2	11.2	9.9	21.3	23.2	16.3	14.1	14.4
C	–	179/13	54.3	13.2	10.8	21.8	26.3	17.1	13.3	14.9
C	–	180/13	53.0	11.7	11.4	23.8	26.0	19.0	17.5	16.4
C	–	180/13	55.6	11.8	10.1	22.5	25.5	18.1	17.5	17.2
C	–	182/13	48.1	10.9	9.3	19.7	24.7	15.3	14.3	14.7
C	–	188/13	52.5	13.3	10.3	21.8	25.9	18.4	16.7	17.1
C	–	192/13	53.2	12.5	10.1	22.4	25.5	17.3	15.6	15.1
C	–	192/13	49.7	10.4	8.4	22.1	24.0	16.0	15.1	14.3
C	–	202/13-14	54.6	13.3	10.5	25.4	27.0	18.0	17.6	16.3
C	–	203/13-14	50.9	12.1	9.7	21.8	25.3	17.1	15.4	15.0
C	–	204/13-14	55.1	12.3	9.5	22.2	22.5	18.0	14.6	15.2
C	–	204/13-14	47.0	12.6	10.1	21.7	21.0	16.9	16.7	15.0
C	–	168/14	46.3	10.4	8.3	20.0	22.2	15.1	14.0	13.7
C	–	170/14	57.0	13.0	11.4	24.2	29.6	18.4	17.0	17.2
C	–	170/14	47.3	11.1	8.7	18.9	20.9	15.1	13.3	13.4
C	–	174/14	52.3	12.2	10.2	21.6	26.6	16.7	15.7	14.6
C	–	178/14	58.1	13.5	10.0	25.2	28.2	17.8	17.3	16.4
C	–	180/14	61.1	13.3	11.6	24.3	24.8	18.7	16.8	16.6
C	–	180/14	49.8	10.5	8.6	20.0	23.9	16.0	14.0	13.3
C	–	184/14	53.8	14.1	11.1	25.3	28.3	18.3	17.3	16.8
C	–	187/14	53.9	14.3	11.4	23.4	27.8	17.8	17.0	17.1
C	–	188/14	52.5	12.5	9.5	23.9	24.0	17.5	15.3	15.4
C	–	188/14	55.0	13.4	10.7	25.4	29.6	19.5	17.1	16.5
C	–	188/14	50.0	10.2	8.5	17.9	21.2	15.3	14.5	14.0
C	–	190/14	58.4	12.6	10.5	24.6	29.1	17.6	16.5	16.7
Σ sample A			x = 54.0 SD = 2.93	x = 12.8 SD = 1.32	x = 10.6 SD = 0.99	x = 23.6 SD = 1.92	x = 25.7 SD = 2.80	x = 17.9 SD = 1.55	x = 16.5 SD = 1.69	x = 16.3 SD = 1.25
Σ sample B			x = 52.1 SD = 3.42	x = 12.5 SD = 1.37	x = 10.1 SD = 1.26	x = 22.8 SD = 2.38	x = 25.2 SD = 2.93	x = 17.2 SD = 1.82	x = 16.2 SD = 1.98	x = 15.6 SD = 1.33
Σ sample C			x = 51.9 SD = 3.81	x = 12.0 SD = 1.19	x = 9.9 SD = 0.99	x = 22.1 SD = 2.24	x = 25.0 SD = 2.53	x = 17.0 SD = 1.39	x = 15.5 SD = 1.60	x = 15.3 SD = 1.33
Σ all samples (A+B+C)			x = 52.6 SD = 3.48	x = 12.5 SD = 1.33	x = 10.2 SD = 1.15	x = 22.9 SD = 2.28	x = 25.3 SD = 2.80	x = 17.4 SD = 1.67	x = 16.1 SD = 1.83	x = 15.7 SD = 1.35

Pril. 17G: Seznam analiziranih drugih stopalnic s pripadajočimi metričnimi podatki.
Annex 17G: List of analysed second metatarsals with relevant metric data.

Facies	**Sediment. level (cm)**	**Square / cut**	**gL**	**sDB**	**sDH**	**pB**	**pH**	**gdB**	**dB**	**dH**
A	-44	38/1	63.4	13.1	10.0	14.9	21.1	17.9	16.7	15.5
A	-44	16/2	72.6	15.2	12.5	16.4	27.0	23.6	19.4	17.6
A	-56	39/1	64.1	14.7	11.1	16.4	24.7	20.9	18.3	16.5
A	-56	36/2	73.6	15.8	12.0	17.2	27.4	23.2	20.7	16.6
A	-56	36/2	69.4	14.7	11.4	15.4	24.7	21.1	17.5	16.5
A	-56	36/2	65.4	14.0	11.2	14.9	22.9	20.1	16.0	15.6
A	-56	35/3	70.3	16.3	12.6	16.0	26.7	23.8	19.9	17.7
A	-56	35/3	70.7	14.7	11.3	15.5	25.4	22.3	18.4	15.9
A	-56	48b/5	65.6	14.9	12.4	15.9	24.5	22.3	17.9	15.9
A	-68	19/3	67.2	13.9	10.9	13.6	22.7	19.5	16.8	14.6
A	-68	36/3	68.6	13.3	10.4	13.5	23.6	19.9	17.2	16.0
A	-68	38/3	72.6	16.5	12.7	16.1	25.8	22.8	20.3	17.6
A	-81	39/3	66.8	15.5	11.0	15.7	25.2	21.7	18.8	16.8
A	-81	19/4	70.1	14.5	11.7	15.4	26.6	21.4	18.5	17.0
A	-81	19/4	67.3	15.4	12.9	16.4	26.5	23.9	19.0	17.9
A	-81	37/4	72.1	16.4	12.1	16.2	26.9	23.3	19.7	17.4
A	-81	38/4	70.7	16.0	12.1	16.5	25.2	23.4	21.4	18.1
A	-81	38/4	70.4	16.2	12.3	16.9	23.4	22.9	19.8	17.5
A	-81	41c/7	68.8	16.9	12.7	17.5	25.8	23.8	19.3	17.1
A	-94	28/4	70.3	18.3	12.8	17.5	27.0	24.0	19.8	17.9
A	-94	36/5	75.4	16.8	12.9	16.5	27.8	24.2	20.2	18.5
A	-94	38/5	71.1	17.3	12.4	17.2	28.2	25.0	20.4	18.9
A	-94	13/6	68.8	16.4	12.7	16.3	26.8	22.9	19.7	17.4
A	-94	13/6	70.4	14.8	12.1	15.3	24.8	22.3	17.9	17.5
A	-106	48a/8	62.4	14.2	11.6	14.8	21.5	19.7	17.0	15.8
A	-117	39/6	71.3	17.5	12.7	17.6	28.5	23.3	19.3	17.9
A	-117	36/7	69.1	14.8	11.4	17.3	24.1	22.1	19.5	17.4
A	-117	41a/9	63.1	13.7	12.3	14.8	21.3	19.9	17.3	15.6
A	-117	41b/10	70.7	16.5	12.5	18.4	25.4	24.0	18.3	17.8
A	-117	55c/10	68.9	15.7	11.9	16.6	25.5	22.3	18.9	17.3
A	-129	38/8	67.8	13.6	10.7	15.6	23.2	20.6	18.1	16.8
A	-129	34/9	69.0	18.0	11.1	18.4	27.6	24.9	20.4	16.7
A	-129	48b/11	65.0	15.5	10.7	15.4	24.6	22.7	19.0	16.7
A	-141	19/9	65.9	16.6	11.5	15.5	25.4	22.0	17.8	16.1
A	-141	20/9	66.9	15.8	11.3	15.9	25.8	22.1	19.1	16.9
A	-141	36/9	65.2	15.3	10.4	15.9	25.5	22.9	19.0	16.3
A	-141	41c/12	72.0	16.0	12.6	17.7	28.6	23.9	20.5	17.7
A	-141	55b/12	76.3	15.4	12.2	17.0	28.7	24.6	20.2	17.9
A	-153	22/10	66.5	13.2	10.6	14.4	21.8	18.6	15.9	14.8
A	-165	62c/14	73.5	16.6	11.8	16.3	27.2	23.3	19.0	17.1
A	-177	31/11	70.1	15.5	12.0	15.4	24.3	21.7	18.6	16.4
A	-177	40/11	67.9	15.8	11.5	16.9	24.1	22.9	19.3	16.9
A	-177	48b/15	72.5	15.4	13.7	16.9	27.4	23.9	17.8	16.7
A	-189	31/12	59.9	12.5	10.2	13.4	21.0	18.5	15.3	14.3
A	-189	34a/15	71.3	15.8	11.2	14.3	27.3	22.1	17.9	16.6
A	-189	48b/16	68.9	15.5	12.6	15.0	26.0	20.6	17.7	16.2
A	-201	34b/17	69.1	15.4	11.0	15.7	22.1	22.1	19.1	16.6
A	-201	41b/17	70.6	16.9	12.4	16.0	26.4	23.4	19.8	17.1
A	-213	28/14	70.6	14.7	11.4	16.9	25.4	22.6	19.7	15.9
A	-213	37/15	62.4	11.9	10.1	12.4	21.4	18.7	14.8	13.6
A	-225	29/15	66.7	14.3	10.0	14.0	21.5	19.6	16.6	14.0
A	-225	19/16	64.6	12.5	10.5	13.5	20.7	17.6	15.9	14.5
A	-225	23/16	69.0	15.0	12.4	14.6	25.5	20.7	17.3	15.9
A	-225	26/16	67.7	13.3	11.4	16.3	24.2	20.4	18.2	16.3
A	-225	26/16	72.4	14.6	11.1	16.2	26.7	21.0	17.1	15.9
B	-237	48a/18	72.1	15.9	12.3	15.5	26.2	22.4	16.6	16.1
B	-237	62b/19	66.6	14.7	12.2	14.1	23.5	21.4	16.8	15.5
B	-237	29/16	62.3	13.0	9.7	13.6	22.1	18.3	15.7	14.8
B	-237	31/16	72.1	15.0	12.4	17.1	26.3	22.4	19.7	16.8
B	-237	31/16	68.4	15.9	12.0	16.7	26.0	22.6	18.2	16.4
B	-237	32/16	69.8	16.4	12.4	16.7	24.5	22.1	19.1	16.5
B	-237	32/16	74.1	16.9	13.3	16.6	27.2	22.3	19.4	17.3
B	-237	23/17	64.9	13.9	10.6	14.3	20.7	20.4	16.4	14.9
B	-237	13/18	68.0	15.2	11.0	15.9	25.0	21.5	17.8	16.5
B	-237	17/18	69.4	16.4	13.0	16.1	23.7	21.4	17.0	15.6
B	-249	41b/20	69.5	17.7	13.8	17.3	22.6	24.1	19.1	16.0

continued...

Pril. 17G / Annex 17G (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-249	29/17	66.2	12.7	10.0	13.3	24.0	18.9	15.8	15.5
B	-249	29/17	63.7	12.9	9.0	12.5	18.2	18.0	15.2	14.1
B	-249	25/18	65.1	14.7	11.6	15.0	23.6	19.3	16.7	15.4
B	-249	26/18	62.7	12.1	10.1	12.9	21.3	18.6	15.4	14.9
B	-249	13/19	70.6	15.5	12.8	16.1	24.6	22.8	19.5	16.0
B	-261	28/18	67.3	15.4	10.9	15.4	20.9	22.1	18.2	15.5
B	-261	31/18	67.5	16.8	12.2	15.2	22.3	21.4	18.3	15.4
B	-261	38/19	69.6	15.5	12.4	16.3	26.1	22.7	19.9	17.8
B	-261	13/20	63.5	14.9	11.9	17.6	26.2	22.4	18.4	16.3
B	-273	32/19	71.8	16.7	12.9	17.5	26.1	24.6	21.2	18.2
B	-273	26/20	68.3	14.4	11.3	15.4	25.7	23.0	20.0	17.2
B	-273	36/20	60.1	12.4	9.3	13.1	21.7	18.0	15.6	14.6
B	-273	14/21	64.2	16.3	12.9	15.6	26.3	22.3	19.2	15.9
B	-285	13/22	69.8	15.3	12.9	16.3	26.1	22.2	19.3	17.3
B	-297	28/21	73.9	16.7	14.2	16.8	27.2	24.7	22.2	18.5
B	-297	28/21	58.3	13.4	11.1	13.5	22.0	20.5	17.6	14.8
B	-297	32/21	67.0	14.9	11.9	15.1	26.2	21.3	18.9	16.8
B	-297	40/21	68.4	13.8	12.5	16.2	23.9	20.3	18.0	15.6
B	-297	20/22	69.6	15.1	11.7	15.4	25.1	21.4	15.5	15.5
B	-297	25/22	67.4	15.8	11.2	16.2	26.0	22.1	17.3	16.0
B	-297	13/23	68.0	14.9	11.4	16.5	25.1	22.1	19.6	16.3
B	-297	16/23	66.2	12.8	9.9	12.5	18.7	18.6	15.8	14.6
B	-297	35/23	72.0	16.0	12.0	17.6	27.3	23.3	22.8	17.8
B	-309	32/22	62.2	13.6	9.9	14.4	21.6	21.9	17.1	15.2
B	-309	20/23	69.4	15.0	12.3	14.8	23.0	20.0	17.0	16.4
B	-309	22/23	68.2	16.4	12.0	16.4	24.5	21.8	18.9	16.5
B	-309	22/23	68.6	16.1	12.0	14.7	24.9	21.3	18.7	16.4
B	-309	25/23	60.7	12.5	9.9	13.2	21.3	19.0	16.6	14.8
B	-309	37/23	70.8	15.8	12.4	16.9	26.2	22.3	19.2	16.9
B	-321	28/23	67.8	13.8	10.7	16.3	24.8	20.8	17.5	16.0
B	-321	28/23	65.9	14.8	11.0	16.2	22.9	22.5	19.5	16.4
B	-321	39/23	67.3	15.4	12.0	16.0	24.5	23.1	20.5	17.2
B	-321	39/23	67.9	15.1	10.8	14.7	25.2	21.6	18.6	15.8
B	-321	40/23	66.0	16.4	11.7	16.0	23.8	21.9	18.5	15.5
B	-321	40/23	67.1	15.0	11.0	15.6	24.5	21.9	18.5	15.6
B	-321	13/25	68.4	15.3	10.8	16.3	26.1	22.3	19.1	17.1
B	-333	25/25	64.7	15.8	12.3	16.7	24.0	22.3	18.1	16.8
B	-333	26/25	69.6	17.7	12.2	17.3	26.5	24.2	19.2	18.2
B	-333	13/26	71.2	15.3	11.9	16.9	27.0	23.0	19.3	16.6
B	-345	29/25	68.5	14.8	12.5	16.3	25.0	23.3	19.2	17.0
B	-345	31/25	62.8	14.6	9.1	13.9	23.0	19.1	14.3	14.0
B	-345	39/25	65.2	13.1	10.2	13.8	23.2	20.2	18.2	16.1
B	-345	19/26	61.4	14.1	10.4	14.4	20.0	21.8	19.0	15.7
B	-345	26/26	69.4	17.5	12.8	16.6	24.4	–	–	–
B	-357	19/27	69.7	13.7	10.9	14.1	24.0	21.4	18.4	14.8
B	-357	20/27	69.4	14.4	11.6	15.5	21.8	22.1	19.3	15.4
B	-357	23/27	72.2	16.5	12.2	15.5	24.3	23.1	18.6	16.4
B	-357	23/27	69.0	14.8	11.9	15.9	23.5	21.9	19.1	16.2
B	-357	36/27	65.7	15.0	10.7	15.9	23.5	22.1	19.4	16.0
B	-357	34/28	68.1	15.3	11.3	16.9	25.2	22.3	19.0	16.0
B	-357	35/28	66.1	15.4	10.8	14.7	25.8	23.5	21.3	16.7
B	-369	28/27	63.4	12.5	9.0	13.5	22.9	18.9	16.5	14.5
B	-369	26/28	69.8	14.7	11.5	15.1	25.1	22.1	18.5	16.0
B	-369	36/28	63.3	14.1	10.7	13.6	22.3	19.9	16.4	14.8
B	-369	13/29	70.4	15.9	11.7	17.0	22.9	23.0	19.6	16.9
B	-369	14/29	65.1	13.3	10.5	13.3	21.5	18.8	16.1	14.0
B	-369	16/29	64.2	11.4	8.9	13.5	20.0	19.1	15.4	14.7
B	-381	20/29	64.5	12.2	8.8	13.4	20.3	17.9	16.2	13.8
B	-381	14/30	71.9	13.2	10.0	15.2	25.5	22.0	16.6	16.2
B	-381	16/30	61.5	13.3	9.1	12.2	18.3	17.6	15.7	12.9
B	-381	16/30	67.1	14.0	10.9	15.5	27.6	20.7	17.1	15.7
B	-393	28/29	67.6	12.9	9.6	13.9	21.9	20.5	17.1	15.6
B	-393	25/30	63.6	12.5	8.6	14.2	21.4	18.9	16.0	14.0
B	-393	13/31	61.9	13.2	9.0	12.4	21.6	18.6	14.9	13.6
B	-393	17/31	68.9	14.0	12.5	15.1	25.4	20.9	18.0	15.4
B	-405	26/31	66.8	13.5	10.2	14.9	24.9	22.1	19.9	16.0

continued...

Pril. 17G / Annex 17G (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-405	38/31	60.8	14.7	10.0	13.7	20.6	18.8	15.4	12.6
B	-417	19/32	69.3	15.3	12.6	17.6	26.7	23.1	20.8	18.0
B	-417	22/32	68.7	16.1	11.0	16.4	24.5	23.0	19.8	16.1
B	-417	36/32	58.8	13.1	8.6	13.3	17.8	18.3	15.2	13.8
B	-417	37/32	60.2	11.5	9.0	12.2	20.2	18.7	15.8	14.0
B	-417	17/33	70.5	16.2	12.2	15.9	23.8	23.2	19.6	16.7
B	-417	34/33	71.7	15.9	11.5	16.4	25.7	22.0	18.1	16.1
B	-417	34/33	72.4	15.3	12.4	17.0	28.5	23.8	20.3	16.6
B	-429	19/33	63.7	13.6	9.7	13.6	21.2	18.7	14.6	13.6
B	-429	19/33	59.1	13.2	10.1	13.2	18.5	17.9	15.5	13.5
B	-429	13/34	64.5	13.9	10.5	15.2	24.8	20.6	17.5	15.9
B	-429	14/34	69.4	15.4	12.2	16.3	26.5	23.9	20.1	17.0
B	-429	34/34	63.7	10.9	8.6	14.1	21.3	18.0	15.0	15.0
B	-429	35/34	66.0	13.7	9.2	13.7	22.6	20.7	17.0	15.7
B	-429	35/34	68.9	15.0	11.2	16.4	25.1	22.1	19.3	17.2
C	-441	19/34	73.2	15.3	11.2	17.1	27.2	23.1	20.4	18.6
C	-441	20/34	65.8	14.5	10.1	14.5	24.4	20.4	18.4	15.7
C	-441	–	68.02	14.9	10.6	15.8	25.3	22.2	18.5	17.3
C	-441	13/35	67.4	15.8	11.7	15.9	25.0	23.7	19.8	16.1
C	-441	13/35	71.7	15.5	11.3	16.0	25.6	20.9	17.5	16.2
C	-441	17/35	58.1	11.6	8.1	13.3	21.1	17.5	14.4	13.7
C	-453	14/36	67.2	15.0	13.8	17.9	27.4	21.5	18.1	16.5
C	-453	34/36	70.0	14.5	11.5	16.4	26.1	22.1	19.1	15.9
C	-453	34/36	65.1	11.9	9.4	13.9	21.5	18.5	16.4	14.8
C	–	164/13	70.4	14.7	11.3	16.9	26.5	23.5	18.6	16.0
C	–	165/13	64.7	13.7	9.6	13.5	21.1	20.3	17.0	15.1
C	–	170/13	71.4	14.9	12.0	14.9	26.0	22.4	18.1	16.0
C	–	174/13	65.5	14.6	9.8	14.9	24.6	20.3	16.7	15.8
C	–	180/13	63.2	14.4	11.5	14.7	24.2	20.1	15.7	14.5
C	–	182/13	65.0	15.4	12.0	14.2	22.7	21.0	17.2	15.2
C	–	182/13	68.7	15.3	9.8	16.7	26.2	21.7	18.6	14.5
C	–	184/13	62.7	12.2	8.1	14.0	22.4	18.5	16.4	15.2
C	–	184a/13	63.3	12.4	7.7	13.4	18.8	17.6	15.3	14.4
C	–	188/13	61.9	13.0	8.7	13.7	21.6	18.9	16.6	14.1
C	–	188/13	59.9	12.1	9.0	13.1	21.0	19.1	16.8	14.5
C	–	190/13	61.1	13.4	9.8	13.7	21.5	19.2	17.9	15.2
C	–	202/13-14	62.4	13.3	9.4	13.7	19.6	18.6	15.5	14.4
C	–	203/13-14	71.1	16.1	11.7	16.4	24.6	22.9	18.4	16.4
C	–	204/13-14	71.7	16.8	11.7	16.1	25.5	23.7	17.9	16.6
C	–	204/13-14	71.5	15.2	10.9	14.8	26.5	22.2	19.2	16.1
C	–	204/13-14	65.2	12.4	9.2	13.4	23.1	18.6	15.7	14.7
C	–	168/14	61.3	11.9	8.7	12.2	22.4	18.7	16.8	14.1
C	–	168/14	67.8	15.7	11.3	16.6	24.1	21.7	19.4	15.6
C	–	169/14	64.8	14.1	10.7	14.1	23.4	20.1	16.9	14.7
C	–	170/14	65.5	12.7	10.0	12.6	21.9	19.8	16.2	15.0
C	–	174/14	70.7	16.3	11.3	15.0	25.3	23.5	19.6	17.7
C	–	179/14	65.0	14.4	9.0	14.2	23.2	20.5	17.5	15.0
C	–	179/14	61.8	11.2	8.4	14.2	22.8	18.0	15.6	15.2
C	–	180/14	60.1	12.8	9.6	13.6	20.7	18.7	15.6	14.8
C	–	187/14	60.8	11.2	8.4	13.1	22.0	17.9	15.3	13.4
C	–	188/14	63.3	14.0	9.7	13.5	22.6	19.6	16.8	14.0
C	–	190/14	61.7	13.6	9.7	15.0	21.9	19.1	15.9	14.7
C	–	192/14	66.7	14.6	11.8	16.0	25.0	22.9	17.7	15.6
Σ sample A			x = 68.8 SD = 3.38	x = 15.3 SD = 1.39	x = 11.7 SD = 0.88	x = 15.9 SD = 1.29	x = 25.1 SD = 2.18	x = 22.0 SD = 1.85	x = 18.5 SD = 1.47	x = 16.6 SD = 1.13
Σ sample B			x = 66.9 SD = 3.60	x = 14.6 SD = 1.47	x = 11.1 SD = 1.32	x = 15.2 SD = 1.45	x = 23.8 SD = 2.39	x = 21.2 SD = 1.82	x = 18.0 SD = 1.82	x = 15.8 SD = 1.21
Σ sample C			x = 65.7 SD = 3.99	x = 14.0 SD = 1.51	x = 10.2 SD = 1.39	x = 14.7 SD = 1.40	x = 23.5 SD = 2.19	x = 20.5 SD = 1.91	x = 17.3 SD = 1.46	x = 15.3 SD = 1.10
Σ all samples (A+B+C)			x = 67.2 SD = 3.77	x = 14.7 SD = 1.52	x = 11.1 SD = 1.32	x = 15.3 SD = 1.45	x = 24.1 SD = 2.36	x = 21.3 SD = 1.91	x = 18.2 SD = 1.70	x = 15.9 SD = 1.25

Pril. 17H: Seznam analiziranih tretjih stopalnic s pripadajočimi metričnimi podatki.
Annex 17H: List of analysed third metatarsals with relevant metric data.

Facies	**Sediment. level (cm)**	**Square / cut**	**gL**	**sDB**	**sDH**	**pB**	**pH**	**gdB**	**dB**	**dH**
A	-32	55a/2	73.5	15.8	10.9	18.3	27.7	20.8	18.4	16.5
A	-44	34b/4	83.9	17.2	13.9	20.1	31.3	23.0	19.4	17.3
A	-56	34/3	72.1	15.6	10.8	20.2	26.3	21.0	16.8	15.4
A	-68	34/4	71.7	15.1	10.6	18.6	27.0	20.6	17.8	16.0
A	-68	35/4	66.1	14.3	9.8	16.8	24.8	19.7	15.6	14.5
A	-68	41a/5	78.9	18.3	13.3	24.1	32.8	25.8	20.8	18.8
A	-81	31/3	80.2	18.2	14.0	22.6	30.9	27.8	22.1	18.2
A	-81	22/4	83.9	18.2	14.6	22.2	32.2	25.4	21.4	19.0
A	-81	16/5	81.0	19.0	13.4	23.8	32.6	23.5	20.5	18.3
A	-81	16/5	78.9	18.0	13.5	23.0	30.2	25.0	19.7	18.3
A	-81	34/5	81.6	19.1	12.3	18.8	32.8	22.5	19.9	18.6
A	-81	34a/6	76.4	16.1	11.9	20.7	27.4	22.2	19.3	15.8
A	-81	48a/6	81.7	17.5	12.0	21.5	32.1	24.4	20.1	18.7
A	-81	48c/7	78.7	18.9	13.3	25.2	30.1	24.7	20.8	17.6
A	-94	39/4	80.9	18.9	11.9	18.9	31.7	23.6	18.9	17.5
A	-94	38/5	80.9	18.3	12.1	22.3	31.4	24.1	21.0	19.3
A	-94	34c/8	81.4	19.9	14.3	27.0	33.1	25.9	21.1	19.1
A	-94	55c/8	82.7	18.4	13.6	24.9	34.2	25.5	21.8	20.5
A	-106	39/5	80.4	19.1	13.2	25.1	32.0	25.9	22.5	20.2
A	-106	41a/8	83.4	19.4	13.4	25.4	30.1	26.5	21.7	18.9
A	-106	32/6	68.6	14.5	10.4	19.2	24.8	19.4	15.7	16.2
A	-106	25/7	69.2	15.9	11.1	21.5	27.2	22.7	19.3	17.1
A	-106	13/8	80.9	19.1	13.2	25.0	30.6	25.6	20.5	19.5
A	-106	35/8	81.5	19.0	12.2	22.0	30.3	24.1	19.7	17.9
A	-129	48b/11	79.4	19.0	14.1	25.9	30.4	25.2	20.4	18.5
A	-129	48c/11	79.6	16.3	13.4	21.0	28.7	24.3	19.8	17.5
A	-129	55c/11	80.5	17.4	13.9	27.2	30.4	24.5	21.0	18.8
A	-129	62c/11	75.4	15.7	10.9	22.1	28.9	22.4	19.8	17.7
A	-141	13/10	84.6	20.1	13.8	26.6	32.9	25.7	21.9	20.1
A	-153	29/9	79.3	15.1	13.1	19.7	26.6	22.5	20.2	18.0
A	-153	32/9	78.9	15.0	12.3	17.3	24.1	20.7	16.1	15.0
A	-153	48b/13	79.5	16.7	12.5	25.0	27.3	23.7	19.5	18.5
A	-177	28/11	80.0	18.3	13.3	28.0	28.7	25.0	20.4	18.6
A	-177	32/11	71.9	14.3	11.5	17.2	26.5	20.3	16.8	16.6
A	-189	13/14	81.3	19.3	13.7	26.5	30.3	25.1	20.9	17.9
A	-189	62a/15	79.4	16.3	12.9	22.8	28.9	23.7	18.9	16.6
A	-201	41b/17	84.8	18.6	14.4	25.3	33.2	25.4	23.0	20.2
A	-201	41b/17	77.9	18.0	12.6	24.2	28.6	25.7	21.0	17.8
A	-213	28/14	78.6	16.8	11.7	22.8	28.3	25.0	19.8	18.1
A	-213	32/14	74.6	18.3	12.0	23.3	27.8	22.9	18.8	17.7
A	-213	19/15	73.4	17.4	13.6	21.5	28.1	22.5	18.1	16.7
A	-213	36/15	71.2	16.5	11.7	21.5	25.4	22.2	18.9	16.9
A	-213	17/16	73.3	15.2	10.7	20.5	27.9	20.6	17.5	15.0
A	-225	23/16	73.9	15.9	11.9	21.4	25.8	21.7	18.7	17.1
A	-225	26/16	84.7	19.2	13.9	24.6	29.7	26.2	21.4	18.7
A	-225	26/16	73.1	14.1	9.9	20.6	23.9	19.4	16.3	15.8
A	-225	26/16	75.5	18.7	11.8	22.6	28.4	23.3	19.2	17.4
B	-237	48a/18	80.3	19.0	13.1	25.5	28.6	24.9	19.8	17.6
B	-237	41b/19	73.5	15.4	10.6	18.8	23.3	19.9	15.8	14.9
B	-237	48c/19	86.2	17.4	14.7	22.6	31.9	23.9	20.8	18.7
B	-237	26/17	72.0	17.1	11.9	18.3	27.6	22.7	19.8	18.9
B	-237	26/17	75.6	15.5	12.3	20.8	27.2	22.4	20.4	17.7
B	-237	14/18	75.3	15.1	10.3	20.0	23.9	19.2	15.4	14.7
B	-237	14/18	78.0	16.9	12.8	21.4	28.3	22.0	18.2	16.9
B	-237	35/18	77.2	17.4	12.3	21.8	30.2	24.3	19.5	17.8
B	-249	34a/19	69.0	12.8	11.2	22.4	25.4	19.9	17.4	15.1
B	-249	20/18	73.0	15.3	10.9	21.2	27.7	21.7	18.6	16.6
B	-249	26/18	80.7	17.5	12.7	24.7	29.5	23.6	19.8	18.1
B	-249	38/18	67.7	15.5	10.8	18.6	24.6	21.0	18.9	14.4
B	-261	39/18	80.4	17.9	13.5	24.6	30.3	25.0	21.4	19.8
B	-273	40/19	76.0	17.9	11.7	20.2	28.1	23.1	19.3	17.8

continued...

Pril. 17H / Annex 17H (nadaljevanje / cont.)

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
B	-285	26/21	75.5	17.6	13.5	22.1	29.4	24.8	20.4	17.8
B	-285	26/21	76.4	17.8	12.6	21.4	27.5	23.2	19.2	17.1
B	-285	13/22	78.8	17.4	12.5	24.6	29.3	23.7	19.6	17.7
B	-285	13/22	77.9	17.9	14.1	21.3	31.6	24.3	22.1	18.5
B	-285	14/22	81.9	19.2	12.8	24.8	32.4	25.6	20.6	18.5
B	-285	17/22	79.3	15.6	12.7	18.8	24.3	22.1	18.3	16.6
B	-285	34/22	78.9	19.0	12.4	20.1	29.3	23.3	19.2	18.4
B	-285	34/22	69.8	14.5	11.5	20.2	24.9	21.0	18.2	16.4
B	-297	28/21	78.8	18.2	11.7	24.2	28.9	24.3	19.2	17.8
B	-297	39/21	65.4	15.6	11.2	19.4	27.2	22.6	18.5	15.7
B	-297	40/21	75.9	16.5	11.9	20.9	27.3	22.1	19.8	16.8
B	-297	20/22	78.3	17.6	13.2	22.7	29.4	23.4	19.1	17.6
B	-297	22/22	75.6	18.5	12.3	22.5	29.2	22.6	19.0	18.2
B	-309	40/22	73.4	16.5	11.9	21.9	29.3	22.9	20.2	17.3
B	-309	22/23	77.2	17.6	12.4	19.0	30.0	23.4	19.2	17.7
B	-309	23/23	80.5	17.4	12.7	26.5	32.2	25.0	21.1	18.2
B	-309	25/23	72.3	17.0	11.6	22.8	25.7	23.1	18.8	16.2
B	-309	37/23	73.5	15.4	12.1	19.5	27.0	23.9	20.3	18.0
B	-321	40/23	84.2	17.5	14.4	20.8	31.8	25.1	21.2	20.5
B	-321	19/24	79.2	17.5	12.3	24.9	28.1	25.1	20.2	18.6
B	-321	37/24	80.5	17.8	13.0	21.8	27.9	23.4	19.1	15.9
B	-333	32/24	72.2	17.5	11.9	23.9	27.9	23.4	19.3	17.8
B	-333	39/24	73.8	18.4	11.7	20.7	29.3	24.0	19.7	18.0
B	-333	39/24	80.3	18.1	13.2	25.0	29.5	24.7	19.9	16.3
B	-333	40/24	79.9	17.6	11.8	22.5	27.9	25.2	18.9	19.0
B	-333	20/25	80.2	16.7	14.1	22.5	29.5	23.9	20.4	17.5
B	-333	25/25	74.7	18.9	12.3	20.7	25.6	23.0	18.4	17.1
B	-333	26/25	69.8	15.4	9.8	19.6	24.8	20.2	16.7	14.9
B	-345	29/25	78.6	17.2	11.2	19.9	30.4	23.3	20.3	16.0
B	-345	31/25	77.0	16.4	11.1	20.5	27.3	21.2	19.2	17.6
B	-345	39/25	80.3	19.4	12.9	22.9	30.4	25.3	21.1	19.5
B	-345	23/26	81.3	17.3	12.5	24.7	31.0	24.5	22.3	17.4
B	-345	25/26	70.1	14.1	10.0	21.9	23.0	21.5	17.9	16.1
B	-345	38/26	82.9	18.2	12.6	20.6	30.4	24.0	21.0	18.7
B	-345	38/26	66.4	15.5	11.7	18.7	27.9	22.1	19.0	17.0
B	-345	16/27	78.2	18.8	12.5	23.1	28.4	24.0	21.1	18.4
B	-345	17/27	75.3	16.5	12.9	17.0	28.0	22.6	19.4	17.5
B	-357	36/27	67.0	15.0	10.9	17.0	25.1	21.1	17.3	16.0
B	-357	37/27	80.4	17.2	13.2	19.0	28.0	24.2	19.7	17.9
B	-357	16/28	75.0	16.6	11.1	21.5	28.7	22.2	18.6	17.0
B	-369	28/27	73.0	16.2	11.1	16.7	25.0	21.8	17.2	16.0
B	-369	29/27	72.1	15.6	10.9	20.6	28.0	21.3	17.5	16.0
B	-369	40/27	82.9	15.6	10.8	19.9	25.8	20.0	17.7	15.8
B	-369	40/27	71.3	15.7	10.7	19.6	23.5	20.5	17.0	14.8
B	-369	13/29	77.3	17.9	12.7	18.5	24.9	21.0	16.8	15.8
B	-369	16/29	79.9	17.1	12.0	21.5	29.3	23.4	19.0	17.3
B	-369	16/29	71.9	15.3	10.3	18.4	25.8	20.3	17.0	14.9
B	-369	16/29	75.0	14.7	11.4	17.5	26.6	20.1	17.3	15.1
B	-381	26/29	69.5	15.1	10.8	16.3	24.6	21.0	18.2	16.3
B	-381	35/30	83.1	18.9	12.7	26.5	33.5	24.3	22.9	19.8
B	-393	25/30	70.4	14.7	9.6	20.3	24.6	21.0	16.5	16.1
B	-393	14/31	68.9	14.8	10.2	18.5	23.6	19.5	15.8	13.5
B	-393	16/31	72.7	13.7	9.9	16.0	25.9	18.4	15.0	13.7
B	-393	17/31	82.4	17.0	11.8	21.9	26.9	23.4	18.2	16.2
B	-393	35/31	79.2	17.4	11.0	20.4	26.8	22.8	19.6	17.2
B	-405	36/31	71.3	16.4	12.0	21.3	26.1	21.5	18.6	16.3
B	-405	35/32	67.1	14.2	10.1	19.1	24.8	19.7	16.1	14.2
B	-417	36/32	80.2	15.6	11.8	19.9	27.2	23.6	18.6	16.1
B	-417	35/33	70.4	15.6	11.4	22.0	25.7	20.8	17.6	16.3
B	-417	25/33	72.3	14.3	10.1	22.0	24.9	20.7	17.5	16.0
B	-429	16/34	77.9	16.7	10.9	20.6	27.1	22.9	18.6	16.7
B	-429	17/34	78.7	17.2	12.8	25.4	29.9	23.6	20.1	18.3
C	-441	13/35	77.3	18.3	11.9	22.4	27.1	24.0	19.1	17.0
C	-441	13/35	79.1	16.6	12.8	22.7	30.9	24.8	20.7	19.0
C	-441	34/35	73.4	17.4	11.7	19.8	25.4	21.2	19.1	16.3
C	-441	34/35	78.2	16.0	12.8	24.0	30.8	23.6	20.1	17.9

continued...

Pril. 17H / Annex 17H (nadaljevanje / cont.)

Facies	**Sediment. level**	**Square / cut**	**gL**	**sDB**	**sDH**	**pB**	**pH**	**gdB**	**dB**	**dH**
C	-453	19/35	71.0	14.7	11.2	18.0	25.4	20.5	18.2	15.8
C	-453	20/35	72.9	16.2	10.8	19.6	27.2	20.6	19.2	16.2
C	-465	20/36	76.2	16.8	11.3	23.9	27.4	21.9	19.7	17.7
C	–	155-157/13	74.1	17.0	12.4	22.8	28.2	22.8	19.9	15.5
C	–	163/13	69.5	13.9	9.8	19.7	23.3	19.2	16.6	14.1
C	–	167/13	69.4	15.0	9.5	19.2	23.0	21.4	17.3	14.9
C	–	169/13	79.6	17.5	12.4	22.6	27.3	23.7	19.3	16.7
C	–	169/13	65.6	14.4	10.1	18.3	22.7	20.9	17.1	14.8
C	–	179/13	77.9	15.4	12.7	22.1	28.0	21.2	17.3	16.5
C	–	180/13	79.4	16.6	11.9	18.1	26.1	20.9	18.0	15.9
C	–	180/13	82.6	16.4	11.7	20.4	26.8	22.2	18.0	16.2
C	–	181/13	78.8	17.8	12.6	22.5	27.2	23.3	19.6	17.0
C	–	181/13	68.0	14.4	10.0	20.9	25.3	20.9	17.8	15.4
C	–	182/13	74.1	17.0	11.7	22.8	28.3	22.6	19.7	17.5
C	–	184/13	73.1	14.5	9.7	23.0	25.6	20.5	18.5	15.8
C	–	189/13	72.9	15.8	12.0	21.0	25.8	21.6	17.8	16.2
C	–	189/13	78.5	16.3	12.3	22.8	27.8	23.1	18.0	16.4
C	–	189/13	83.8	16.8	12.1	24.2	26.4	22.4	18.3	16.3
C	–	190/13	72.1	13.8	10.3	20.5	25.3	18.9	16.0	15.4
C	–	190/13	71.0	15.0	10.5	22.9	22.6	20.6	17.5	15.1
C	–	192/13	68.9	13.7	9.7	22.5	23.8	18.8	16.2	14.8
C	–	192/13	79.2	18.4	13.4	23.2	29.1	26.0	22.1	17.2
C	–	193/13	74.4	15.3	9.6	20.6	24.2	21.3	17.8	15.2
C	–	203/13-14	78.1	16.3	11.5	23.8	27.3	22.0	18.4	15.8
C	–	204/13-14	74.2	15.0	10.9	21.8	25.6	21.7	18.0	16.3
C	–	167/14	72.5	15.0	10.8	18.1	23.9	21.2	17.1	15.1
C	–	168/14	80.1	18.0	12.6	21.2	27.7	23.0	19.4	16.6
C	–	170/14	77.7	16.4	11.0	18.3	26.6	22.9	19.2	16.4
C	–	170/14	71.3	14.5	8.9	20.4	22.9	20.0	16.5	16.7
C	–	173/14	71.8	13.8	8.5	18.3	23.2	19.7	13.9	14.0
C	–	174/14	80.6	16.7	11.9	23.7	27.0	23.0	19.2	16.7
C	–	184/14	69.4	12.5	8.9	20.3	24.7	18.7	16.2	15.3
C	–	187/14	69.6	15.4	9.8	20.1	23.6	21.1	16.5	15.0
C	–	188/14	81.3	17.5	13.6	22.5	32.1	25.2	21.4	18.2
C	–	189/14	81.7	17.2	13.0	22.7	30.4	24.4	20.6	17.9
C	–	189/14	72.8	15.2	10.6	21.4	25.7	21.5	18.1	16.5
C	–	190/14	80.3	17.4	12.3	21.0	28.3	23.7	19.1	16.9
C	–	192/14	77.5	15.9	11.3	20.6	28.9	22.4	18.4	17.6
Σ sample A			x = 78.1 SD = 4.62	x = 17.4 SD = 1.70	x = 12.5 SD = 1.27	x = 22.4 SD = 2.85	x = 29.2 SD = 2.67	x = 23.6 SD = 2.10	x = 19.6 SD = 1.79	x = 17.7 SD = 1.43
Σ sample B			x = 75.9 SD = 4.73	x = 16.7 SD = 1.45	x = 11.9 SD = 1.13	x = 21.1 SD = 2.41	x = 27.7 SD = 2.41	x = 22.6 SD = 1.72	x = 19.0 SD = 1.62	x = 17.0 SD = 1.46
Σ sample C			x = 75.2 SD = 4.53	x = 15.9 SD = 1.41	x = 11.2 SD = 1.31	x = 21.3 SD = 1.84	x = 26.4 SD = 2.37	x = 21.9 SD = 1.73	x = 18.3 SD = 1.58	x = 16.2 SD = 1.11
Σ all samples (A+B+C)			x = 76.3 SD = 4.76	x = 16.7 SD = 1.60	x = 11.9 SD = 1.30	x = 21.5 SD = 2.47	x = 27.8 SD = 2.68	x = 22.7 SD = 1.93	x = 19.0 SD = 1.72	x = 17.0 SD = 1.47

Pril. 17I: Seznam analiziranih četrtih stopalnic s pripadajočimi metričnimi podatki.
Annex 17I: List of analysed fourth metatarsals with relevant metric data.

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
A	-32	48a/2	76.7	14.0	11.8	18.3	23.0	20.0	17.2	15.8
A	-56	38/2	90.7	17.0	14.4	19.6	31.0	25.0	21.8	17.8
A	-68	37/3	89.3	16.2	15.1	24.1	29.9	25.8	23.7	18.8
A	-68	38/3	83.7	16.4	13.3	19.9	33.0	23.1	20.0	16.7
A	-81	32/3	93.6	19.6	14.8	24.1	33.3	25.3	19.3	19.8
A	-81	25/4	80.8	15.9	12.2	22.3	29.4	21.6	19.0	17.6
A	-81	48b/7	90.1	18.0	16.3	22.2	32.3	26.9	23.9	19.6
A	-94	35/6	92.9	16.8	16.1	21.4	31.6	24.3	22.3	18.4
A	-94	48b/8	82.0	15.9	13.7	20.8	29.8	24.6	21.5	18.3
A	-106	35/7	88.1	18.4	14.8	21.0	31.1	26.3	24.7	19.4
A	-106	48c/9	89.1	17.8	15.0	21.5	28.8	23.4	20.0	18.4
A	-106	55b/9	95.0	18.2	14.3	23.0	33.9	26.9	21.8	19.8
A	-117	13/8	86.7	18.3	13.7	23.9	32.2	25.1	22.0	19.2
A	-117	48a/9	88.8	17.0	13.1	21.5	32.3	22.1	18.3	18.1
A	-117	41c/10	92.9	18.8	15.8	23.8	32.0	27.2	23.4	20.7
A	-117	55b/10	76.2	14.6	12.9	18.5	27.4	21.8	19.2	16.2
A	-129	16/9	92.8	18.9	15.0	22.0	31.6	24.5	21.6	19.1
A	-141	36/9	92.0	17.3	13.7	23.5	31.6	25.1	21.8	20.4
A	-141	34/10	87.4	17.7	14.8	20.5	28.2	24.9	22.4	18.1
A	-153	34c/13	89.0	18.9	12.9	23.4	31.5	25.6	22.7	19.8
A	-165	48c/14	83.1	16.4	11.7	20.1	27.0	21.1	18.2	18.2
A	-177	20/12	77.2	14.3	12.1	18.8	23.2	19.1	17.2	16.4
A	-177	16/13	90.5	17.1	15.1	22.3	30.1	26.0	23.3	19.3
A	-177	41b/15	86.0	17.6	15.4	24.4	31.2	27.8	24.5	20.1
A	-213	28/14	88.4	17.1	13.6	21.9	29.7	25.8	22.8	18.8
A	-213	29/14	88.5	17.1	15.0	18.5	24.0	23.1	19.6	17.5
A	-213	32/14	90.1	17.1	13.8	20.7	28.4	24.2	19.4	18.5
A	-213	38/15	84.7	16.8	12.4	20.7	24.1	22.1	18.5	17.6
A	-213	35/16	75.4	16.4	12.1	19.1	27.2	22.8	18.9	16.0
A	-225	32/15	83.0	14.3	13.5	21.0	26.6	22.7	20.5	17.7
A	-225	39/15	78.1	14.4	12.7	21.2	27.6	19.7	17.1	16.2
A	-225	19/16	90.8	17.7	13.5	22.6	31.5	24.7	21.9	18.8
A	-225	22/16	78.7	14.2	13.1	17.9	26.1	22.0	19.2	17.2
B	-237	41a/18	80.3	16.8	12.3	20.1	25.8	22.8	20.2	16.9
B	-237	41b/19	91.8	18.0	13.7	23.9	31.4	25.5	22.4	19.4
B	-237	25/17	85.8	16.9	12.2	23.3	27.9	23.7	21.5	16.8
B	-237	25/17	89.6	19.9	14.6	22.9	27.4	25.3	21.8	18.1
B	-237	26/17	90.3	16.5	14.8	21.0	30.0	23.3	21.2	18.0
B	-237	26/17	93.5	18.1	13.3	23.0	27.7	24.7	20.4	18.1
B	-249	23/18	81.3	17.7	13.8	21.1	26.4	23.6	19.3	17.9
B	-249	36/18	89.5	17.6	13.8	26.0	30.5	24.2	23.4	19.9
B	-249	13/19	80.2	18.1	12.9	21.0	24.5	24.0	20.2	16.7
B	-261	55a/20	77.8	14.2	11.8	19.1	25.0	20.6	15.7	15.9
B	-261	34b/21	87.7	18.5	13.4	22.8	27.5	23.3	19.1	17.8
B	-261	28/18	90.1	17.7	14.9	22.4	31.3	24.4	21.7	17.5
B	-261	32/18	90.1	18.0	14.6	21.9	31.1	26.4	23.6	19.4
B	-261	20/19	73.0	14.7	12.4	18.8	23.6	21.4	16.7	15.2
B	-261	20/19	92.6	18.5	14.5	23.9	30.1	26.2	21.8	18.2
B	-261	36/19	87.8	17.8	14.2	22.4	30.3	25.4	22.6	19.8
B	-273	19/20	84.3	17.0	14.0	22.9	29.4	23.6	22.5	18.8
B	-273	17/21	86.8	17.6	12.9	21.4	31.1	25.2	22.1	18.3
B	-285	32/20	83.3	19.4	13.3	24.7	25.2	23.2	17.7	17.1
B	-285	39/20	94.3	19.0	16.4	22.4	34.0	27.4	24.8	21.0
B	-285	39/20	83.5	17.3	14.6	20.9	29.0	25.3	21.2	17.4
B	-285	19/21	89.4	17.8	13.4	21.6	30.2	25.9	21.8	18.8
B	-285	34/22	79.8	16.0	13.0	20.9	28.3	23.4	19.0	17.6
B	-297	39/21	78.2	16.2	11.9	21.2	25.9	22.5	18.8	17.1
B	-309	28/22	81.7	18.9	13.2	24.3	31.1	24.6	20.5	19.5
B	-309	20/23	83.0	15.7	12.0	19.5	27.5	22.8	19.9	17.7
B	-309	26/23	83.2	18.1	13.5	21.2	28.7	24.7	21.4	18.2
B	-309	37/23	86.9	19.4	13.5	23.0	32.6	26.7	23.7	20.4
B	-309	34/24	90.5	18.1	15.5	23.3	32.2	26.2	21.7	20.1
B	-321	40/23	84.7	16.7	13.0	22.0	29.4	23.2	20.1	18.5
B	-321	40/23	83.1	15.4	12.1	18.3	27.9	21.7	18.0	17.6
B	-321	37/24	86.0	16.2	13.5	21.4	32.4	25.9	23.0	19.7
B	-321	37/24	94.9	18.9	13.7	21.3	30.6	24.0	19.2	18.7

continued...

Pril. 17I / Annex 17I (nadaljevanje / cont.)

Facies	**Sediment. level (cm)**	**Square / cut**	**gL**	**sDB**	**sDH**	**pB**	**pH**	**gdB**	**dB**	**dH**
B	-321	14/25	87.2	18.0	14.7	24.0	29.5	26.3	22.1	19.7
B	-333	19/25	85.5	17.1	13.7	22.9	33.2	25.5	20.1	19.9
B	-333	23/25	87.6	18.1	13.1	23.8	28.6	24.0	22.2	18.5
B	-333	25/25	75.3	14.8	11.9	18.8	27.1	22.9	20.0	17.4
B	-333	26/25	75.9	14.0	11.5	18.0	26.7	21.4	18.7	16.2
B	-333	26/25	91.0	19.6	13.8	25.1	32.8	27.5	23.2	21.4
B	-345	40/25	80.1	15.4	12.4	20.0	26.8	21.1	17.6	16.5
B	-345	40/25	78.2	15.5	13.0	19.2	25.7	22.5	20.1	16.2
B	-345	38/26	79.8	14.9	10.9	17.5	26.7	20.2	18.9	16.5
B	-357	39/26	76.5	13.2	11.6	16.5	24.8	19.1	16.1	15.0
B	-357	40/26	85.8	17.4	12.9	21.8	31.0	25.5	22.5	17.0
B	-369	19/28	79.2	14.6	11.7	20.8	27.8	21.8	19.6	17.6
B	-369	22/28	75.3	15.1	10.5	17.6	23.3	19.2	16.2	14.8
B	-369	25/28	86.5	16.8	15.0	21.3	28.7	26.4	22.0	17.9
B	-369	17/29	80.6	14.8	10.9	19.6	25.9	20.2	17.0	15.7
B	-381	20/29	87.2	17.0	13.3	22.2	31.6	24.9	23.0	19.5
B	-381	22/29	75.9	14.1	11.7	19.2	27.9	20.5	18.6	16.4
B	-381	14/30	80.3	15.5	11.2	19.4	26.6	23.3	20.5	17.1
B	-381	35/30	75.3	13.5	11.2	19.5	24.5	21.0	17.6	16.4
B	-393	17/31	79.7	15.0	11.9	16.8	26.6	21.2	18.2	16.5
B	-393	17/31	76.1	13.3	11.1	18.5	23.5	20.4	15.7	15.2
B	-405	36/31	76.9	13.8	11.0	18.5	25.0	21.0	16.9	14.5
B	-405	16/32	71.7	13.7	10.7	17.1	22.9	17.1	13.7	14.5
B	-405	35/32	80.9	13.8	12.6	19.7	26.0	21.3	18.4	16.2
B	-417	37/32	96.0	19.0	13.5	24.6	32.9	23.7	21.2	20.5
B	-417	29/31	84.9	18.2	14.4	21.1	30.3	25.8	22.7	18.4
B	-417	13/33	87.5	16.9	15.2	23.6	32.3	26.2	23.1	20.7
B	-429	35/34	74.9	15.6	11.8	18.6	25.6	21.7	18.2	16.5
C	-441	20/34	79.0	14.9	13.3	17.6	23.4	21.6	20.8	16.8
C	-441	22/34	84.2	17.3	12.3	22.2	26.4	23.2	20.0	17.9
C	-441	34/35	82.3	15.6	12.6	20.6	26.5	23.5	20.1	17.9
C	-453	14/36	78.2	15.0	10.9	19.3	24.3	22.3	19.2	16.6
C	-453	16/36	98.5	18.9	14.1	24.2	30.1	27.3	22.2	18.8
C	–	163/13	89.1	16.0	13.3	22.5	24.2	23.5	19.8	16.7
C	–	164/13	78.2	14.6	10.8	23.2	23.5	20.8	19.1	16.7
C	–	165/13	87.5	16.2	12.3	24.0	25.7	23.3	20.3	17.4
C	–	168/13	78.0	14.2	11.2	25.3	22.9	19.0	17.8	15.6
C	–	171/13	76.0	14.3	11.0	25.5	23.0	20.9	19.4	16.7
C	–	175/13	88.1	17.7	13.2	22.7	27.5	26.6	22.9	18.3
C	–	179/13	81.7	16.0	13.4	23.3	26.9	23.3	20.3	17.6
C	–	180/13	76.6	14.3	10.5	21.2	21.1	19.6	17.5	15.3
C	–	180/13	73.8	14.7	11.6	23.1	21.8	20.4	15.7	14.5
C	–	182/13	75.9	14.5	10.1	22.6	23.1	21.2	17.6	15.8
C	–	189/13	77.5	14.3	10.7	18.4	21.9	19.6	16.3	14.4
C	–	189/13	78.4	15.6	10.8	26.1	24.6	21.5	19.9	17.5
C	–	203/13-14	88.9	16.7	15.3	22.9	32.3	26.1	23.6	19.6
C	–	204/13-14	99.8	18.2	13.5	26.9	30.0	26.7	24.3	20.6
C	–	204/13-14	81.6	18.9	13.0	23.4	27.6	25.2	22.1	18.3
C	–	167/14	89.9	18.3	12.3	24.3	30.8	25.8	20.7	18.1
C	–	168/14	79.0	15.2	11.5	19.8	21.7	19.7	14.9	13.9
C	–	170/14	87.8	16.5	11.9	25.5	27.8	24.4	20.6	16.9
C	–	171/14	86.2	17.2	13.6	23.8	27.4	24.9	22.1	18.6
C	–	174/14	76.0	15.6	9.7	21.1	22.6	21.5	18.7	16.6
C	–	179/14	78.3	16.0	9.7	25.9	22.4	22.1	18.9	16.3
C	–	181/14	77.6	14.2	10.7	21.7	25.4	21.4	19.2	16.7
C	–	187/14	81.2	17.7	12.2	26.3	28.3	24.1	20.5	17.2
C	–	189/14	92.2	18.9	14.0	28.7	29.5	26.5	23.1	19.8
C	–	191/14	90.8	18.4	13.2	29.2	27.9	26.6	23.5	19.9
C	–	191/14	76.9	15.2	11.5	19.3	23.7	22.0	20.4	16.3
C	–	192/14	83.7	15.7	11.7	21.6	25.3	23.2	20.7	16.7
C	–	192/14	96.7	18.0	14.0	31.6	28.5	24.6	20.9	18.2
Σ sample A			x = 86.4 SD = 5.65	x = 16.8 SD = 1.51	x = 13.9 SD = 1.28	x = 21.3 SD = 1.86	x = 29.4 SD = 3.00	x = 24.0 SD = 2.24	x = 20.8 SD = 2.21	x = 18.3 SD = 1.33
Σ sample B			x = 83.7 SD = 5.99	x = 16.6 SD = 1.82	x = 13.0 SD = 1.34	x = 21.1 SD = 2.26	x = 28.4 SD = 2.85	x = 23.5 SD = 2.29	x = 20.2 SD = 2.40	x = 17.8 SD = 1.69
Σ sample C			x = 83.3 SD = 7.02	x = 16.2 SD = 1.57	x = 12.1 SD = 1.41	x = 23.4 SD = 3.11	x = 25.7 SD = 2.99	x = 23.1 SD = 2.39	x = 20.1 SD = 2.23	x = 17.2 SD = 1.57
Σ all samples (A+B+C)			x = 84.3 SD = 6.27	x = 16.6 SD = 1.68	x = 13.0 SD = 1.48	x = 21.8 SD = 2.60	x = 27.9 SD = 2.23	x = 23.5 SD = 2.31	x = 20.3 SD = 2.31	x = 17.8 SD = 1.61

Pril. 17J: Seznam analiziranih petih stopalnic s pripadajočimi metričnimi podatki.
Annex 17J: List of analysed fifth metatarsals with relevant metric data.

Facies	Sediment. level (cm)	Square / cut	gL	sDB	sDH	pB	pH	gdB	dB	dH
A	-44	36/1	83.1	14.2	13.3	26.4	33.3	26.9	23.8	19.4
A	-56	48a/4	82.8	13.3	13.2	25.7	31.7	23.3	21.5	16.4
A	-68	38/3	93.6	16.5	14.3	31.1	33.9	26.2	23.7	20.7
A	-68	17/4	78.9	12.1	12.1	25.6	28.7	20.8	19.8	16.7
A	-68	35/4	90.7	15.1	14.5	26.0	32.7	24.4	19.4	18.4
A	-68	41a/5	94.7	14.1	14.0	26.9	30.0	25.9	21.4	20.5
A	-68	–	92.91	15.6	15.3	32.3	35.8	24.8	23.3	19.6
A	-68	48c/6	79.3	12.4	11.6	27.1	26.6	23.9	20.6	16.8
A	-81	41a/6	85.8	13.2	11.7	24.7	28.6	23.0	20.3	17.4
A	-81	48b/7	87.7	15.4	14.1	30.5	32.3	27.1	23.2	18.6
A	-81	48c/7	97.1	16.1	14.2	32.5	37.6	28.0	24.8	20.3
A	-94	39/4	80.4	12.1	10.8	23.5	26.4	22.0	19.7	16.2
A	-94	41a/7	87.3	15.2	12.7	31.6	31.9	23.2	21.6	18.5
A	-117	48b/10	89.1	15.2	15.0	30.0	34.2	26.9	22.9	18.6
A	-129	16/9	87.7	14.5	14.0	28.9	31.6	22.9	22.7	20.0
A	-129	41c/11	89.4	16.0	13.3	30.8	32.2	28.3	24.5	19.5
A	-129	41c/11	88.2	16.6	15.7	35.5	34.7	30.3	27.7	20.6
A	-129	48b/11	85.0	14.2	13.3	26.0	34.0	21.1	19.7	17.4
A	-141	17/10	80.6	13.9	12.0	22.2	22.6	22.1	21.0	18.1
A	-141	35/10	97.7	17.4	13.3	34.0	36.9	26.1	24.5	20.7
A	-141	35/10	88.0	15.5	14.8	30.0	29.7	25.4	24.3	18.4
A	-141	48b/12	90.8	15.4	13.9	33.1	34.6	27.3	24.8	18.2
A	-141	55b/12	92.6	16.2	14.8	26.7	34.5	24.1	22.9	17.7
A	-153	26/10	83.6	15.5	16.1	27.6	29.3	28.2	25.9	17.9
A	-153	48a/12	86.1	16.2	14.1	30.4	32.7	25.2	24.1	17.4
A	-153	34b/13	88.9	15.3	13.6	33.7	35.4	23.7	23.2	20.5
A	-165	28/10	85.2	15.6	12.5	25.9	29.3	24.4	20.8	17.7
A	-201	29/13	84.5	14.5	13.0	29.6	32.1	24.7	24.0	17.4
A	-201	40/13	86.2	15.2	13.8	30.3	32.1	25.0	23.2	18.5
A	-213	28/14	95.4	14.2	12.7	29.9	33.8	25.7	23.9	18.3
A	-213	36/15	97.3	15.3	14.8	33.5	37.5	28.1	26.7	19.4
A	-213	37/15	77.7	13.2	11.4	23.9	27.6	21.5	20.2	16.7
A	-225	40/15	77.0	12.6	10.4	17.8	22.6	18.6	17.4	15.7
A	-225	26/16	80.5	12.3	12.8	26.4	25.0	21.6	18.9	15.9
A	-225	13/17	97.5	17.2	14.5	34.8	35.2	27.9	27.5	20.3
B	-237	26/17	90.7	17.3	15.2	29.5	32.1	28.6	25.5	19.0
B	-249	55c/20	88.4	15.4	13.1	30.1	32.6	25.3	23.1	17.6
B	-249	29/17	87.0	15.6	12.5	26.6	27.8	24.6	20.5	17.3
B	-249	32/17	98.4	14.2	14.3	30.7	34.4	24.5	24.6	18.4
B	-249	40/17	95.5	16.4	15.5	33.6	34.7	27.4	24.2	19.2
B	-249	36/18	80.0	14.4	11.2	27.0	28.9	22.0	21.9	15.8
B	-249	35/19	90.3	16.7	15.6	33.6	36.1	26.1	23.4	18.9
B	-261	55a/20	82.6	14.1	12.3	25.7	33.7	23.1	21.4	17.2
B	-261	25/19	86.6	14.1	13.5	30.5	30.1	25.1	21.3	18.6
B	-261	38/19	90.7	17.3	14.8	32.0	33.7	26.1	23.5	18.5
B	-273	28/19	79.2	16.6	14.7	30.1	32.4	25.1	24.5	18.2
B	-273	31/19	82.8	17.2	14.3	31.4	33.2	27.4	26.4	18.5
B	-273	31/19	76.8	13.1	11.4	23.6	27.0	21.6	19.3	16.6
B	-273	14/21	86.7	17.7	12.9	32.6	31.8	28.8	24.3	17.4
B	-273	17/21	81.3	14.9	11.7	25.9	23.6	25.8	22.2	17.8
B	-285	23/21	91.3	15.8	14.6	32.7	34.5	26.7	25.1	19.2
B	-285	25/21	96.7	14.9	16.4	36.1	34.0	28.9	27.3	20.6
B	-297	32/21	88.9	14.8	13.6	29.9	33.9	25.7	23.4	18.0
B	-297	32/21	93.1	16.9	15.2	31.6	31.5	27.4	24.6	19.0
B	-309	29/22	84.2	15.5	13.8	32.7	35.3	26.8	25.6	18.4
B	-321	40/23	85.3	13.8	12.0	25.5	28.0	21.8	21.0	17.3
B	-321	40/23	87.7	15.8	14.3	33.2	34.6	27.1	23.9	18.4
B	-321	23/24	80.4	13.5	11.1	25.4	26.6	23.8	21.6	15.3
B	-321	25/24	81.8	13.5	12.3	26.3	31.1	23.1	20.9	17.8
B	-333	35/25	91.8	14.6	15.4	31.5	34.3	25.8	24.2	17.1
B	-333	29/24	79.8	13.7	12.0	29.3	27.3	24.5	23.0	16.8
B	-333	32/24	78.3	13.5	12.8	25.9	26.8	22.2	22.6	16.7
B	-333	39/24	82.2	15.3	12.9	30.4	27.3	24.5	20.4	17.0
B	-333	19/25	80.3	12.9	12.0	21.8	26.0	19.6	16.8	15.4
B	-333	26/25	90.3	16.4	15.5	34.4	33.9	27.5	23.6	20.3
B	-333	26/25	87.3	12.9	11.6	28.6	32.8	24.5	23.2	17.3

continued...

Pril. 17J / Annex 17J (nadaljevanje / cont.)

Facies	**Sediment. level (cm)**	**Square / cut**	**gL**	**sDB**	**sDH**	**pB**	**pH**	**gdB**	**dB**	**dH**
B	-333	26/25	87.3	14.5	12.5	30.0	30.8	26.5	24.4	17.8
B	-333	26/25	84.8	14.6	12.9	30.6	30.3	25.5	21.9	17.7
B	-333	36/25	75.6	13.5	12.2	24.1	26.3	22.3	21.4	16.5
B	-345	32/25	94.3	16.6	16.3	35.1	35.7	28.2	27.8	19.1
B	-345	39/25	90.1	14.3	13.6	29.6	34.7	27.4	23.0	18.7
B	-345	40/25	78.0	13.8	12.6	26.0	27.6	22.8	21.6	17.6
B	-345	14/27	89.5	14.3	14.3	31.0	32.8	23.6	22.1	17.6
B	-345	17/27	78.1	12.0	10.7	26.3	28.6	21.4	18.7	16.0
B	-345	35/27	90.9	15.3	14.2	30.5	34.5	28.1	26.5	20.2
B	-357	39/26	81.2	13.6	11.8	24.2	29.7	23.2	21.0	16.7
B	-357	40/26	85.1	14.6	14.7	28.0	30.6	23.8	22.9	17.3
B	-357	40/26	81.8	14.7	11.8	29.9	33.6	23.2	23.6	16.3
B	-357	40/26	78.4	13.0	11.2	25.5	27.7	23.2	23.4	16.9
B	-357	37/27	89.2	13.6	13.4	31.9	32.4	25.8	23.0	19.0
B	-357	13/28	74.6	12.0	11.7	25.0	26.0	21.7	18.9	15.8
B	-357	13/28	86.6	15.5	14.8	33.1	35.0	25.7	24.7	18.1
B	-357	13/28	83.6	14.2	12.7	30.2	29.4	28.0	23.5	18.9
B	-369	40/27	92.0	14.4	15.0	31.0	32.0	27.4	23.8	18.2
B	-369	36/28	88.8	17.4	15.7	34.1	35.7	28.5	25.3	19.0
B	-369	37/28	80.8	12.9	12.4	24.9	24.8	22.5	20.5	16.4
B	-369	13/29	84.6	14.5	13.4	31.4	32.5	23.8	20.8	17.1
B	-369	17/29	87.9	17.3	13.1	24.7	31.3	25.8	21.7	18.0
B	-381	32/28	83.7	13.7	14.2	28.0	28.3	25.4	22.3	17.6
B	-381	13/30	75.1	12.4	11.0	25.1	28.8	22.7	19.3	16.4
B	-381	14/30	81.8	12.8	10.5	26.3	27.3	23.2	21.1	16.7
B	-381	14/30	80.9	13.2	10.6	24.5	26.4	21.5	19.4	16.1
B	-393	39/29	74.5	13.5	13.5	24.0	28.1	21.5	19.3	15.9
B	-393	20/30	75.5	12.0	12.4	24.4	26.2	22.7	21.8	17.0
B	-393	13/31	79.1	13.5	11.9	25.7	28.0	22.0	18.6	15.8
B	-405	17/32	91.9	16.3	15.8	29.2	33.7	25.5	23.8	18.1
B	-405	35/32	76.7	13.4	12.1	21.7	25.7	22.3	20.0	16.1
B	-417	36/32	78.3	12.5	11.0	25.7	26.7	22.0	20.3	15.1
B	-417	13/33	81.2	12.2	13.2	25.6	26.1	23.0	21.4	17.2
B	-417	17/33	88.5	14.9	14.8	29.8	32.8	26.2	25.0	18.3
B	-429	22/33	81.2	13.7	12.4	23.9	29.8	24.5	21.7	16.3
B	-429	22/33	86.1	13.4	13.0	26.1	30.1	23.8	21.2	17.2
B	-429	22/33	79.5	12.9	11.4	26.2	27.5	22.9	19.4	16.5
B	-429	37/33	73.4	14.1	12.3	24.6	27.9	24.2	21.1	16.1
B	-429	14/34	94.6	17.4	15.8	30.7	33.6	26.4	25.6	18.7
B	-429	35/34	91.7	16.5	15.5	32.1	36.0	28.3	28.1	18.1
C	-441	19/34	90.0	14.3	14.4	31.5	33.5	27.7	23.1	18.6
C	-441	20/34	78.9	13.4	11.8	25.9	29.9	23.8	21.7	16.5
C	-441	23/34	85.3	13.2	12.7	30.6	28.6	25.7	23.8	17.4
C	-453	20/35	90.2	14.4	13.3	29.1	33.4	25.4	23.0	17.4
C	–	163/13	90.2	15.8	15.0	33.1	34.6	28.7	26.3	19.0
C	–	163/13	91.8	17.0	15.0	34.6	36.0	27.2	23.8	17.7
C	–	164/13	81.9	13.1	10.8	24.6	28.1	20.9	19.9	16.5
C	–	165/13	79.5	14.8	11.2	21.3	25.8	21.0	18.2	15.8
C	–	169/13	88.4	14.9	14.4	30.5	31.9	25.4	22.0	16.9
C	–	180/13	76.2	12.9	10.1	26.1	27.0	22.0	20.4	16.3
C	–	184/13	79.0	11.7	10.9	25.4	26.5	23.4	22.1	17.0
C	–	184a/13	86.5	13.3	12.1	27.0	30.2	23.9	22.0	17.3
C	–	190/13	73.8	13.2	10.6	20.6	26.2	21.1	17.6	14.8
C	–	203/13-14	85.6	15.0	14.4	31.9	32.7	26.5	24.5	17.7
C	–	170/14	75.3	13.1	11.9	28.1	28.1	22.6	22.5	17.0
C	–	173/14	80.2	12.5	11.3	19.9	27.9	20.0	17.3	15.6
C	–	179/14	82.6	14.1	14.0	29.5	33.0	24.6	21.3	17.2
C	–	184a/14	87.3	17.1	13.7	29.7	32.2	24.9	19.7	18.5
C	–	187/14	88.1	16.2	13.6	31.7	30.8	25.6	24.9	18.4
C	–	188/14	80.2	14.1	12.1	26.0	27.9	23.7	22.3	15.9
C	–	188/14	95.2	14.9	14.2	31.4	35.2	26.1	24.3	18.8
Σ sample A			x = 87.5 SD = 5.96	x = 14.8 SD = 1.45	x = 13.5 SD = 1.35	x = 28.7 SD = 3.94	x = 31.6 SD = 3.86	x = 24.8 SD = 2.60	x = 22.7 SD = 2.47	x = 18.4 SD = 1.48
Σ sample B			x = 84.7 SD = 6.02	x = 14.6 SD = 1.54	x = 13.2 SD = 1.57	x = 28.6 SD = 3.48	x = 30.6 SD = 3.34	x = 24.7 SD = 2.26	x = 22.6 SD = 2.33	x = 17.5 SD = 1.22
Σ sample C			x = 84.1 SD = 5.93	x = 14.2 SD = 1.44	x = 12.7 SD = 1.58	x = 28.0 SD = 4.11	x = 30.4 SD = 3.17	x = 24.3 SD = 2.40	x = 21.9 SD = 2.41	x = 17.1 SD = 1.13
Σ all samples (A+B+C)			x = 85.4 SD = 6.09	x = 14.6 SD = 1.50	x = 13.2 SD = 1.52	x = 28.5 SD = 3.70	x = 30.9 SD = 3.47	x = 24.7 SD = 2.37	x = 22.5 SD = 2.38	x = 17.7 SD = 1.35

18. SKLEP

IVAN TURK

V sklepnem poglavju običajno strnemo vse ugotovitve iz posameznih poglavij. Ker bi bilo to ponavljanje že napisanega, sem se odločil za drugačen pristop, ki omogoča sumaren, vendar stvaren pregled vseh temeljnih podatkov o najdišču in izboljšuje možnosti za ugotavljanje povezanosti različnih sklopov najdb, prikazanih v *tab. 19.1*. Skratka, malo drugače izpeljan sklep lahko dodatno pripomore k boljšemu razumevanju najdišča in njegovega zapletenega sistema.

Poglavja obravnavajo posamezne teme po bolj ali manj skupnem stratigrafskem ključu, ki sem ga predlagal kot eden od vodij izkopavanj v Divjih babah I in kot odgovorni urednik tega zbornika. Poleg stratigrafskega ključa, ki je lahko subjektiven (členitev profila najdišča v geološke in druge plasti) ali objektiven (ločitev sedimentov po globinah, merjenih od stalne globinske točke), je tu še kronološki ključ. Podatke, razvrščene po enem in/ali drugem ključu je težko uskladiti. Žal so sklepi, ki se nanašajo na posamezne teme, zelo odvisni od načina usklajevanja stratigrafije s kronologijo, pri čemer slednja predpostavlja sočasnost različnih sklopov najdb. Najboljši način za uskladitev stratigrafije in kronologije vidim v sedimentacijskih nivojih in ne v geoloških plasteh, kot je običajno. Razloge za to sem navedel v poglavju 2 tega zbornika. Vendar so tudi pri takšnem načinu težave, povezane s kronologijo posameznih najdb, ki so razpršene v prostoru (*tab. 19.1*).

Vsi nivoji so se sedimentirali v približno 40.000 letih. V tem času sta bila vsaj dva velika zastoja v sedimentiranju, ki sta skupaj trajala kakšnih 15.000 let (glej poglavje 6 v tem zborniku). Vsak od 37 sedimentacijskih nivojev ima tako časovno ločljivost 675 let. To pomeni, da za nobeno najdbo ne morem trditi, da je dejansko sočasna z drugo oz. drugimi, če najdbe ne predstavljajo zaokrožene celote, kot so npr. oglje v ognjišču, anatomska lega kosti, sestavljivi odlomki kosti in drug na drugega prilegajoči se odbitki . V nivojih, kjer je prišlo do daljše prekinitve v odlaganju sedimentov (hiata ali vrzeli), so se lahko nakopičile najdbe iz zelo dolgega časovnega obdobja, kar otežuje njihovo razlago in lahko povzroči celo napačno sklepanje.

Posamezne skupine najdb, kot vir informacij, niso vedno časovno usklajene med seboj, še manj pa z drugimi viri informacij, kot so zmrzlinski klasti, agregati in drugi pojavi v sedimentih. V 700 letih in več je lahko prišlo do prepleta informacij iz različnih obdobij, in sicer tako zaradi narave vira kot vpliva časa. Zato so kronološke razlage najdišč in druge razlage, ki izhajajo iz kronologije, pogosto vprašljive, ker so nezanesljive in do določene mere subjektivne. Divje babe I niso v tem nobena izjema, imajo pa to prednost pred drugimi podobnimi najdišči v regiji, da je subjektivnost zmanjšana in nadzorovana s pomočjo metode, ki smo jo uporabili v poizkopavalnem postopku. Nova metoda, ki se od utečenih, splošno sprejetih, metod razlikuje samo v načinu izvedbe, je sad dolgoletnega dela na enem najdišču in ukvarjanja z enimi in istimi problemi (glej Turk 2003a, 2006).

V *tabeli 19.1* so prikazani podatki v stratigrafsko-kronološkem zaporedju. Razen temperaturnih podatkov, osnovanih na talnih zmrzlinskih klastih, vzorčenih v profilih, so vsi podatki uravnoteženi in usklajeni oz. objektivno primerljivi, ker se nanašajo na izmerjeno globino in določeno površino oz. prostornino sedimentov (glej poglavje 1 v tem zborniku). Informacija ni popolna, zaradi omejene površine bloka sedimentov s sedimentacijskimi nivoji. Predvsem niso upoštevane nekatere redke najdbe, kot npr. konice iz organskih materialov, redke živalske in rastlinske vrste ipd. Vse to je lahko moteče.

Kvantitativno-kvalitativne podatke sem razdelil v dve kronološki skupini (faciji A in B), ki, žal, pripadata srednjemu glacialu kot enotni kronoconi. Kronocona zgodnjega glaciala (facija C-1), ki bi primerjalno s srednjim glacialom dala zanimive rezultate, je slabo predstavljena, zaradi neustrezne metode v prvih letih izkopavanj, ko smo najdišče obravnavali na tradicionalni način (glej S. Brodar 1958, 277; Osole 1965, 144). Glede na stara izkopavanja, smo klimo tokrat določili neodvisno od ostankov flore in favne, kar je omogočilo križno preverjanje paleoklimatskih in paleookoljskih izsledkov, pridobljenih iz različnih virov.

Značilno za podatke, prikazane v *tabeli 19.1*, je, da niso zvezni. Edina izjema so avtigeni agregati (glej podpoglavje 5.3 v tem zborniku) in najdbe jamskega medveda, ki je živel neprekinjeno v okolici najdišča. Zveznost pri drugih podatkih lahko spremljamo le v krajših odsekih, kar dokazuje vsaj daljšo prisotnost posameznih vrst, kot so snežna in gozdna voluharica, rjavi medved, volk, kuna zlatica, gams in svizec, v okolici najdišča.

Vsaj štirje najvišji sedimentacijski nivoji so zaradi več 10.000 let dolgega zastoja v sedimentiranju kontaminirani s holocenskimi in pleistocenskimi najdbami. To potrjujejo predvsem ostanki drobnice in oglje bukve, datirano s ^{14}C-metodo (glej.poglavje 8 v tem zborniku). Takšne kontaminacije so mogoče tudi v drugih sedimentacijskih nivojih, povsod tam, kjer je prišlo do daljšega zastoja v sedimentiranju. V plasteh 2–5a je lahko prišlo do mešanja najdb iz različnih nivojev oz. plasti zaradi bio- in krioturbacije. Zato moramo razlage, ki se nanašajo na najzgornejše sedimentacijske nivoje, jemati z določeno mero previdnosti.

Artefakti, oglje in zoglenele kosti predstavljajo pretežno kratkotrajno človekovo dejavnost v jami in njegovo včasih daljšo prisotnost v okolici. To zlasti velja za oglje v ognjiščih, ohranjenih *in situ*, ki se ponaša z največjo časovno ločljivostjo. Lesno oglje s takih ognjišč dejansko predstavlja bližnjo drevesno vegetacijo enega dneva ali tedna.

Zogleneli kostni odlomki so zanesljiv znak za prisotnost ognjišč, tudi če se ta niso ohranila *in situ*. Oglje je namreč lahko prišlo v jamo tudi pri požarih v naravi, kot se je to zgodilo v času sedimentiranja plasti 4. V takšnih primerih ni zoglenelih kosti. Oglje in zogleneli kostni drobci so se gravitacijsko premikali iz ognjiščnega nivoja skozi pore med klasti v nižje ležeče nivoje, zaradi česar se je oboje – poleg običajne bočne razpršitve, ki je kvarno vplivala na ohranitev oglja – razpršilo v navpični smeri do 50 cm globoko (glej *tab. 19.1*). V navpični smeri se je proces ustavil, ko so se pore zapolnile s preperino, bočno pa se je nadaljeval, dokler niso ognjišče prekrili novi sedimenti.

Ker so v velikem ognjišču v sedimentacijskem nivoju –333 cm (facija B) zastopani izključno iglavci, in sicer skoraj vse vrste, lahko precej zanesljivo sklepamo, da tedaj tu niso uspevali listavci. Nasprotno temu je v nekaterih sedimentacijskih nivojih facije A in B poleg iglavcev običajno tudi več vrst listavcev, med njimi tudi bukev. Sklep, ki se ponuja, je dvojen: bodisi, da so ljudje obiskovali jamo samo v obdobjih z gozdno vegetacijo (iglasti in mešani gozdovi), bodisi, da je bil gozd ves čas prisoten. V faciji A je faza, v kateri ni oglja, so pa artefakti. Ali tedaj, vsaj na koncu, ni bilo gozda? Mrzla in suha klima bi lahko prizadela drevesne vrste in gozd bi postopno izginil. Nenazadnje zaradi požara, zabeleženega v času sedimentiranja plasti 4, ki je trenuten dogodek brez dolgoročnih posledic. Najdbe favne (*tab. 19.1*) in peloda (Šercelj, Culiberg 1991) ne podpirajo v celoti izginotje gozda. Na postopen prehod iz tople in vlažne klime v mrzlo in suho kaže zmanjševanje števila najdb tipične gozdne favne od sedimentacijskega nivoja –165 cm navzgor.

Poleg živalskih vrst, ki so značilne za odprte habitate (*Pirrhocorax pirrhocorax, Lanius excubitor, Chionomys nivalis, Microtus* ex gr. *agrestis-arvalis, Marmota marmota*), so v sedimentacijskih nivojih brez oglja tudi takšne, ki živijo izključno v gozdu (*Myodes glareolus, Martes martes*). Med pelodom močno prevladujejo iglavci (*Pinus, Picea*), ki se jim v plasti 4 pridruži alpska drežica (*Selaginella selaginoides*), tipična arkto-alpinska vrsta. Gozdna voluharica (*Myodes glareolus*) je med najpogostejšimi malimi sesalci v Divjih babah I (glej poglavje 10 v tem zborniku, *sl. 10.5*). Vendar jo je v sedimentacijskih nivojih –106 in –117 cm najmanj, potem pa začasno sploh izgine.

Najbolj mrzlo in suho klimatsko fazo lahko opredeljujeta sedimentacijska nivoja –81 in –94 cm, če oglje v sedimentacijskem nivoju –81 cm izvira iz višjega nivoja in je polh v sedimentacijskem nivoju –94 cm (sub)recentna kontaminacija. Med pelodom so v profilu v plasti 4 zastopani samo bor in smreka ter alpska drežica. Med favno v obeh sedimentacijskih nivojih ni tipičnih gozdnih vrst, razen ene najdbe kune zlatice, so pa tipični predstavniki odprtih habitatov (*Pirrhocorax pirrhocorax, Microtus* ex gr. *agrestis-arvalis, Marmota marmota*).

Med facijama A in B kljub veliki razliki v količini oglja, ki je neposredno povezana s številčnostjo artefaktov, ni večjih kakovostnih razlik (*tab. 19.1*). Razmerje med listavci in iglavci je nespremenjeno. V obeh facijah so uravnoteženo zastopane (7:7 in 8:8) bolj ali manj iste vrste listavcev in iglavcev. V faciji A so med listavci *Ostrya, Fraxinus, Fagus, Acer* in *Ulmus,* v faciji B pa *Carpinus-Ostrya, Carpinus, Fraxinus, Fagus, Acer, Alnus* in *Sorbus*. Med iglavci so v obeh facijah *Pinus, Pinus cembra, Picea, Abies, Taxus* in *Juniperus*, v faciji B pa še *Larix*. Bistveno drugačno razmerje se nakazuje v faciji C, kjer verjetno prevladujejo listavci. To so pokazale analize peloda v profilu pri jamskem vhodu, ki kažejo povečano prisotnost bukve in drugih listavcev (Šercelj, Culiberg 1991).

V različnih obdobjih so v neposredni okolici najdišča uspevale različne drevesne vrste in ljudje so neselektivno uporabljali njihov les za kurjavo. Manj verjetno je, da bi v okolici najdišča ves čas rastle vse ugotovljene vrste, katerih les bi ljudje selektivno uporabljali za kurjavo. Pelodne analize v profilu pri jamskem vhodu so v plasteh facijev A in B ugotovile samo naslednje drevesne vrste: *Pinus, Picea, Betula, Alnus, Corylus, Ostrya, Tilia, Fraxinus, Hedera, Salix* in *Sambucus* (Šercelj, Culiberg 1991). Razlike med ogljem, ki predstavlja trenutno, bližnjo vegetacijo, in pelodom, ki predstavlja tudi zelo oddaljeno vegetacijo iz daljšega obdobja, so očitne in pričakovane. Nepričakovana novost je velik delež listavcev v ognjiščih iz obdobja srednjega glaciala oz. srednjega virma. Česa podobnega ne poznamo z drugih slovenskih paleolitskih najdiščih, ki naj bi časovno pokrivala ves zadnji glacial (Šercelj, Culiberg 1985). To bi se dalo razložiti z obiski jame predvsem v toplih obdobjih, kar pa ne gre posploševati. Vemo, da je bilo ognjišče v sedimentacijskem nivoju –333 cm (glej poglavje 12 v tem zborniku, *sl. 12.5.1*) uporabljano v zelo mrzli in vlažni klimi, kar je navzkrižno potrjeno s sedimentološkimi, antrakotomskimi in paleontološkimi dejstvi (glej *tab. 19.1*). Tudi številna ognjišča v plasti 6 so iz obdobja z mrzlo klimo.

Ljudje so Divje babe I obiskovali v različnih klimatskih pogojih, kar pomeni, da klima ni neposredno vplivala na njihovo prisotnost v okolici. Vse kaže, da se okolje, kljub evidentnim klimatskim nihanjem in bližini Alp, ni bistveno spreminjalo, npr. iz gozdne pokrajine (vključno s tajgo) v stepo ali celo tundro, kar je značilno za predele severno in vzhodno od alpskega loka in je v času zgodnjega glacialnega maksimuma povzročilo poselitveno praznino. Novejše intenzivne raziskave starih jamskih najdišč kažejo, da so tudi v Karpatih v visokem glacialu bila poleg obdobij tajge in tundre obdobja, ko so uspevali mešani gozdovi (M. Hajnalová, E. Hajnalová 2005). Intenzivno preučevanje paleolitskih ognjišč bo tudi v prihodnje prineslo zelo koristne podatke o paleookolju, ki se bodo odlikovali po izjemni časovni ločljivosti, ki jo pri vnosu peloda ne moremo pričakovati.

Ostanki favne, ki služijo interpretaciji nekdanjega okolja, so se sedimentirali v bistveno daljšem obdobju kot oglje. Najkrajši možni čas je približno 700 let. Pri malih sesalcih gre predvsem za selekcijo sov, pri nezverskih ostankih pa za selekcijo velikih plenilcev in/ali človeka.

Ostanki ptic roparic predstavljajo neznaten delež med sicer redkimi ostanki avifavne (glej poglavje 9 v tem zborniku). Gre za po en ostanek snežne sove (*Nyctea scandica*), belorepca (*Haliaeetus* cf. *albicilla*), navadne kanje (*Buteo buteo*) in navadne postovke (*Falco tinnunculus*), najden v plasteh facije A. V sedimentacijskih nivojih facije A je šestkrat manj najdb malih sesalcev kot v faciji B, ki je brez najdb ptic roparic (*tab. 19.1*). V več sedimentacijskih nivojih na koncu facije B ni ostankov malih sesalcev ali pa so izjemno redki. Relativno redki so ti ostanki tudi v vsej faciji A. Največja koncentracija najdb malih sesalcev je v sedimentacijskih nivojih facije C in spodnjega dela facije B, kar lahko povežemo z velikimi podornimi bloki, ki so bili idealno počivališče ptic roparic. Vse koncentracije malih sesalcev so bočno omejene.

Redka najdba je tretja prstnica fazana (*Phasianus colchicus*) v sedimentacijskem nivoju –453 cm. Kronološko sodi v zgodnji glacial in je poleg najdb iz plasti H–J v Vindiji (V. Malez 1988) ena najstarejših najdb te vrste v regiji. Kontaminacija je glede na protokol izključena. Kako je osamljena najdba prišla v Divje babe I, je uganka, ki se jo da smiselno razložiti edino s posredovanjem neandertalskih obiskovalcev jame v obdobju najbogatejšega paleolitskega horizonta. Podobno lahko razložim tudi nekoliko mlajšo osamljeno najdbo tretje prstnice mamuta ali nosoroga. Znano je, da so neandertalci, pa tudi njihovi predhodniki občasno že zbirali »spominke«. Ne nazadnje imamo za to količinski posredni dokaz tudi v Divjih babah I, kjer so neandertalci načrtno zbirali velike medvedje podočnike (glej podpoglavje 12.2 v tem zborniku).

Med malimi sesalci se bolj ali manj zvezno pojavljajo ostanki izrazito gozdne vrste *Myodes glareolus* in izrazito travniške vrste *Microtus* ex gr. *agrestis-arvalis*. Najbolj zvezno vertikalno (časovno) porazdelitev imajo ostanki snežne voluharice (*Chionomys nivalis*), kar lahko razložimo s stalno prisotnostjo kamnišč, ki so še danes značilnost okolice najdišča. V nekontaminiranih sedimentacijskih nivojih se sporadično pojavljajo ostanki krta (*Talpa europaea/caeca*) in polha (*Glis glis*); slednji tudi skupaj z ostanki bukve (*Fagus*), kar kaže na dokaj milo klimo sredi »visokega glaciala« (srednjega virma). Seveda moramo biti zelo previdni pri kronoloških povezavah ostankov malih sesalcev z drugimi paleontološkimi najdbami in s sedimentološkimi podatki. Zaradi majhnosti so ti ostanki lahko potovali celo globlje v sediment kot koščki oglja iz ognjišč, zlasti v nivojih in predelih z velikimi bloki. Zato ni izključeno, da mali sesalci iz več zaporednih sedimentacijskih nivojev pripadajo istemu časovnemu horizontu, dolgemu ±700 let.

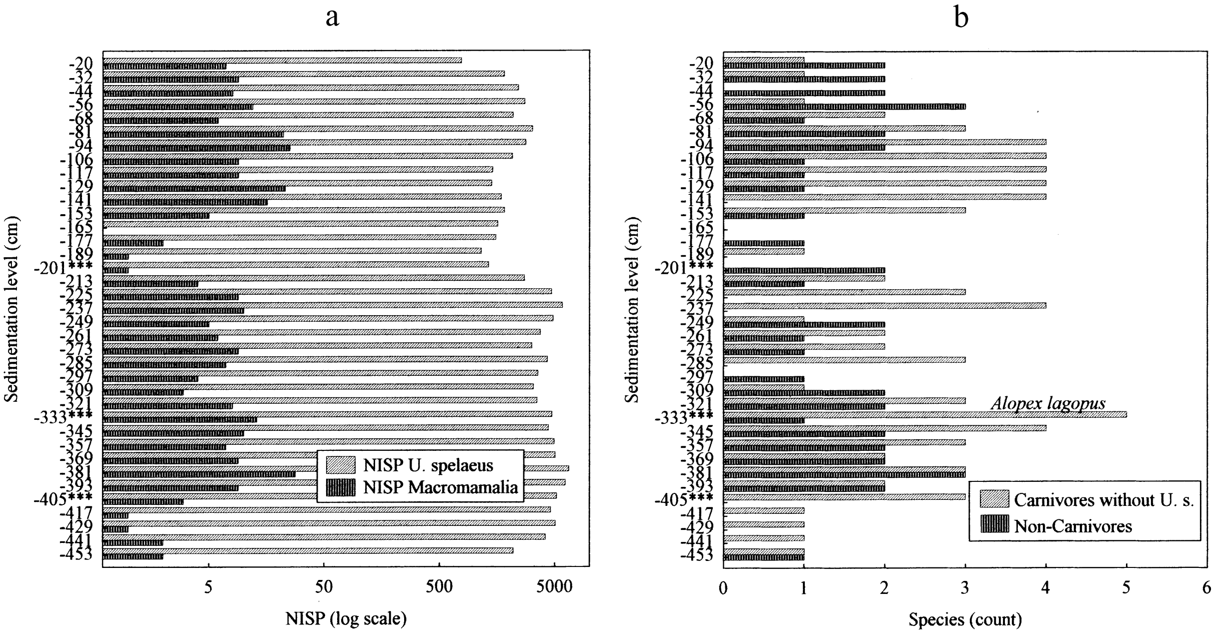
Kvalitativne odnose med facijami in malimi sesalci obravnava poglavje 10 v tem zborniku (glej predvsem *sl. 10.5*). Čeprav je v faciji B šestkrat več najdb malih sesalcev, je nekaterih vrst, ki so dobri okoljski pokazatelji, manj kot v faciji A. To zlasti velja za vrsti *Chionomy nivalis* in *Microtus* ex. gr. *agrestis -arvalis*, kar lahko pomeni, da je bil teren v okolici jame v faciji B bolj poraščen in so roparice težje prišle do dela plena, ki se je zaradi spremenjenega okolja tudi številčno zmanjšal, ni pa nikoli povsem izginil. Večje razlike v tafocenozi malih sesalcev sta B. Toškan in B. Kryštufek ugotovila med facijama C in B ter C in A (glej poglavje 10 v tem zborniku).

V območju prehoda iz kisikove izotopske stopnje OIS 5 (= facija C-1) v OIS 4 (= facija B) oz. iz zgodnjega virma v srednji virm med malimi sesalci ni opaziti nobene večje spremembe. Omeniti moram le dve tipično stepski vrsti, katerih ostanke smo našli samo v sedimentacijskih nivojih v območju prehoda. To sta *Sicista* cf. *subtilis* in *Vespertilio murinus* (za podrobnosti glej poglavje 10 v tem zborniku). Podobno temu se najzgornjejši sedimentacijski nivoji facije A proti pričakovanju niso okužili z arkto-alpinsko mikrofavno kisikove izotopske stopnje OIS 2 oz. mlajšega virma. Oboje se da razložiti takole: prvi glacialni vrhunec v kisikovi izotopski stopnji OIS 4 je bil v Alpah manj mrzel kot drugi v kisikovi izotopski stopnji OIS 2 (glej Preusser 2004), čeprav kisikova izotopska krivulja kaže ravno obratno in tega nihče ne zna ali noče razložiti. V drugem glacialnem vrhuncu pred približno 24.000 leti je bil jamski vhod že tako majhen, da je jama zamrznila in postala negostoljubna za vse, ki so tedaj živeli v njeni okolici.

Ostanki velikih sesalcev so, čeprav maloštevilni, od vseh najdb najbolj zvezno porazdeljeni v sedimentacijskih nivojih (*sl. 19.1a*). Za to so zaslužne predvsem zveri, ki so stalno obiskovale jamo in vanjo vlačile ostanke plena, zlasti če so imele v njej brloge, kot jamski medved, rjavi medved, jamski lev, leopard in volk. Njihovi mladiči so lahko v jami tudi poginili, med njimi zelo pogosto mladiči jamskega medveda, katerih ostanki predstavljajo več kot 80 % vseh medvedjih ostankov (glej poglavji 12 in Debeljak 2002a,c).

Med živali, ki so bolj ali manj stalno živele v okolici jame, sodita, poleg jamskega medveda tudi volk (*Canis lupus*) in kuna zlatica (*Martes martes*). Stalna prisotnost kune zlatice kaže na stalno prisotnost gozda, vsaj iglastega. V zgornjih šestih sedimentacijskih nivojih kune ni, potem pa se pojavlja zvezno do vključno nivoja -153 cm, nato ponovno izgine v štirih zaporednih nivojih (-165 do - 201 cm). Za te štiri nivoje je značilno najmanjše število vrst velikih sesalcev (*sl. 19.1a*) in zmanjšanje števila vrst malih sesalcev. Težko je ugotoviti vzrok za to. V tem odseku je kratka in zelo mrzla klimatska faza, ki jo predstavlja plast 6. Ta plast, ki je nastala s preperevanjem jamskih polic, se je zelo hitro sedimentirala na območju analiziranega bloka sedimentov. Gre za plast z največjim številom ognjišč, katerih oglje je razpršeno po vsej jami, in pripada skoraj izključno iglavcem. Podobna paleontološka slika je še v dveh do treh sedimentacijskih nivojih, in sicer -249 do -273 cm, v faciji B, ki sicer pripadajo zmerni in vlažni klimi. Kune zlatice ni, oglje pa je skoraj izključno od iglavcev. Veliki sesalci so normalno zastopani (*sl. 19.1a*). V drugih sedimentacijskih nivojih facije B nastopa kuna zlatica bolj ali manj zvezno. Bolj ali manj stalno prisotnost gozda v facijah A in B potrjujejo tudi izsledki pelodne analize vzorcev plasti izkopavanj M. Brodarja (Šercelj, Culiberg 1991).

Med velikimi sesalci je tudi nekaj vrst, ki dajejo prednost odprtim habitatom. Takšna vrsta je alpski svizec (*Marmota marmota*), ki je morala biti zaradi zveznega pojavljanja v številnih sedimentacjskih nivojih precej stalna v okolici najdišča. V enem primeru nastopa skupaj z drugo značilno alpsko vrsto kozorogom (*Capra ibex*), v dveh pa s tipično arktično vrsto polarno lisico (*Alopex lagopus*), od tega enkrat skupaj s poljskim, morda planinskim zajcem (*Lepus* sp.). V prvem primeru gre za sedimentacijski nivo, ki je lahko kontaminiran z najdbami, ki dejansko pripadajo kisikovi izotopski stopnji OIS 2, v drugih dveh pa za sedimentacijska nivoja, ki sta se izoblikovala v mrzli in zelo vlažni klimi v kisikovi izotopski stopnji OIS 3. Na ostanke gamsa (*Rupicapra rupicapra*) naletimo v številnih sedimentacijskih nivojih. To vrsto je podobno, kot snežno voluharico (*Chyonomis nivalis*), privlačila skalnata okolica jame kot prostorska stalnica. Vendar obe vrsti le redko nastopata skupaj, in sicer večkrat v faciji A kot B. Manjša gamsja populacija še danes živi v predelu najdišča, snežne voluharice pa ni več zaznati med plenom recentnih sov (Kryštufek 1997).



Sl. 19.1a, b: Stratigrafski prikaz določljivih ostankov jamskega medveda in preostalih velikih sesalcev (a) ter stratigrafski prikaz številčnosti zveri brez jamskega medveda in nezveri (b).

Fig. 19.1a, b: Stratigraphic survey of identifiable remains of cave bear and other large mammals (a) and stratigraphic survey of the numbers of carnivores without cave bear and non-carnivores (b).

V omočju prehoda iz kisikove izotopske stopnje OIS 5 (= facija C-1) v OIS 4 (= facija B) oz. zgodnjega glaciala (virma) v visoki glacial (srednji virm) ni zastopanih veliko vrst velikih sesalcev, značilnih za izrazito mrzlo klimo. V oči bode predvsem majhno število vrst in najdb, saj sta zastopani zgolj dve vrsti (*Martes martes* in *Vulpes* s. *Alopex*), če ne upoštevamo jamskega medveda. Med lesnim ogljem so zastopani skoraj izključno iglavci (*Pinus, Picea, Larix, Abies, Taxus* in *Juniperus*). Med ostanki malih sesalcev so tako predstavniki gozda kot travnikov. Redkost in posebnost je *Sicista* cf. *subtilis*, kot tipičen stepski element, ki se pridruži drugi tipični stepski vrsti *Vespertilio murinus*. Splošna floristično-favnistična slika je zelo podobna sliki v sedimentacijskih nivojih −165 do −201 cm. V obeh primerih imamo opraviti z elementi zmerne in mrzle klime s prevlado elementov mrzle klime. Oba tipa klime sta bila ugotovljena tudi sedimentološko.

Z vidika lova je pomembno razmerje med zvermi in nezvermi (verjetnim plenom). Zveri močno prevladujejo v večini sedimentacijskih nivojev (*sl. 19.1b*), zaradi česar jih moramo poleg človeka upoštevati kot verjetne prinašalke plena. Veliko vrst zveri in veliko vrst plena je samo v spodnjih nivojih facije B (*sl. 19.b*), kjer imamo opraviti s pretežno mrzlo klimo. Zato sklepamo, da so bile glavne prinašalke plena zveri. V več nivojih facije A je veliko vrst zveri in malo vrst plena. Tudi na tem odseku je bila klima pretežno mrzla. V nekaterih sedimentacijskih nivojih, zveznih (−405 do −441 cm) in nezveznih (−141 −189, −225, −237, −285 cm), je ena ali več vrst zveri in nič plena (*sl. 19.b*). Ker je v dveh od teh nivojev (−225 do −237 cm) tudi relativno veliko artefaktov (22 kosov), je vprašanje, kdo je lovil in kaj je lovil. Če so lovili ljudje, so lovili zveri. V poštev pridejo rjavi medved (*Ursus arctos*), jamski lev (*Panthera spelaea*), volk (*Canis lupus*) in kuna zlatica (*Martes martes*). To je precej neobičajen plen za ljudi in ne tako neobičajen za zveri. Torej so zveri lovile zveri, če ni bilo druge možnosti.

V sedimentacijskih nivojih z ognjišči in pod njimi ni opaziti niti povečanega števila vseh ostankov velikih sesalcev niti povečanega števila nezverskih vrst oz. običajnega lovskega plena. Zato sklepamo, da se ljudje, ki so prihajali v jamo, tedaj niso veliko ukvarjali z lovom. Seveda to ne izključuje možnosti, da nekateri ostanki ne predstavljajo njihovega plena. B. Toškan, ki je obdelal vse najdbe favne, je ugotovil (poglavje 11 v tem zborniku), da so ljudje lovili predvsem jelena, srno, gamsa in kozoroga ter vsaj v faciji A zelo verjetno tudi svizca.

Razmerje med zverskimi in nezverskimi vrstami je v obeh facijah enako. Manjše razlike so samo v zastopanosti vseh vrst in številu ostankov. Slednjih je več v faciji A, za kar so zaslužne zveri. Za facijo A so značilne naslednje zveri: *Ursus spelaeus, Ursus arctos, Panthera pardus, Lynx lynx, Canis lupus, Mustela putorius, Martes martes* in *Lutra lutra* ter nezveri: *Marmota marmota, Rupricapra rupricapra, Capra ibex* in *Cervus elephus*. Za facijo B pa naslednje zveri: *Ursus spelaeus, Ursus arctos, Panthera spelaea, Felis silvestris, Canis lupus, Mustela putorius, Martes martes, Vulpes* s. *Alopex* in *Alopex lagopus* ter nezveri: *Marmota marmota, Lepus* sp.*, Rupricapra rupricapra* in *Capreolus capreolus.*

V sklopu facijev beležimo dva izrazita vrhunca ostankov velikih sesalcev, natančneje zveri brez jamskega medveda, v faciji A in enega v faciji B. Vsi vrhunci so povezani z mrzlo-suho in mrzlo in zelo vlažno klimo, ki je domnevno pognala zveri v jamske brloge. Med ostanki zveri in nezveri ni povezave. Prav tako ne med ostanki jamskega medveda in ostanki zveri.

Jamski medved se je odzival na klimatske spremembe po svoje. Absolutno največ ostankov je v sedimentacijskih nivojih, za katere je značilna mrzla in zelo vlažna klima, kar pomeni, da ga je bolj kot mraz motila vlaga. V zaostrenih razmerah je prišlo tudi do tekmovanja za jamske brloge med samci na eni strani in samicami ter mladiči na drugi. Različno razmerje med spoloma v faciji C na eni strani ter facijama B in A na drugi strani, oz. podobno razmerje v toplo/suhi klimi v faciji C in delu facije A s primerljivo klimo, jasno odslikavajo stopalnice (metacarpalia) prednjih šap (glej poglavje 17 v tem zborniku). Delež samcev, ki so večji od samic, se je povečal v mrzli in vlažni klimi. Morfometrične raziskave lobanj, velikih dolgih kosti in metapodijev jamskega medveda iz Divjih bab I (glej poglavja 15–17 v tem zborniku) niso potrdile obstoja različnih vrst ali podvrst medvedov, kot to predvideva Rabeder s sodelavci (2004c) za alpska najdišča, zlasti ne, če izsledke raziskav obravnavamo v luči vseh zbranih klimatokronoloških

▷▷

Tab. 19.1: Stratigrafski pregled vseh najdb, razvrščenih v sedimentacijske nivoje v bloku sedimentov (glej poglavje 1 v tem zborniku, *tab. 1.1a*, *b*; *sl. 1.3*). Vsi podatki, razen temperaturnih, so stratigrafsko direktno primerljivi. Vlažnost je podana s povprečno volumensko maso sedimentne frakcije 0,5–3 mm v vsakem sedimentacijskem nivoju (n = 25 oz. 21), ki predstavlja gostoto agregatov (Turk 2003a). Krepko so izpisane najdbe, ki ne sodijo v časovni okvir sedimentacijskih nivojev in so vanje zašle veliko pozneje, oglje bukve npr. pred 60 leti, ostanki drobnice v času od prazgodovine do danes. Podčrtane so vrste, značilne za odprto pokrajino in gozdno mejo. Ognjiščni nivoji so označeni z zvezdicami.

Tab. 19.1: Stratigraphic survey of all finds classified by sedimentation levels (see chapter 1 in this volume, *Tab. 1.1a, b; Fig. 1.3).* All data except temperature are directly comparable stratigraphically. Humidity is given in average volumetric weight of sediment fraction 0.5-3 mm in each sedimentation level (n = 25 or 21), which represents the density of aggregates (Turk 2003a). Finds in bold do not belong within the time frame of sedimentation levels and were deposited a great deal later, beech charcoal, e.g., 60 years ago, remains of sheep or goat throughout the period from prehistory to the present. Species typical of open landscape and forest line are underlined. Sedimentation levels with the remains of a hearth are marked with asterisks.

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	Artefacts	Burned bone fragments	FLORA List of species	NISP (Charcoal)	Deciduous trees	Coniferuous trees
						Charcoal			
-20	A	2 (Temperate)	1.23 (Dry)	0	0	*Ostrya,* *Fraxinus* cf. *ornus,* ***Fagus***	4	(3?)	0
-32	A	2 (Temperate)	1.33 (Dry)	0	0	*Fraxinus,* ***Fagus,*** *Pinus*	4	(2?)	1
-44	A	3 (Temperate)	1.33 (Dry)	0	3	*Carpinus,* *Fraxinus,* ***Fagus,*** *Picea,* *Abies*	12	(3?)	2
-56	A	3 (Temperate)	1.36 (very Dry)	0	0	/	0	0	0
-68	A	3 (Temperate)	1.24 (Dry)	0	0	*Ostrya,* *Fraxinus,* *Fraxinus* cf. *ornus,* *Fagus,* *Acer,* *Pinus*	50	5	1
-81	A	4 (Ccold)	1.22 (Dry)	2	1	*Fraxinus,* *Acer,* *Abies*	12	2	1
-94	A	4 (Cold)	1.24 (Dry)	2	2	/	0	0	0

continued...

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	FAUNA List of species			NISP (Aves)	NISP (Micromamalia)	NISP (*Ursus spelaeus*)	NISP (Macromamalia)	Carnivores	Non-Carnivores
				Birds	Small mammals	Large mammals						
-20	A	2 (Temperate)	1.23 (Dry)	/	*Myodes glareolus,* Arvicolidae	*U. spelaeus,* *L. lynx,* *M. marmota,* *R. rupicapra,* ***Ovis* s. *Capra***	0	5	773	7	2	2(3?)
-32	A	2 (Temperate)	1.33 (Dry)	/	Vespertilionidae, *Myodes glareolus,* *Arvicola terrestris,* *Chionomys nivalis,* *Microtus* ex gr. *agrestis-arvalis,* Arvicolidae, ***Glis glis***	*U. spelaeus,* *U.* cf. *arctos,* *M. marmota,* *R. rupicapra,* ***Ovis* s. *Capra***	0	9	1823	9	2	2(3?)
-44	A	3 (Temperate)	1.33 (Dry)	/	*Sorex minutus,* *Sorex alpinus,* *Myodes glareolus,* *Chionomys nivalis,* ***Glis glis***	*U. spelaeus,* *M. marmota,* *R. rupicapra*	0	9	2423	8	1	2
-56	A	3 (Temperate)	1.36 (very Dry)	/	*Myodes glareolus,* *Chionomys nivalis,* Arvicolidae, *Apodemus* ex gr. *flavicollis-sylvaticus,* ***Glis glis***	*U. spelaeus,* *C. lupus,* *M. marmota,* *R. rupicapra,* *C. ibex,* ***Ovis* s. *Capra***	0	7	2745	12	2	3(4?)
-68	A	3 (Temperate)	1.24 (Dry)	/	*Talpa europea,* *Microtus* ex gr. *agrestis-arvalis,* Arvicolidae	*U. spelaeus,* *U. arctos,* *C. lupus,* *M. marmota*	0	3	2172	6	3	1
-81	A	4 (Ccold)	1.22 (Dry)	/	/	*U. spelaeus,* *U. arctos,* *C. lupus,* *M. putorius,* *M. marmota,* *R. rupicapra*	0	0	3191	22	4	2
-94	A	4 (Cold)	1.24 (Dry)	*P. pyrrhocorax*	*Microtus* ex gr. *agrestis-arvalis,* Arvicolidae, ***Glis glis***	*U. spelaeus,* *U. arctos,* *C. lupus,* *P. pardus,* *M. martes,* *M. marmota,* *R. Rupricapra*	3	4	2795	25	5	2

continued...

Tab. 19.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	Artefacts	Burned bone fragments	FLORA List of species	NISP (Charcoal)	Deciduous trees	Coniferuous trees
						Charcoal			
-106	A	5a (Cold)	1.23 (Dry)	2	1	/	0	0	0
-117	A	5a (Cold)	1.24 (Dry)	1	1	/	0	0	0
-129	A	5a (Cold)	1.21 (Humid)	1	1	/	0	0	0
-141	A	5 (Temperate)	1.18 (Humid)	0	0	/	0	0	0
-153	A	5 (Temperate)	1.19 (Humid)	0	0	/	0	0	0
-165	A	5 (Temperate)	1.20 (Humid)	0	0	/	0	0	0
-177***	A	5 (Temperate)	1.20 (Humid)	0	2	Indet. deciduous, *Pinus,* *Pinus cembra,* *Picea,* *Taxus,* *Juniperus,* indet. conifer	54	1	6

continued...

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	FAUNA List of species			NISP (Aves)	NISP (Micromamalia)	NISP (*Ursus spelaeus*)	NISP (Macromamalia)	Carnivores	Non-Carnivores
				Birds	Small mammals	Large mammals						
-106	A	5a (Cold)	1.23 (Dry)	*Lanius excubitor*	*Myodes glareolus*, *Chionomys nivalis*, *Microtus agrestis*	*U. spelaeus*, *U. arctos*, *C. lupus*, *P. pardus*, *M. martes*, *R. rupicapra*	1	3	2149	9	5	1
-117	A	5a (Cold)	1.24 (Dry)	*Turdus merula*	*Myodes glareolus*, *Arvicola terrestris*, *Microtus* ex gr. *agrestis-arvalis*, Arvicolidae	*U. spelaeus*, *U. arctos*, *C. lupus*, *M. martes*, *M. putorius*, *C. elaphus*	1	5	1448	9	5	1
-129	A	5a (Cold)	1.21 (Humid)	*Lanius excubitor*, *P. pyrrhocorax*, Aves indet.	*Myodes glareolus*, *Arvicola terrestris*, *Chionomys nivalis*, Arvicolidae	*U. spelaeus*, *U. arctos*, *C. lupus*, *M. martes*, *M. putorius*, *M. marmota*	3	10	1416	23	5	1
-141	A	5 (Temperate)	1.18 (Humid)	/	*Myodes glareolus*, *Arvicola terrestris*, *Chionomys nivalis*, Arvicolidae	*U. spelaeus*, *U. arctos*, *C. lupus*, *M. putorius*, *L. lutra*	0	11	1718	16	5	0
-153	A	5 (Temperate)	1.19 (Humid)	*Buteo buteo*	*Sorex alpinus*, *Myodes glareolus*, *Chionomys nivalis*, *Microtus* ex gr. *agrestis-arvalis*, *Microtus* ex gr. *liechtensteini-subterraneus*, Arvicolidae	*U. spelaeus*, *C. lupus*, *M. martes*, *M. putorius*, *M. marmota*	0	16	1832	5	4	1
-165	A	5 (Temperate)	1.20 (Humid)	/	*Talpa europea*, *Myodes glareolus*, *Arvicola terrestris*, *Microtus* ex gr. *agrestis-arvalis*, Arvicolidae	*U. spelaeus*	0	10	1601	0	1	0
-177***	A	5 (Temperate)	1.20 (Humid)	/	*Myodes glareolus*, Arvicolidae	*U. spelaeus*, *R. rupicapra*	0	7	1542	2	1	1

continued...

Tab. 19.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	Artefacts	Burned bone fragments	FLORA List of species	NISP (Charcoal)	Deciduous trees	Coniferuous trees
						Charcoal			
-189	A	5 (T.)	1.23 (D.)	0	11	/	0	0	0
-201***	A	6 (Cold)	1.25 (Dry)	0	222	*Ulmus,* indet. deciduous, *Pinus,* *Picea,* *Abies,* *Taxus?,* *Juniperus,* indet. conifer	19	2	6
-213	A	6 (Cold)	1.22 (Dry)	1	193	*Fraxinus,* *Ulmus,* *Acer?,* indet. deciduous, *Pinus,* *Picea,* *Abies,* *Taxus,* indet. conifer	92	4	5
-225	A	7 (Temperate)	1.15 (Humid)	12	101	*Pinus,* *Abies,* *Taxus,* indet. conifer	22	0	4
SUM Facies A				***21***	***538***		***269***	***7***	***7***
-237	B	7 (Temperate)	1.06 (Humid)	10	53	*Pinus,* *Picea,* *Taxus,* indet. conifer	4	0	4
-249	B	8a (Temperate)	1.02 (Humid)	13	32	*Pinus,* *Picea,* *Abies,* *Taxus,* indet. conifer	15	0	5
-261	B	8a (Temperate)	1.03 (Humid)	17	73	*Pinus,* *Picea,* *Abies,* *Taxus,* indet. conifer	93	0	5

continued...

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	FAUNA List of species			NISP (Aves)	NISP (Micromamalia)	NISP (*Ursus spelaeus*)	NISP (Macromamalia)	Carnivores	Non-Carnivores
				Birds	Small mammals	Large mammals						
-189	A	5 (T.)	1.23 (D.)	*Fringilla coelebs*	*Myodes glareolus,* *Chionomys nivalis*	*U. spelaeus,* *C. lupus*	1	2	1146	1	2	0
-201***	A	6 (Cold)	1.25 (Dry)	/	Arvicolidae	*U. spelaeus,* *R. rupicapra*	0	1	1330	1	1	1
-213	A	6 (Cold)	1.22 (Dry)	/	*Myodes glareolus,* Arvicolidae	*U. spelaeus,* *C. lupus,* *M. martes,* *R. rupicapra*	0	2	2726	4	3	1
-225	A	7 (Temperate)	1.15 (Humid)	/	/	*U. spelaeus,* *U. arctos,* *C. lupus,* *M. martes*	0	0	4699	9	4	0
SUM Facies A							***9***	***104***	***37529***	***168***	***8***	***4***
-237	B	7 (Temperate)	1.06 (Humid)	/	*Arvicola terrestris*	*U. spelaeus,* *U. arctos,* *C. lupus,* *P. spelaea* *M. martes*	0	1	5820	10	5	0
-249	B	8a (Temperate)	1.02 (Humid)	/	/	*U. spelaeus,* *U. arctos,* *M. marmota,* *R. rupicapra*	0	0	4841	5	2	2
-261	B	8a (Temperate)	1.03 (Humid)	/	*Talpa europea*	*U. spelaeus,* *U. arctos,* *C. lupus,* *R. rupicapra*	0	1	3746	6	3	1

continued...

Tab. 19.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	Artefacts	Burned bone fragments	FLORA List of species	NISP (Charcoal)	Deciduous trees	Coniferuous trees
						Charcoal			
-273	B	8a (Temperate)	1.01 (H.)	1	17	*Carpinus-Ostrya,* *Pinus,* *Abies,* indet. conifer	23	1	3
-285	B	8b (Temperate)	1.01(H.)	1	15	Indet. decid. (?), *Pinus,* *Abies*	7	1	2
-297	B	8b (T.)	0.98 (v. H.)	0	5	*Abies*	1	0	1
-309	B	8b (Temperate)	0.97 (very H.)	0	2	*Carpinus,* *Fraxinus,* *Fagus,* *Pinus*	18	3	1
-321	B	8b (Cold)	0.96 (very Humid)	11	1	*Fraxinus,* *Carpinus,* *Fagus*	3	3	0
-333***	B	8b (Cold)	0.98 (very Humid)	19	1467	*Fagus,* *Carpinus,* *Pinus,* *Pinus* cf. *cembra,* *Picea,* *Larix,* *Larix-Picea,* *Abies,* *Taxus,* *Juniperus,* indet. conifer	261	2	9
-345	B	8b-10 (Cold)	0.96 (very Humid)	4	349	*Alnus viridis,* *Pinus,* *Picea,* *Larix,* *Abies,* *Taxus,* indet. conifer	377	1	6

continued...

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	FAUNA List of species			NISP (Aves)	NISP (Micromamalia)	NISP (*Ursus spelaeus*)	NISP (Macromamalia)	Carnivores	Non-Carnivores
				Birds	Small mammals	Large mammals						
-273	B	8a (Temperate)	1.01 (H.)	/	/	*U. spelaeus,* *U. arctos,* *P. spelaea,* *M. marmota*	0	0	3168	9	3	1
-285	B	8b (Temperate)	1.01(H.)	*Nucifraga* cf. *caryocatactes*	*Chionomys nivalis,* *Myodes glareolus*	*U. spelaeus,* *U. arctos,* *C. lupus,* *M. martes*	1	3	4332	7	4	0
-297	B	8b (T.)	0.98 (v. H.)	/	/	*U. spelaeus,* *M. marmota*	0	0	3575	4	1	1
-309	B	8b (Temperate)	0.97 (very H.)	/	/	*U. spelaeus,* *M. martes,* *M. marmota,* *R. rupicapra*	0	0	3256	3	2	2
-321	B	8b (Cold)	0.96 (very Humid)	/	/	*U. spelaeus,* *U. arctos,* *Alopex lagopus,* *M. martes,* *M. marmota,* *Lepus* sp.	0	0	3488	8	4	2
-333***	B	8b (Cold)	0.98 (very Humid)	/	*Chionomys nivalis,* *Arvicola terrestris,* *Myodes glareolus*	*U. spelaeus,* *U.* cf. *arctos* *C. lupus,* *P. spelaea,* *M. martes,* *M. putorius,* *R. rupicapra*	0	15	4713	13	6	1
-345	B	8b-10 (Cold)	0.96 (very Humid)	/	*Arvicola terrestris,* *Sorex alpinus/araneus,* *Talpa europaea/caeca,* *Myodes glareolus*	*U. spelaeus,* *Alopex lagopus?,* *F. silvestris,* *M. martes,* *M. putorius,* *M. marmota,* *C. capreolus*	0	18	4399	10	5	2

continued...

Tab. 19.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	Artefacts	Burned bone fragments	FLORA List of species	NISP (Charcoal)	Deciduous trees	Coniferuous trees
						Charcoal			
-357	B	8b-10 (Cold)	0.94 (very Humid)	1	103	*Pinus,* *Pinus* cf. *cembra,* *Picea,* *Larix,* *Abies,* *Taxus,* *Juniperus,* indet. conifer	45	0	8
-369	B	10 (Temperate)	0.96 (very H.)	2	2	*Fraxinus,* *Pinus,* *Abies*	6	1	2
-381	B	10 (Temperate)	0.99 (very Humid)	5	0	*Sorbus,* *Fagus,* *Pinus,* *Picea,* *Larix,* *Abies*	54	2	4
-393	B	11 (Cold)	1.02 (Humid)	1	1	*Pinus,* *Picea,* *Abies,* *Taxus,* *Juniperus*	29	0	5
-405***	B	11 (Cold)	1.08 (Humid)	1	13	*Acer,* *Pinus,* *Picea,* *Larix,* *Abies-Larix,* *Abies,* *Taxus,* *Juniperus*	68	1	7
-417	B	12-11 (Cold)	1.06 (Humid)	3	0	*Sorbus,* *Pinus,* *Picea,* *Larix*	64	1	3

continued...

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	FAUNA List of species			NISP (Aves)	NISP (Micromamalia)	NISP (*Ursus spelaeus*)	NISP (Macromamalia)	Carnivores	Non-Carnivores
				Birds	Small mammals	Large mammals						
-357	B	8b-10 (Cold)	0.94 (very Humid)	/	*Arvicola terrestris,* *Sorex araneus,* *Sorex alpinus/araneus,* *Chionomys nivalis,* *Arvicola terestris,* *Myodes glareolus*	*U. spelaeus,* *U. arctos,* *C. lupus,* *M. martes,* *M. marmota,* *C. capreolus*	0	32	4945	7	4	2
-369	B	10 (Temperate)	0.96 (very H.)	/	*Chionomys nivalis,* *Arvicola terestris,* *Myodes glareolus*	*U. spelaeus,* *C. lupus,* *M. martes,* *M. marmota,* *C. Capreolus*	0	15	5023	9	3	2
-381	B	10 (Temperate)	0.99 (very Humid)	*Lagopus mutus*	*Chionomys nivalis,* *Arvicola terrestris,* *Myodes glareolus,* *Microtus* ex gr. *agrestis-arvalis*	*U. spelaeus,* *U. arctos,* *C. lupus,* *M. martes,* *M. marmota,* *R. rupicapra,* *C. elaphus*	0	34	6618	28	4	3
-393	B	11 (Cold)	1.02 (Humid)	/	*Sorex alpinus,* *Sorex araneus,* *Chionomys nivalis,* *Arvicola terrestris,* *Myodes glareolus,* *Microtus* ex gr. *agrestis-arvalis*	*U. spelaeus,* *U.* cf. *arctos,* *C. lupus,* *M. martes,* *R. rupicapra*	0	74	6185	9	3	2
-405***	B	11 (Cold)	1.08 (Humid)	/	*Sorex alpinus/araneus,* *Chionomys nivalis,* *Arvicola terrestris,* *Myodes glareolus,* *Microtus* ex gr. *agrestis-arvalis*	*U. spelaeus,* *U.* cf. *arctos,* *M. martes,* *M. putorius*	0	105	5201	3	4	0
-417	B	12-11 (Cold)	1.06 (Humid)	/	*Talpa europaea/caeca,* *Chionomys nivalis,* *Arvicola terrestris,* *Myodes glareolus,* *Microtus* ex gr. *agrestis-arvalis,* *Microtus* ex gr. *liechtensteini-subterraneus*	*U. spelaeus,* *M. martes*	0	159	4587	1	2	0

continued...

Tab. 19.1 (nadaljevanje / cont.)

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	Artefacts	Burned bone fragments	FLORA List of species	NISP (Charcoal)	Deciduous trees	Coniferuous trees
						Charcoal			
-429	B	12 (Temperate)	1.15 (Humid)	4	0	*Pinus,* *Picea,* *Larix*	25	0	3
SUM Facies B				***93***	***2133***		***1120***	***8***	***8***
-441	C-1	13 (Temperate)	1.27 (Dry)	7	0	*Sorbus,* *Sorbus-Crataegus nigra,* *Alnus,* indet. deciduous, *Pinus,* *Larix*	27	4	2
-453	C-1	14 (Temperate)	1.38 (very Dry)	4	1	/	0	0	0
SUM Facies A-C				***125***	***2672***		***1389***	***9***	***8***

podatkov in razlag, in če upoštevamo vedenjske vzorce živečih medvedov. Jamski medved in druge velike zveri (lev, panter, ris, volk) niso bili plen paleolitskih lovcev, temveč so naravno poginili v jami brlogu. Na kosteh je izjemno malo sledov, ki jih pustijo zveri, in še manj sledov, ki jih pustijo ljudje (glej podpoglavje 12.3 v tem zborniku, *tab. 12.3.1*). Seveda to ne pomeni, da se tako ljudje kot zveri niso ukvarjali s kostmi, predvsem s kostmi jamskega medveda, ki jih je bilo največ. Tako smo ugotovili, da so ljudje zbirali kanine medvedjih samcev, intenzivno razbijali ali odnašali lobanje brez mandibul, stegnenice in golenice jamskega medveda. To se najlepše vidi v treh nivojih z ognjišči, kjer se vzorec teh ostankov pri odraslih primerkih razlikuje od vzorca pri nedoraslih primerkih, ki so bili predvsem tarča zveri (glej podpoglavje 12.5 v tem zborniku). Izjema je ognjišče v sedimentacijskem nivoju –177 cm. V faciji A, kjer je kosti manj, so te bolj fragmentirane kot v faciji B, kjer je kosti bistveno več. Način, kako sta človek in zver ravnala s kostmi, je očitno narekovalo izobilje ali pomanjkanje surovine, bogate s proteini. Odzivi na obilje ali pomanjkanje so vedno, povsod in pri vseh posameznikih enaki.

V Divjih babah I smo po daljšem času ponovno odkrili in dokumentirali najdbe, ki vsebujejo elemente medvedjega kulta tudi pri neandertalcih (glej podpoglavje 12.4 v tem zborniku) in ne samo pri modernem človeku v mlajšem paleolitiku. Obstoj takšnega kulta v srednjem paleolitiku so že davno ovrgli, tako kot so ovrgli t. i. protolitska orodja in dali zanje novo razlago (Koby 1954; Chase 1987). Zavrnitev kulta je

Sedimentation level (cm)	Facies	Layer & climate (temperature)	Climate (humidity)	FAUNA List of species			NISP (Aves)	NISP (Micromamalia)	NISP (*Ursus spelaeus*)	NISP (Macromamalia)	Carnivores	Non-Carnivores
				Birds	Small mammals	Large mammals						
-429	B	12 (Temperate)	1.15 (Humid)	/	*Sorex alpinus*, *Sorex alpinus/araneus*, *Chionomys nivalis*, *Arvicola terrestris*, *Myodes glareolus*, *Microtus* ex gr. *agrestis-arvalis*, *Microtus* ex gr. *liechtensteini-subterraneus*, *Muscardinus avellanarius*, *Sicista* cf. *subtilis*	*U. spelaeus*, *Vulpes* s. *Alopex*	0	198	5065	1	2	0
SUM Facies B							***1***	***655***	***78962***	***133***	***9***	***4***
-441	C-1	13 (Temperate)	1.27 (Dry)	/	*Vespertilio murinus*, *Chionomys nivalis*, *Arvicola terrestris*, *Myodes glareolus*, *Microtus* ex gr. *agrestis-arvalis*, *Microtus* ex gr. *liechtensteini-subterraneus*	*U. spelaeus*, *M. martes*	0	210	4149	2	2	0
-453	C-1	14 (Temperate)	1.38 (very Dry)	*Phasianus colchicus*	*Talpa europaea/caeca*, *Chionomys nivalis*, *Arvicola terrestris*, *Myodes glareolus*, *Microtus* ex gr. *agrestis-arvalis*, *Microtus* ex gr. *liechtensteini-subterraneus*	*U. spelaeus*, *M. martes*, *C. capreolus*	1	204	2191	2	2	1
SUM Facies A-C							***11***	***1173***	***122831***	***305***	***9***	***4***

bila preuranjena, razlaga nastanka protolitskih orodij oz. zaobljenih kostnih fragmentov pa napačna. O lovu, kultu in izrabi kostnih ostankov jamskega medveda bomo več poročali v načrtovanem drugem delu monografije. O zaobljenosti kosti pa tole: večina kostnih odlomkov ni bila zaobljena zaradi suhega transporta (*charriage à sec*), kot je razložil F.-E. Koby (1941) in kot je bilo splošno sprejeto, temveč zaradi kemijskega preperevanja robov in štrlečih delov. Gre za enak proces, kot pri kamninah, kjer mehansko zdrobljeni kosi na mestu sferično preperevajo. Preperevanje (raztapljanje) je najmočnejše na robovih, ki postopno postajajo bolj in bolj zaobljeni. V najdiščih s številnimi kostnimi ostanki obstaja korelacija med zaobljevanjem in globinskim korozijskim razjedanjem kamninskih klastov in kostnih fragmentov (glej podpoglavje 5.2 v tem zborniku, *sl.5.2.3*). Preperevanje je najmočnejše v tleh in je neposredno odvisno od hitrosti sedimentiranja.

Standardna kvantitativno-kvalitativna metoda, uporabljena prvič pri nas v Divjih babah I, je v kombinaciji z bolj objektivnim stratigrafskim pristopom prinesla vrsto novih izsledkov in nove odgovore na nekatera stara vprašanja, za katera smo mislili, da so bila ustrezno rešena. Nadaljevati v tej smeri se zdi vsekakor smiselno in obetavno. Hkrati se je treba zavedati, da nobena rešitev ni dokončna, ker se vedno odkrijejo boljši načini za reševanje vedno enakih vprašanj, in da novi odgovori porajajo nova vprašanja.

18. CONCLUSION

IVAN TURK

A concluding chapter normally summarises all the findings from individual chapters. Since this would repeat what has already been written, I decided on a different approach, which enables a brief but objective review of all the basic data on the site and improves the possibility of establishing correlations among the various groups of finds shown in *Tab. 19.1*. In short, a conclusion reached in a slightly different manner may additionally contribute to a better understanding of the site and its complex system.

The chapters deal with individual themes by a more or less common stratigraphic key, which I proposed as one of the heads of excavations in Divje babe I and as the editor-in-chief of this volume. In addition to the stratigraphic key, which may be subjective (division of the site profile into geological and other layers) or objective (stratification of sediments by depths, measured from a datum), there is here a further chronological key. It is difficult to harmonise data classified by one and/or another key. Unfortunately, conclusions relating to individual themes depend very much on the manner of adjusting stratigraphy to chronology, whereby the latter presupposes the contemporaneity of various groups of finds. I see the best way of harmonising stratigraphy with chronology in sedimentation levels and not in geological layers as is usual. I give the reasons for this in Chapter 2 of this volume. However, there are also difficulties with such a method, connected with the chronology of individual finds that are dispersed spatially (*Tab. 19.1*).

All levels were deposited over the course of 40,000 years. During this period there were at least two major breaks in sedimentation, which together lasted some 15,000 years (see Chapter 6 in this volume). Each of the 37 sedimentation levels has a temporal resolution of 675 years. This means that I cannot claim that any of the finds are contemporary with each other, unless the finds are closed, such as the charcoal in a hearth, anatomically connected bones, conjoined fragments of bones and conjoining flakes. In levels where there was a more extended break in the deposition of sediments (hiatus or gap), finds can accumulate from a very long time period, which makes their interpretation difficult and can even cause wrong conclusions.

Individual groups of finds as a source of information are not always synchronized among themselves, still less with other sources of information such as congelifracts, aggregates and other phenomena in sediments. Over the course of 700 years and more, an intermixture of information from various periods can occur, both because of the nature of the source and the effect of time. Chronological interpretations of sites and interpretations that are derived from chronology are often questionable, because they are unreliable and, to a certain extent, subjective. Divje babe I is no exception in this but has the advantage over other similar sites in the region that the subjectivity is reduced and controlled by the method that we used in the excavation process and after it. The new method (statistics in combination with sedimentation levels), which differs from established, generally accepted methods only in the manner of implementation, is the fruit of many years of work at a single site dealing with the same problems (see Turk 2003a, 2006).

Table 19.1 shows data in stratigraphic-chronological succession. Except for temperature data, based on congelifracts sampled in the profile, all the data are balanced and synchronized in terms of stratigraphy, or objectively comparable, because they relate to a measured depth and specific area or volume of sediments (see Chapter 1 in this volume). The information is not complete, because of the limited area of the block of sediments with sedimentation levels. Above all, some of the rare finds, such as points from organic materials, rare animal and plant species etc are not taken into account. All these could be disruptive.

I divided the quantitative and qualitative data into two chronological groups (facies A and B) which, unfortunately, belong to the Middle Glacial as a uniform chronozone. The Early Glacial chronozone (facies C-1), which would give interesting results in comparison with the Middle Glacial chronozone, is badly represented because the method used in the first years of excavation, when the site was treated in the traditional manner (see S. Brodar 1958, 277; Osole 1965, 144), was unsuitable. In relation to the older excavations we then determined climate independently from the remains of flora and fauna, which enabled cross-checking of the palaeoclimatic and palaeoenvironmental results obtained from the various sources.

It is characteristic of the data shown in *Table 19.1*, that they are discontinuous. Authigenic aggregates are the only exception (see sub-chapter 5.3 in this volume) and finds of cave bear, which lived continuously in the vicinity of the site. We can only monitor continuity of other data in shorter sections that indicate at least a prolonged presence of individual species, such as arctic and forest vole, brown bear, wolf, pine marten, ibex and marmot, in the vicinity of the site.

Because of a more than 10,000 year break in sedimentation, all four of the highest sedimentation levels are contaminated by Holocene and Pleistocene finds. This is confirmed above all by the remains of small cattle and beech charcoal dated by the ^{14}C-method (see Chapter 8 in this volume). Such contamination is also possible in other sedimentation levels, anywhere where there was an extended break in sedimentation. In layers 2–5a, a mixing of finds from various levels or layers could have occurred because of bio- and cryoturbation. So interpretations relating to the uppermost sedimentation levels must be treated with some caution.

Artefacts, charcoal and charred bones represent predominantly short-term human activities in the cave and a more prolonged human presence in the environment. This applies particularly to charcoal in hearths, preserved *in situ*, which has the highest temporal resolution. The charcoal from such hearths actually represents the nearby tree vegetation of a day or a week.

Charred bone fragments are a reliable sign of the presence of hearths, even if they have not been preserved *in situ.* Charcoal can also enter the cave from fires in nature, as happened during the time of sedimentation of Layer 4. In such cases there is no charred bone. Charcoal and charred bone fragments gravitate from hearth levels through the gaps (voids) between clasts to underlying levels, because of which both – in addition to a normal lateral dispersion which badly effects the preservation of charcoal – are dispersed vertically up to 50 centimetres downwards (see *Tab. 19.1*). The process is halted in a vertical direction when the gaps are filled with matrix, but lateral movement continues until the hearth is covered by new sediment.

Since exclusively conifers, and almost all species of them, are represented in the large hearth in sedimentation level –333 cm (facies B), it can fairly reliably be concluded that deciduous trees did not grow at that time. In contrast, in some sedimentation levels of facies A and B, in addition to conifers there are also a number of deciduous species, including beech. Two conclusions are possible: either that people only visited the cave in periods with forest vegetation (coniferous and mixed forest) or that forest was present throughout. There is a phase in facies A in which there is no charcoal but there are artefacts. Was there then, at least at the end, no forest? A cold and dry climate could have affected tree species and forest could have gradually disappeared. Not least because of fire, recorded at the time of sedimentation of Layer 4, which is a momentary event without long-term consequences. Finds of fauna (*Tab. 19.1*) and pollen (Šercelj, Culiberg 1991) do not support a hypothesis of the complete disappearance of forest. A gradual transition from a warm and humid climate to a cold and dry one is indicated by a reduction in the number of finds of typical forest fauna from sedimentation level –165 cm upwards.

In addition to animal species that are typical of open habitat (*Pirhocorax pirrhocorax, Lanius excubitor, Chionomys nivalis, Microtus* ex gr. *agrestis-arvalis, Marmota marmota*), sedimentation levels without charcoal also contain species that are exclusively forest dwellers (*Myodes glareolus, Martes martes*). Conifers (*Pinus, Picea*) greatly predominate among pollen, which is joined in Layer 4 with spores of lesser clubmoss (*Selaginella selaginoides*), a typical arcto-alpine species. Bank vole (*Myodes glareolus*) is among the commonest small mammals at Divje babe I (see Chapter 10 in this volume, *Fig. 10.5*). However, there are fewest remains in sedimentation levels –106 and –117 cm, and then it temporarily disappears completely.

The coldest and driest climatic phases can be identified as levels –81 and –94 cm, if charcoal in sedimentation level –81 cm originates from a higher level and the dormouse in sedimentation level–94 cm is (sub)recent contamination. Only pine and spruce pollen and spores of lesser clubmoss are represented in the profile in Layer 4. There are no typical forest species among fauna in the two sedimentation levels, except one find of pine marten, but there are typical representatives of open habitats (*Pirrhocorax pirrhocorax, Microtus* ex gr. *agrestis-arvalis, Marmota marmota*).

There is no major difference in quality between facies A and B (*Tab. 19.1*), despite the great difference in the amount of charcoal, which is in direct proportion to the number of artefacts. The ratio between deciduous and coniferous species is unchanged. There is balanced representation in both facies (7:7 and 8:8) of more or less the same deciduous and coniferous species. Facies A contains the deciduous species *Ostrya, Fraxinus, Fagus, Acer* and *Ulmus,* and facies B *Carpinus-Ostrya, Carpinus, Fraxinus, Fagus, Acer, Alnus* and *Sorbus*. Both facies contain the coniferous species *Pinus, Pinus cembra, Picea, Abies, Taxus* and *Juniperus*, and facies B additionally *Larix*. Essentially different conditions are indicated in facies C, in which deciduous species probably predominated. This is shown by analyses of pollen in the profile at the cave entrance, which show increased presence of beech and other deciduous trees (Šercelj, Culiberg 1991).

Different tree species grew in the immediate vicinity of the site at various periods and people used the wood from them indiscriminately for burning. It is less likely that all the established species grew in the vicinity of the site continuously and people used them selectively for burning. Pollen analysis in the profile at the cave entrance ascertained only the following tree species in facies A and B: *Pinus, Picea, Betula, Alnus, Corylus, Ostrya, Tilia, Fraxinus, Hedera, Salix* and *Sambucus* (Šercelj, Culiberg 1991). The differences between charcoal, which represents the immediately nearby vegetation, and pollen, which also represents very distant vegetation over an extended period, are clear and expected. The high proportion of deciduous species in hearths from the period of the Middle Glacial or Middle Würm was unexpected. Nothing similar is known from other Slovene palaeolithic sites, which chronologically should cover the whole time span of the last glacial (Šercelj, Culiberg 1985). This might be explained by the cave being visited mainly in warm periods, but this cannot be generalised. We know that the hearth in sedimentation level –333 cm (see Chapter 12 in this volume, *Fig. 12.5.1*) was used in a very cold and humid climate, which is cross-verified by sedimentological, anthracotomical and palaeontological data (see *Tab. 19.1*). A number of the hearths in Layer 6 are also from periods with cold climate.

People visited Divje babe I under various climatic conditions, which means that climate did not directly affect their presence in the surroundings. Everything indicates that the environment, despite evident climatic oscillations and the proximity of the Alps, did not essentially change, e.g., from a forest landscape (including taiga) into steppe or even tundra, which is characteristic of regions north and east of the Alpine arc, and at the time of the early glacial maximum caused a gap in settlement. The most recent intensive investigations of old cave sites show that even in the Lesser Carpathians there were periods when mixed forest grew in the "full glacial", in addition to periods of taiga and tundra (M. Hajnalová, E. Hajnalová 2005). Intensive study of palaeolithic hearths will also in future bring very useful data about the palaeoenvironment, which will be distinguished by exceptional temporal resolution. This cannot be expected from the pollen record.

The remains of fauna which help interpret the ancient environment were deposited over a significantly longer period than the charcoal. The shortest possible time is approximately 700 years. In the case of small mammals, it is mainly the selection of owls, and with non-carnivore remains selection by large carnivores and/or man.

The remains of birds of prey represent an insignificant proportion of remains of avifauna, which are in any case rare (see Chapter 9 in this volume). There is one remain each of snowy owl (*Nyctea scandica*), white-tailed eagle (*Haliaeetus* cf. *albicilla*), common buzzard (*Buteo buteo*) and common kestrel (*Falco tinnunculus*), found in the layers of facies A. There are six times fewer finds of small mammals in the sedimentation levels of facies A than in those of facies B, which is without finds of birds of prey (*Tab. 19.1*). There are no, or extremely few remains of small mammals in a number of sedimentation levels at the end of facies B. The highest concentration of finds of small mammals is in the sedimentation levels of facies C and the lower part of facies B, which could be linked to large rockfall blocks, which were ideal resting places of birds of prey. All the concentrations of small mammals are laterally restricted.

The third phalanx of a pheasant (*Phasianus colchicus*) in sedimentation level –453 cm is a rare find. It belongs chronologically to the Early Glacial and, except for finds from layers H–J in Vindija (V. Malez 1988), is one of the oldest finds of this species in the region. In terms of the protocol, contamination is excluded. How the isolated find got to Divje babe I, is a riddle which could reasonably be explained only by the mediation of Neanderthal visitors to the cave in the period of the richest palaeolithic horizon E. The slightly more recent isolated find of the third phalanx of a mammoth or rhinoceros could be similarly explained. It is known that Neanderthals and even their predecessors occasionally collected »souvenirs«. Not least, there is indirect quantitative evidence from Divje babe I, where Neanderthals deliberately collected large bear canines (see sub-chapter 12.2 in this volume).

Of small mammals, remains of the explicitly forest species *Myodes glareolus* and the explicitly grassland species *Microtus* ex gr. *agrestis-arvalis* appear more or less together. Remains of snow vole (*Chionomys nivalis*) have the most continuous vertical (temporal) distribution, which can be explained by the continuous presence of a rocky environment, which is still today a characteristic of the surroundings of the site. The remains of mole (*Talpa europaea/caeca*) and dormouse (*Glis glis*) appear sporadically in uncontaminated sedimentation levels; the latter also together with remains of beech (*Fagus*), which indicates the fairly mild climate of the »full glacial« (Middle Würm). Considerable caution must of course be taken in chronological correlation of the remains of small mammals with other palaeontological finds and with sedimentological data. Because of their small size, these remains can travel even deeper into the sediment than pieces of charcoal from hearths, especially in levels and parts containing large blocks. It cannot therefore be excluded that the small mammals from a number of successive sedimentological layers belong to the same time horizon, ±700 years long.

Qualitative relations between facies and small mammals are dealt with in Chapter 10 of this volume (see above all *Fig. 10.5*). Although there are six times more finds of small mammals in facies B, there are fewer of some species that are good environmental indicators than in facies A. This applies in particular to the species *Chionomy nivalis* and *Microtus* ex. gr. *agrestis -arvalis*, which could mean that the terrain in the vicinity of the cave was more overgrown in facies B and birds of prey had more difficulty getting their prey, which because of the changed environment was also numerically smaller, although it never completely disappeared. B. Toškan and B. Kryštufek found greater differences in the taphocenosis of small mammals between facies C and B and between C and A (see Chapter 10 in this volume).

In the sedimentation levels of transition from OIS 5 (= facies C-1) to OIS 4 (= facies B) or from the Early Würm to the Middle Würm there are no major changes to be seen among small mammals. Mention must be made of the only two typical steppe species, remains of which we found only in those sedimentation levels. These are *Sicista* cf. *subtilis* and *Vespertilio murinus* (for details see Chapter 10 in this volume). Similarly, the uppermost sedimentation levels of facies A against expectation are not infected with arcto-alpine microfauna of OIS 2 or the Late Würm. Both can be explained as follows: the first glacial maximum in OIS 4 was less cold in the Alps than the second, in OIS 2 (see Preusser 2004), although the oxygen isotope curve shows entirely the reverse and nobody seems to be able to explain that. In the second glacial maximum, approximately 24,000 years ago, the cave entrance, which is almost permanently in shadow, was already so small that the cave froze and became inhospitable to everything then living in the surroundings.

The remains of large mammals, although few in number, of all finds are most continuously distributed in the sedimentation levels (*Fig. 19.1a*). Carnivores are for the most part responsible for this, which constantly visited the cave and dragged their prey into it, especially if they had a lair there, such as cave bear, brown bear, cave lion, leopard and wolf. Their young could also die in the cave, including very often the young of cave bear, whose remains represent more than 80% of all bear remains (see Chapters 12 and Debeljak 2002a, c).

Animals that more or less continuously lived in the surroundings of the cave include wolf (*Canis lupus*) and pine marten (*Martes martes*) in addition to cave bear (*Ursus spelaeus*). The constant presence of pine marten indicates the constant presence of forest, at least conifers. There is no marten in the upper six sedimentation levels, but it then appears downwards consistently until level –153 cm inclusive, then disappears in the next four levels (–165 do – 201 cm). The smallest number of large mammals is characteristic of these four levels (*Fig. 19.1a*) and a falling number of small mammals. It is difficult to ascertain the cause of this. There is a short and very cold climatic phase in this segment, represented by Layer 6. This layer, which came mostly from the weathering of the cave shelves, was very quickly deposited in the slightly depressed region of the analysed block of sediments. It is the layer with the largest number of hearths, the charcoal of which is scattered throughout the cave and belongs almost exclusively to conifers. There is a similar palaeontological picture in a further two to three sedimentation levels, namely –249 to –273 cm in facies B, which belong to a moderate and humid climate. There is no pine marten, and charcoal is almost exclusively from conifers. Large mammals are normally represented (*Fig. 19.1a*). Pine marten appears more or less continuously in other sedimentation levels of facies B. The more or less constant presence of forest in facies A and B is also confirmed by the results of pollen analysis of samples of layers excavated by M. Brodar (Šercelj, Culiberg 1991).

Large mammal species include some species that prefer open habitat. Marmot (*Marmota marmota*) is such a species which, because of its regular appearance in numerous sedimentation levels, must have been fairly continuously in the vicinity of the site. In one case it appears together with another typical alpine species, ibex (*Capra ibex*), and in two with the typical arctic species arctic fox (*Alopex lagopus*), in one of which cases together with brown hare, perhaps mountain hare (*Lepus* sp.). In the first case, the sedimentation level may be contaminated with finds which actually belong to OIS 2, and the second two sedimentation levels were deposited in a cold and very humid climate in OIS 3. We came across the remains of chamois (*Rupicapra rupicapra*) in several sedimentation levels. This species, like the snow vole (*Chyonomis nivalis*), was attracted to the rocky environment of the cave as a spatial constant. However, the two species only rarely appear together, more often in facies A than B. A small chamois population still lives today in the area of the site, but snow vole is no longer found among the prey of recent owls (Kryštufek 1997).

In the region of transition from OIS 5 (= facies C-1) to OIS 4 (= facies B) or the Early Glacial (Würm) to the "full glacial" (Middle Würm) not many species characteristic of an explicitly cold climate, are represented. The small number of species and finds is above all striking, since only two species are represented (*Martes martes* and *Vulpes* s. *Alopex*), other than cave bear. The charcoal is almost exclusively from conifers (*Pinus, Picea, Larix, Abies, Taxus* and *Juniperus*). The remains of small mammals include both forest and grassland representatives. Southern birch mouse *Sicista* cf. *subtilis* is a particular rarity; a typical steppes species, which is joined by another typical steppes species *Vespertilio murinus*. The general floristic-faunistic picture is very similar in sedimentation levels –165 to –201 cm. In both cases there are elements of moderate and cold climates, with a predominance of elements of cold climate. Both types of climate were also found sedimentologically.

From the point of view of hunting, the ratio between carnivores and non-carnivores (probably prey) is important. Carnivores greatly predominate in the majority of sedimentation levels (*Fig. 19.1b*), because of which they must be taken into account together with people as probable transporters of prey. There are only a large number of species of carnivore and a large number of species of prey in the lower levels of facies B (*Fig. 19.b*), when there was a predominantly cold climate. We therefore conclude that the main carriers of prey were carnivores. A number of levels of facies A contain a large number of predatory species but few species of prey. In this segment, too, the climate was predominantly cold. In some sedimentation levels, continuously (–405 to –441 cm) and discontinuously (–141, –189, –225, –237, –285 cm), there is one or more species of predator but no prey (*Fig. 19.b*). Because in two of these levels (–225 to –237 cm) there is also a relatively large number of artefacts (22 items), the question is raised of who hunted and what. If people hunted, they hunted predators. The following can be considered: brown bear (*Ursus arctos*), cave lion (*Panthera spelaea*), wolf (*Canis lupus*) and marten (*Martes martes*). These are fairly unusual prey for people but not so unusual for carnivores. So predators preyed on predators if there was no other choice.

In and below sedimentation levels with hearths, there is no observable increase in the number of all remains of large mammals nor an increased number of non-predator species or normal hunting game. We therefore conclude that the people who came to the cave were not then greatly involved in hunting. There is of course the possibility that some remains do represent their prey. B. Toškan (Chapter 11 in this volume), who processed all finds of fauna found that people hunted mainly red and roe deer, chamois and ibex and, at least in facies A, probably also marmot.

The ratio between carnivores and non-carnivores in the two facies is the same. There are only minor differences in the representation of all species and the number of remains. There are more non-carnivores in facies A, thanks to carnivores. The following carnivores are characteristic of facies A: *Ursus spelaeus, Ursus arctos, Panthera pardus, Lynx lynx, Canis lupus, Mustela putorius, Martes martes* and *Lutra lutra* and non-carnivores: *Marmota marmota, Rupricapra rupricapra, Capra ibex* and *Cervus elephus*. For facies B the following carnivores: *Ursus spelaeus, Ursus arctos, Panthera spelaea, Felis silvestris, Canis lupus, Mustela putorius, Martes martes, Vulpes* s. *Alopex* and *Alopex lagopus* and non-carnivores: *Marmota marmota, Lepus* sp., *Rupricapra rupricapra* and *Capreolus capreolus.*

Two pronounced peaks of remains of large mammals, more precisely carnivores without cave bear, are recorded in facies A and one in facies B. All peaks are connected with cold and dry or cold and very humid climates, which presumably drove the carnivores into the cave lair. There is no correlation between the remains of carnivores and non-carnivores.

Cave bear reacted to climate change in its own way. In absolute terms, there are the most remains in sedimentation levels characterised by a cold and very humid climate which means that humidity disturbed cave bear more than cold. In more severe conditions, there was competition for cave lairs between males on the one hand and females with cubs on the other. The different ratios between the sexes in facies C on the one hand and facies A and B on the other, or the similar ratios in the warm/dry climate in facies C and part of facies A with a comparable climate is clearly illustrated in metacarpals (see Chapter 17 in this volume). The share of males, which are larger than females, increases in a cold and humid climate. Morphometric investigation of skulls, large long bones and metapodia of cave bear from Divje babe I (see Chapters 15–17 in this volume) did not confirm the existence of different species or subspecies of bear, as suggested by Rabeder *et al* (2004c) for Alpine sites, if the results of the research are treated in the light of all collected climatochronological data and their interpretations, and taking into account the behaviour pattern of living bears. Cave bear and other large carnivores (lion, panther, lynx, wolf) were not the prey of palaeolithic hunters, but died naturally in the cave lair. There are very few traces left by carnivores on bones and still fewer traces left by people (see sub-chapter 12.3 in this volume, *Tab. 12.3.1*). This does not, of course, mean that neither people nor carnivores made use of bones, above all cave bear bones, of which there were the most. We thus established that people collected the canines of male bears, and intensively smashed or carried off skulls without the mandible, femurs and tibia of cave bear. This is most clearly seen in the three levels with hearths, where the sample of these remains from adult specimens differs from the sample of immature specimens, which were the primary target of carnivores (see sub-chapter 12.5 in this volume). The hearth in sedimentation level –177 cm is an exception. In facies A, where there are fewest such bones, these are more fragmented than in facies B, where there are significantly more bones. The manner in which people and carnivores treated bones was clearly dictated by the abundance or lack of raw materials rich in proteins. Responses to abundance or lack are always the same, everywhere and with all individuals.

In Divje babe I, after a long time we again uncovered and documented finds that suggest elements of a bear cult also with Neanderthals (see sub-chapter 12.4 in this volume) and not just with anatomically modern humans in the Upper Palaeolithic. The existence of such a cult in the Middle Palaeolithic has long been refuted, just as the notion of »protolithic« tools was refuted and a new explanation given for them (Koby 1954; Chase 1987). The refutation of the cult was overhasty, the interpretation of the formation of protolithic tools or rounded bone fragments was mistaken. We will report more about hunting, the bear cult and the use of cave bear bones in the planned second part of the monograph. However, very briefly concerning the 'rounding' of bones: the majority of bone fragments were not rounded by *charriage ŕ sec*, as F.-E. Koby (1941) explained and as has been generally accepted, but by chemical weathering of the edges and projecting parts. It is the same process as with rocks, in which mechanically fragmented pieces are spherically weathered *in situ*. Weathering (dissolving) is greatest at the edges, which gradually become more and more rounded. At sites with numerous bone remains, as Divje babe I, there is a correlation between rounding and cavernous corrosion of limestone or dolomite clasts and bone fragments (see sub-chapter 5.2 in this volume, *Fig.5.2.3*). Weathering is greatest in the top soil and is directly dependent on the rate of sedimentation.

The standard quantitative-qualitative method first used in Slovenia at Divje babe I, in combination with a more objective stratigraphic approach, has brought a series of new results and new answers to some old questions which we thought had been satisfactorily answered. It certainly seems sensible and promising to continue in this direction. At the same time, there must be awareness that no solution is final, because better ways are always being found for resolving always the same questions, and that new answers give rise to new questions.

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SKLEPNA BESEDA

Če na koncu prvega dela monografskega zbornika o Divjih babah I, kot urednik in vodilni avtor, potegnem črto pod skupnim delom, ugotavljam naslednje:

Raziskovanje paleolitskih najdišč ima mnogo ciljev, med katerimi sta temeljna za razumevanje vseh procesov v določenem prostoru, kronologija in paleookolje. Najdišča ponujajo v tem pogledu različne možnosti, odvisno od njihovega potenciala in od tega kako ta potencial izkoristimo.

Pomemben del vsake raziskave je tudi kronološko umeščanje najdišč, raztresenih v prostoru. Takšno početje običajno imenujemo »sinteza« in je zelo cenjeno. V tem monografskem zborniku boste, kljub dodelani kronostratigrafiji najdišča, zaman iskali takšno sintezo, ker je ni. Ni je zato, ker enostavno ni mogoča zaradi pomanjkanja zanesljivih, enoznačnih podatkov. Večplastnih slovenskih srednjepaleolitskih najdišč (Betalovega spodmola in drugih) trenutno ni mogoče kronološko vzporediti z Divjimi babami I na način, ki bi vzdržal vsaj najmanjšo možno kritiko. Tudi s tujimi najdišči, ki sicer razpolagajo z bistveno večjo količino kvantitativno-kvalitativnih podatkov kot slovenska najdišča brez Divjih bab I, ni dosti bolje. Za primer navajam v letih 1966–1977 raziskano srednjepaleolitsko (kisikova izotopska stopnja OIS 3) večplastno jamsko najdišče La Baume de Gigny, 485 m n., v. v gorovju Jura v Franciji, ki ima podobno topografsko lego in sedimentno okolje kot Divje babe I in razpolaga s solidno bazo podatkov, ki so bili dobro analizirani in interpretirani (*La Baume de Gigny (Jura),* 27e supplément à Gallia Préhistoire, Campy, M., J. Chaline in M. Vuillemey (ur.), 1989). Vendar primerjava z Divjimi babami I kljub temu ni mogoča, vsaj ne takšna, ki je ne bi bilo mogoče zlahka ovreči, na podlagi mnogih neskladij v celotnem naboru podatkov. Glavni problem pri kronološkem vzporejanju predstavljajo v tem primeru številne sedimentacijske vrzeli v obeh najdiščih, ki večinoma niso sinhrone, in način, kako je bila ugotovljena paleoklima, od katere je odvisno paleookolje (prim. Campy, Chaline 1993). Sklicevanje na regionalne posebnosti v primeru klimatskih sprememb ni mogoče. Te so bile povsod podobne in so se od območja do območja razlikovale kvečjemu po moči, dolžini in faznem odmiku. Pač pa so lahko do neke mere odzivi okolja na klimatske spremembe po regijah drugačni.

Kar zadeva raziskave paleookolja v Divjih babah I, so te pokazale, da to ni bili takšno, kot bi moralo biti na podlagi ustaljenih predstav o ledeni dobi, tj. človeku neprijazno in bistveno drugačno od današnjega. Na to so prvič opozorila odkritja paleolitskih najdišč v različnih visokih gorstvih, ki naj bi bila v ledeni dobi prekrita z večnim snegom in ledom, pa takšne in drugačne najdbe kažejo, da niso bila. Vsesplošno zakoreninjeno predstavo o ledenodobnem okolju temeljito spreminjajo tudi najnovejše raziskave povsod po Evropi. Vse na podlagi izpopolnjenih raziskovalnih metod in tehnik. Številna neskladja in protislovja v ogromni bazi najrazličnejših podatkov, takšne in drugačne kakovosti, pa silijo izkušene raziskovalce v drugačna razmišljanja o ledenodobnem okolju.

Spoznanje, da Divjih bab I ni mogoče kronološko povezati z drugimi domnevno sočasnimi najdišči na eni strani, in oblikovanje temeljev za drugi del monografskega zbornika, ki bo obravnaval kamene in druge izdelke, ognjišča in njihovo vlogo v življenju neandertalcev, vprašanje lova ter odnos jamski medved – človek, na drugi strani, sta glavna dosežka dvajsetletnega raziskovalnega dela snovalcev tega zbornika.

Na tej relativno uspešni točki raziskovalne naloge sem se kot pobudnik in usklajevalec vse dejavnosti, vezane na to nalogo, odločil, da njeno nadaljevanje v celoti prepustim mladim, trenutno brezposelnim arheologom. Prav tako sem sklenil, da se ne bom vmešaval v njihovo delo, ker bi jih lahko motila že moja prisotnost v stroki, kajti mlade smreke le s težavo zrastejo v senci starih dreves in jih prerastejo. Moja iskrena želja je, da bi bili tisti, ki bodo nadaljevali s paleolitskimi raziskavami v Sloveniji, v vseh pogledih boljši, in da bi obogatili naš paleolitik z novimi najdbami, idejami in pristopi.

Ivan Turk

1995

2007

Sl. 4.1b: Profil y = 2 m. Risba I. Turk (svinčnik) in D. Knific Lunder (tuš).
Fig. 4.1b: Profile y = 2 m. Drawing I. Turk (pencil) and D. Knific Lunder (ink).

Divje

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