

VELIKE PODNEBNE  
SPREMENBE RAZKRITE  
NA PODLAGI  
MALIH FOSILOV.  
NEKDANJE OKOLJE NA  
MEJI MED ZGODNJIM IN  
SREDNJIM WÜRMOM  
V OKOLICI DIVJIH BAB I  
(Z SLOVENIJA)

BIG CLIMATIC CHANGES  
REVEALED  
BY TINY FOSSILS.  
PALAEOENVIRONMENT  
AT THE BOUNDARY  
BETWEEN THE EARLY  
AND MIDDLE WÜRM IN  
THE SURROUNDINGS OF  
DIVJE BABE I (W SLOVENIA)

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“Raziskovanje paleolitskih najdišč ima mnogo ciljev, med katerimi sta temeljna za razumevanje vseh procesov v določenem prostoru kronologija in paleookolje.”

I. Turk [ur.] 2007 (str. 479)

“The investigation of Palaeolithic sites has many objectives, of which the most fundamental to an understanding of all processes in a certain area are the chronology and palaeoenvironment.”

I. Turk [Ed.] 2007 (p. 479)

### Izvleček

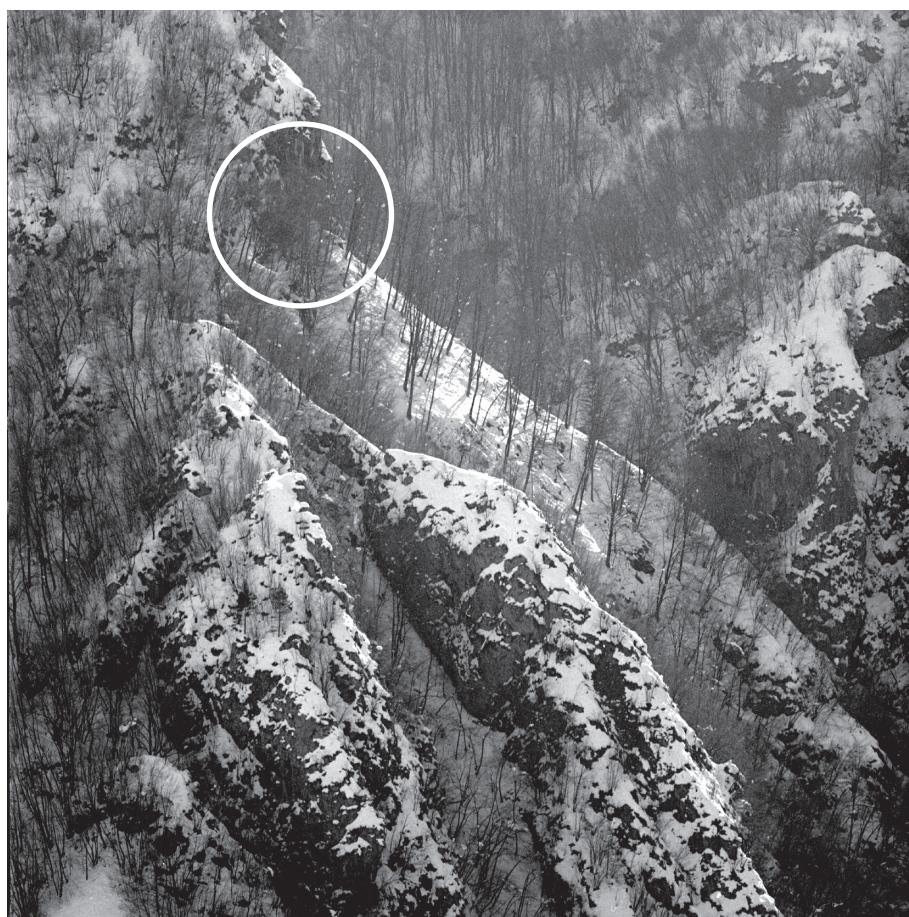
V mlajšepleistocenskih (OIS 3 in OIS 5a) plasteh paleolitskega jamskega najdišča Divje babe I so bili med manjšimi zaščitnimi izkopavanji v letu 2006 najdeni ostanki najmanj 113 primerkov malih sesalcev, pripadajočih vsaj 15 različnim vrstam: *Sorex alpinus*, *S. araneus*, *S. minutus*, *Talpa europaea*, *Chionomys nivalis*, *Arvicola ex gr. amphibious - schermann*, *Myodes glareolus*, *Microtus agrestis*, *M. arvalis*, *M. liechtensteini*, *M. subterraneus*, *Apodemus sylvaticus*, *A. flavicollis*, *Glis glis*, in najmanj ena vrsta netopirjev. Na podlagi tedanjih združb malih sesalcev izhaja, da je povisjana vlažnost v zaključnih fazah kronocone OIS 5a botrovala začetku širjenja gozdov na račun dotlej prevladujočih odprtih habitatov. Navedeni proces se je nadaljeval tudi v kronoconi OIS 3, ko je živiljenjski prostor v okolici Divjih bab I predstavljal mozaičen preplet pretežno iglastih gozdov, travnatih površin in skalnatih predelov. Skladno z zaostritvijo klimatskih razmer je prišlo tudi do sprememb v spolni strukturi v jami prezimovajočih jamskih medvedov v korist samcev. Pridobljeni rezultati pomenijo neodvisno potrditev že objavljenih paleokolskih rekonstrukcij za območje v okolici Divjih bab I na prehodu iz zgodnjega würma v srednji.

**Ključne besede:** Divje babe I, Slovenija, mlajši pleistocen, mikrofauna, jamski medved, paleoklima

### Abstract

Small-scale rescue excavations of the Late Pleistocene layers of the Palaeolithic cave site of Divje babe I, performed in 2006, yielded the remains of at least 113 specimens of small mammals. They belong to at least 15 different species: *Sorex alpinus*, *S. araneus*, *S. minutus*, *Talpa europaea*, *Chionomys nivalis*, *Arvicola ex gr. amphibious - schermann*, *Myodes glareolus*, *Microtus agrestis*, *M. arvalis*, *M. liechtensteini*, *M. subterraneus*, *Apodemus sylvaticus*, *A. flavicollis*, *Glis glis* and at least one bat species. It can be inferred on the basis of the small mammal assemblages that an increase of humidity in the final stages of OIS 5a led to the progressive extension of forests on an expanse of up to then dominating open habitats. The process continued also in OIS 3, when a mosaic of predominantly coniferous forest with meadows and accumulations of rocky boulders is supposed to have existed in the area of Divje babe I. Parallel to the worsening of the climate, a change in the sex structure of cave bears hibernating in the cave has been observed, with an increased share of males. The presented results are to be seen as an independent confirmation of the already published palaeoenvironmental interpretations for the area of Divje babe I at the boundary of the Early and Middle Würm.

**Keywords:** Divje babe I, Slovenia, Late Pleistocene, small mammal fauna, cave bear, palaeoclimate



*Sl. 1: Pobočje nad dolino Idrijce. Označen je vhod v jamo Divje babe I.  
Fig. 1: The slope above the river Idrijca. Marked is the entrance of Divje babe I.*

## UVOD

Mali sesalci so veliko zanesljivejši kazalnik nekdanjih habitatov, kot to velja za velike. Pravzaprav je fosilizirana mikrofavnna eno izmed osrednjih orodij za interpretacijo ekologije ali habitatov v času, ko se je ta kopičila. Tega se je dobro zavedal tudi Ivan Turk – eden vodilnih raziskovalcev paleolitskega obdobja v Sloveniji – in zato mokro presejanje sedimentov uveljavil kot standardni del arheoloških izkopavanj v tem delu Evrope. Na ta način je – med drugim – končno izpolnil predpogojo za izvedbo poglobljenih študij lokalne mlajšekvartarne mikrofavne (npr. Kryštufek 1997; Toškan, Kryštufek 2004; 2007; Toškan 2009).

Obsežna arheološka izkopavanja paleolitskega jamskega najdišča Divje babe I (*sl. 1*), ki jih je v večjem delu vodil prav I. Turk, so navrgla bogat vzorec ostankov malih sesalcev ( $N = 2.877$ ). Pridobitev tako obsežnega gradiva je bila izvrstna priložnost za dokumentiranje würmske mikrofavne z južnega roba alpske poledenitve ter izvedbo poglobljene študije takratnega okolja. Sodeč po razlikah med skupkoma malih sesalcev iz dveh različnih faz zadnje poledenitve (tj. OIS 5a in OIS 3) naj bi

## INTRODUCTION

Small mammal faunas are known to be better proxies for the past environment than are the larger mammals. As a matter of fact, micromammals in the fossil record provide one of the principal methods of interpreting the ecology or habitat existing at the time the fossils were preserved. Being well aware of this fact, Ivan Turk – one of the leading scientists for the Palaeolithic in Slovenia – established wet sieving of sediments as a standard part of archaeological excavations in the region, finally allowing for thorough studies of local Late Quaternary small mammal faunas (e.g. Kryštufek 1997; Toškan, Kryštufek 2004; 2007; Toškan 2009).

Extensive archaeological excavations at the Palaeolithic cave-site of Divje babe I (*Fig. 1*), in the most significant part directed by Turk himself, revealed a large sample of micromammal remains ( $N = 2,877$ ). This material provided a good opportunity to document the Würmian small mammal faunas from the southern border of the Alpine glacier and to obtain deeper insights into the then environment. On the basis of the established differences between the micromammal assemblages dated to chrono-

v tistem času dokaj odprto travniško krajino postopoma nadomestilo pretežno gozdnato okolje s prevladajočo vlogo iglavcev ter posameznimi travniki in skalnatimi površinami (Kryštufek 1997; Toškan, Kryštufek 2007). Izrazito multidisciplinarni pristop k obravnavi posameznih najdišč, ki ga je Ivan Turk vseskozi vneto spodbujal, je zagotovil izhodišče za preverbo zanesljivosti takšne paleookoljske interpretacije. Njena primerjava z izsledki sedimentoloških (Turk, Bastiani 2000; Turk *et al.* 2001; 2005; 2007a) in paleobotaničnih (Šercelj, Culiberg 1991; Culiberg 2007) raziskav ter raziskav sesalske makrofavne (Toškan 2007a) je pokazala na zadovoljivo stopnjo ujemanja med posameznimi kazalniki nekdanjega okolja in podnebnih razmer (Turk 2007a). Ne glede na to so dvomi nekaterih avtorjev o predstavljeni klimatološko-kronološki interpretaciji ostali (npr. Rabeder *et al.* 2008, tab. 1; Brodar 2009, 197 ss.). Tudi zaradi tega sva po manjših zaščitnih izkopavanjih v letu 2006 izkoristila priložnost in dodatno preverila zanesljivost zgornjih rezultatov. Pri tem sva se osredinila na vzorec malih sesalcev, upoštevala pa sva tudi nekatere druge potencjalne kazalnike nekdanjega podnebja (npr. Toškan 2006; 2007a, 239 ss.). Rezultati raziskave so predstavljeni v tem prispevku.

## NAJDIŠČE IN METODE

Divje babe I so 45 m dolga in do 15 m široka vodoravna jama, ki leži 230 m nad strugo reke Idrijce pri Cerknem (450 m n. m.). Debelina pleistocenskih klastičnih sedimentov v jami presega 13 m. Večinoma jih sestavljajo avtohtoni dolomitski bloki, grušč, pesek in melj (Turk *et al.* 2007). Med izkopavanji je bilo prepoznanih 26 plasti (časovni razpon: pribl. 115.000–35.000/40.000 let pred sedanostjo), ki pa jih je bilo makroskopsko težko razlikovati. I. Turk (2003) je zato *ad hoc* določene geološke plasti nadomestil z novimi temeljnimi stratigrafskimi enotami, t. i. faciesi A do C. Zamenjava je bila opravljena na podlagi rezultatov analize vertikalne porazdelitve strukturnih agregatov (0,5–3 mm) in kostnih najdb (> 3 mm) vzdolž več profilov in znotraj dveh blokov sedimentov. Na podlagi več kot 90 razpoložljivih  $^{14}\text{C}$ - (AMS) in ESR<sup>1</sup>-datumov sta bila faciesa A in B datirana v kisikovo izotopsko stopnjo 3 (= OIS 3; *Oxygen Isotopic Stage 3*), facies C pa v OIS 5a–d. Pridobljene so bile tudi štiri datacije U-niza ( $^{230}\text{U}/^{234}\text{Th}$ ), ki pa se v primeru Divjih bab I niso izkazale za zanesljive (Turk *et al.* 2003). Kronocona OIS 4 v jami skoraj ni zastopana, saj je takrat prišlo do daljšega zastoja v sedimentaciji. Prehod med faciesoma A in B sovpada z nekdanjo plastjo 7 (tj. pribl. 50.000 let pred sedanostjo = p. s.) tisti med faciesoma B in C pa z nekdanjo plastjo 11/12 (tj. pribl. 74.000 let p. s.). Slednji se tako

zones OIS 5a and OIS 3, a shift from a rather open habitat to a mosaic of mixed, predominantly coniferous forest, with meadows and rocky boulders has been proposed (Kryštufek 1997; Toškan, Kryštufek 2007). The all-round manner to dealing with the site, tirelessly encouraged by Turk, provided the opportunity to verify the reliability of such a palaeoenvironmental interpretation by comparing it to the results of sedimentological (Turk, Bastiani 2000; Turk *et al.* 2001; 2005; 2007a) and palaeobotanical (Šercelj, Culiberg 1991; Culiberg 2007) analyses, as well as to those that emerged from the study of large mammal remains (Toškan 2007a). While the conclusions generally coincided (Turk 2007a), not all doubts in the reliability of the existing climate-chronological interpretation have been removed (e.g. Rabeder *et al.* 2008, Tab. 1; Brodar 2009, 229 ff). Consequently, additional testing has been carried out by studying the small mammal remains obtained during a very limited rescue excavation in 2006. Other newly acquired data that can presumably be used to reconstruct past climates (e.g. Toškan 2006; 2007a, 260 ff) have also been taken into account. The results are presented in this paper.

## SITE AND METHODS

Divje babe I is a 45-m-long and up to 15-m-wide horizontal cave, lying 230 m above the bed of the Idrijca River near Cerkno (450 m a.s.l.). The thickness of the Pleistocene clastic sediments in the cave exceeds 13 m. They are composed mostly of autochthonous dolomite blocks, rubble, sand and silt (Turk *et al.* 2007). Excavation established 26 layers (time span: approx. 115,000–35,000/40,000 years B.C.), which were mostly difficult to set apart macroscopically. Turk (2003) therefore substituted the *ad hoc* delineated geological layers with facies A to C, which were based on the analysis of the vertical distribution of structural aggregates (0.5–3 mm) and bone remains (> 3 mm) along several profiles and two blocks of sediments. More than 90 (Nelson, Ku 1997; Lau *et al.* 1997; Turk *et al.* 2001; 2006; Blackwell *et al.* 2007) available  $^{14}\text{C}$  (AMS) and ESR<sup>1</sup> dates have shown that facies A and B formed in the Oxygen Isotopic Stage 3 (= OIS 3) and facies C in OIS 5a-d. Four U/Th dates are also available (Nelson, Ku 1997), but since extended gaps in sedimentation greatly influenced mobilisation and absorption of U, thus leading to its remobilisation, the determination of age by the U series method proved inaccurate in this case (Turk *et al.* 2003). OIS 4 is almost not represented in the cave, since a pause in sedimentation occurred at that time. The transition between facies A and B corresponds with the former layer 7 (i.e. approx. 50,000 years B.C.) and the transition between facies B and C with the former layer 11/12 (i.e. approx. 74,000 B.C.), thereby corresponding to the radiometri-

<sup>1</sup> ESR – elektronska spinska rezonanca (*Electronic Spin Resonance*).

<sup>1</sup> ESR – Electronic Spin Resonance.

Sl. 2: Izkopno polje v jami Divje babe I od leta 1989 dalje (modificirano po Turk 1997, sl. 1.3). Prikazane so oznake kvadratov, ki so bili raziskani med zaščitnimi izkopavanji v letu 2006 (tj. kvadrati A–E), ter tistih, ki so bili izkopani v letih 1989–1999 (i.e. 1–68). Opomba: kv. B = kv. 3.

Fig. 2: The excavation field in the cave Divje babe I from 1989 onwards (modified from Turk 1997, Fig. 1.3). Also shown are the marks of quadrants excavated during the campaign of 2006 (i.e. quadrants A–E) as well as of quadrants excavated in the years 1989–1999 (i.e. 1–68). Note: sq. B = sq. 3.

ujema z radiometrično določeno kronološko mejo med OIS 5 in OIS 4 (Turk *et al.* 2001; Blackwell *et al.* 2007).

Metodologija terenskega raziskovanja med zaščitnimi izkopavanji iz leta 2006, ki so dala tukaj obravnavane živalske ostanke, je v celoti sledila tisti iz 90. let prejšnjega stoletja (Turk 2007c). Standardno vzorčno enoto je tako še naprej predstavljal kvader površine 1 x 1 m in debeline 12 cm (sl. 2). Sediment je bil v celoti spran skozi sita z velikostjo luknjic 10 mm, 3 mm in 0,5 mm. Vzorci posameznih frakcij so bili v nadaljevanju pregledani pod stereomikroskopom, pri čemer so bili pobrani ostanki malih sesalcev. Nabранo gradivo je obsegalo zobe, spodnje in zgornje čeljustnice ter postkranielne skeletne elemente, pri čemer pa slednjih v nadaljnjo analizo nisva vključila. Vsi vzorci so označeni s številko kvadrata in izkopa<sup>2</sup> na način kvadrat/izkop; izkopi so označeni od površja navzdol (za globine izkopov oz. režnjev glej Turk 2007c, opomba 1).

Kvantitativne primerjave med favnami temeljijo na številu določenih primerkov (*Number of Identified Specimens*, NISP) in najmanjšem številu živali (*Minimum Number of Individuals*, MNI). Statistična obdelava je bila izvedena s programskim paketom StatSoft 2001, STATISTICA za Windows, verzija 6.0. Nomenklatura meljakov voluharic je povzeta po van der Meulenu (1973).

Živalske ostanke iz Divjih bab I, ki so bili pridobljeni med izkopavanji leta 2006, hrani Narodni muzej Slovenije v Ljubljani.

## OSTANKI MALIH SESALCEV

Skupno je bilo med izkopavanji v letu 2006 pridobljenih 892 predmeljakov in meljakov malih sesalcev, od česar jih je bilo 424 mogoče določiti vsaj do nivoja rodu. Gre za ostanke najmanj 113 živali, ki sva jih pripisala vsaj 15 vrstam iz šestih družin. Delež glodalcev presega 96 odstotkov določljivih primerkov, medtem ko je red netopirjev zastopan z zgolj štirimi najdbami. Vse v vzorcu zastopane vrste so na območju Slovenije prisotne še danes.

<sup>2</sup> Posamezen sedimentacijski nivo je sestavljen iz vodoravno kopanih enot (režnjev) na način, da je upoštevan vpad (nagib) plasti. Sedimentacijski nivoji torej predstavljajo relativni čas (Turk 2003, 10).

cally determined chronological border between OIS 5 and OIS 4 (Turk *et al.* 2001; Blackwell *et al.* 2007).

The fieldwork methodology of the rescue excavations in 2006, which yielded small mammal remains reported in this contribution, conformed to the practice established during the campaigns in the 1990's (Turk 2007c). The basic sample during excavations thus continued to be a 1 x 1 m square with a depth of 12 cm (Fig. 2). The sediment was sieved (mesh sizes of 10 mm, 3 mm, and 0.5 mm, respectively) and small mammal remnants were extracted under the dissecting microscope. The material consisted of isolated teeth, maxillae, mandibles, and postcranial fragments, with the latter not being considered in this paper. All samples are labeled with the number of their square and spit<sup>2</sup> expressed as square/spit. The spits are labeled from the surface downwards (for spit depths see Turk 2007c, footnote 5).

Quantitative comparisons among taxa are based on the *Number of Identified Specimens* (NISP) and on the *Minimum Number of Individuals* (MNI). Statistical analyses were performed using program package STATISTICA for Windows, version 6.0 (StatSoft Inc. 2001). Nomenclature of arvicoline molars follows van der Meulen (1973).

<sup>2</sup> Each sedimentation level is composed of horizontal dug units (spits) in such a way that it takes into account the angle of incidence (dip) of the layer and thus represents relative time (Turk 2003, 24 f.).

Taksonomski in nomenklatorni vir sta Wilson in Reeder (2005).

Red: Rovke in krti (Soricomorpha)  
Družina: Rovke (Soricidae)

*Sorex minutus* Linnaeus, 1766

Gradivo: plast 12: vzorec E/36 (spodnja čeljustnica).

Mala rovka je zastopana s primerkom spodnje čeljustnice z vraščenima prvima dvema meljakoma. Taksonomska določitev temelji na velikosti najdbe.

*Sorex araneus* Linnaeus, 1758

Gradivo: plast 8/10: vzorec C/30 (zob).

Gozdni rovki je bil pripisan izoliran desni prvi zgornji meljak z obarvanim hipokonom; navedena značilnost je namreč vrstno specifična in tako omogoča zanesljivo razlikovanje med vrstama *S. araneus* in *S. alpinus* (Kryštufek 1991, 38).

*Sorex alpinus* Schinz, 1837

Gradivo: plast 8/10: vzorec C/30 (rostrum); plast 10: vzorec C/32 (zob); plast 11: vzorec B/34 (rostrum), vzorec C/34 (rostrum); plast 13: vzorec E/38 (rostrum).

Štirje rostrumi (vsi s še vedno prisotnim M<sup>1</sup>) ter izoliran prvi zgornji meljak pripadajo gorski rovki; nobeden od petih M<sup>1</sup> nima obarvanega hipokona.

*Sorex alpinus/araneus*

Gradivo: plast 8/10: vzorec C/30 (2 zoba); plast 10: vzorec C/31 (spodnja čeljustnica, 3 zobje), vzorec C/32 (3 spodnje čeljustnice, zob); plast 11: vzorec A/34 (zob), vzorec C/33 (rostrum), vzorec E/34 (rostrum), vzorec E/35 (zob); plast 12/13: vzorec A/36 (zob), vzorec B/36 (spodnja čeljustnica).

Večine (N = 16) ostankov rovk iz rodu *Sorex* ni bilo mogoče določiti do nivoja vrste. Sodeč po velikosti najdb te pripadajo bodisi gozdni bodisi gorski rovki.

Družina: krti (Talpidae)

*Talpa cf. europaea* Linnaeus, 1758

Gradivo: plast 11: vzorec C/34 (zob), vzorec E/35 (zob).

Navadnemu krtu sta bila pripisana dva izolirana meljaka. Dasiravno razlikovanje med obema recentnima

The faunistic material from Divje babe I, gathered during the campaign of 2006, is deposited in the National Museum of Slovenia (Ljubljana).

## SMALL MAMMAL REMAINS

In total, 892 small mammal cheek-teeth were obtained by excavations in 2006; 424 of these molars allowed identification to the generic level at least. The material belonged to no less than 113 specimens representing at least 15 species from six families. The share of rodents among identifiable items exceeds 96 %, while bats, on the other hand, are represented by no more than four specimens. All the species in the sample still occur in Slovenia.

Taxonomy and nomenclature follow Wilson, Reeder (2005).

Order: Shrews and moles (Soricomorpha)  
Family: Shrews (Soricidae)

*Sorex minutus* Linnaeus, 1766

Material: Layer 12: sample E/36 (mandible).

The pygmy shrew is represented by a single fragment of mandible with the 1<sup>st</sup> and 2<sup>nd</sup> molar still nested in the bone. The identification to the specific level was based on small size.

*Sorex araneus* Linnaeus, 1758

Material: Layer 8/10: sample C/30 (tooth).

A single right 1<sup>st</sup> upper molar is referable to the common shrew. The determination depends on the pigmented hypocone, which allows reliable separation of *S. araneus* from *S. alpinus* (cf. Kryštufek 1991, 38).

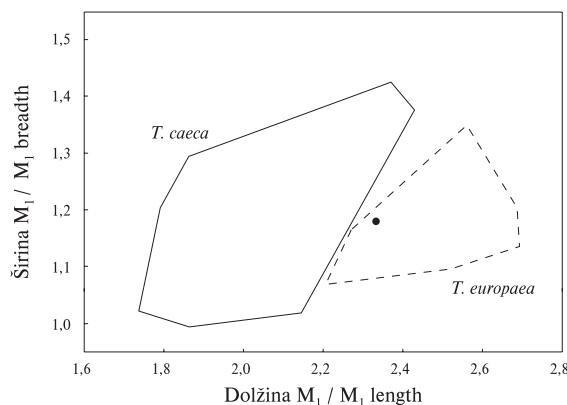
*Sorex alpinus* Schinz, 1837

Material: Layer 8/10: sample C/30 (rostrum); Layer 10: sample C/32 (tooth); Layer 11: sample B/34 (rostrum), sample C/34 (rostrum); Layer 13: sample E/38 (rostrum).

Four rostral fragments (all of them with M<sup>1</sup> still nested in the bone) and an isolated 1<sup>st</sup> upper molar belong to the Alpine shrew. The identification of the finds is based on the non-pigmented hypocones of 1<sup>st</sup> upper molars (cf. Kryštufek 1991, 38).

*Sorex alpinus / araneus*

Material: Layer 8/10: sample C/30 (2 teeth); Layer 10: sample C/31 (mandible, 3 teeth), sample C/32



vrstama rodu *Talpa* (tj. *T. europaea* in *T. caeca* Savii, 1822) zgorj na podlagi morfologije zob ni mogoče (Toškan 2002, 27 s), je takšna odločitev v skladu z odsotnostjo ostankov sredozemskega krta v mlajšem pleistocenu na območju Slovenije. V nasprotju s tem je bil navadni krt zastopan v številnih najdiščih (Rakovec 1973; Pohar 1976; Rabeder 2004), vključno z Divjimi babami I (Kryštufek 1997, 88).

Prvi spodnji meljak iz vzorca E/35 se po svoji velikosti umešča v variacijsko širino za recentne primerke navadnega krta iz zahodne Slovenije (ter tako presega največje vrednosti za sredozemskega krta iz Bosne in Hercegovine, Črne gore in Kosova; sl. 3). Prvi zgornji meljak iz vzorca C/34 je poškodovan in ga zato ni bilo mogoče izmeriti.

Red: Netopirji (Chiroptera)  
Družina: Gladkonosi netopirji (Vespertilionidae)

Gradivo: plast 8/10: vzorec C/30 (zob); plast 10: vzorec C/32 (2 zoba); plast 13: vzorec D/38 (zob).

Štirje izolirani zobje so pripadali netopirjem. Gradivo žal zanesljive določitve do nivoja rodu/vrste ni dopuščalo.

Red: Glodalci (Rodentia)  
Družina: Hrčki (Cricetidae)  
Poddružina: Voluharice (Arvicolinae)

*Myodes glareolus* (Schreber, 1780)

Gradivo: plast 8/10: vzorec A/30 (5 zob), vzorec C/30 (16 zob); plast 10: vzorec A/31 (4 zobje), vzorec A/32 (3 zobje), vzorec C/31 (12 zob), vzorec C/32 (16 zob), vzorec E/33 (spodnja čeljustnica, 22 zob); plast 11: vzorec A/33 (4 zobje), vzorec A/34 (4 zobje), vzorec B/34 (2 zoba), vzorec C/33 (5 zob), vzorec C/34 (8 zob), vzorec E/34 (11 zob), vzorec E/35 (21 zob); plast 12: vzorec A/35 (4 zobje), vzorec B/35 (6 zob), vzorec D/36 (zob), vzorec E/36 (28 zob); plast 12/13: vzorec B/36 (2 zoba); plast 13: vzorec

*Sl. 3:* Odnos med širino in dolžino prvega spodnjega meljaka pri krtih (v mm). Poligona obkrožata vrednosti za 29 recentnih *T. europaea* iz zahodne Slovenije (prekinjena črta) in 30 recentnih *T. caeca* iz Bosne in Hercegovine, Črne gore ter Kosova (sklenjena črta). Pika predstavlja primerek iz Divjih bab I: izkopavanja iz leta 2006 (plast 11: vzorec E/34).

Fig. 3: Scatter plot of breadth of the first lower molar against its length in moles (in mm). Polygons enclose scores for 29 recent *T. europaea* from western Slovenia (dashed line) and 30 recent *T. caeca* from Bosnia and Herzegovina, Montenegro and Kosovo (full line). The dot indicates the specimen from Divje babe I: 2006 excavation (layer 11: sample E/34).

(3 mandibles, tooth); Layer 11: sample A/34 (tooth), sample C/33 (rostrum), sample E/34 (rostrum), sample E/35 (tooth); Layer 12/13: sample A/36 (tooth), sample B/36 (mandible).

Most ( $N = 16$ ) of the remains of *Sorex* shrews did not allow identification to the species level. On the basis of their size they might belong to either the common shrew or the Alpine shrew.

#### Family: Moles (Talpidae)

*Talpa cf. europaea* Linnaeus, 1758

Material: Layer 11: sample C/34 (tooth), sample E/35 (tooth).

Two isolated molars have been ascribed to the European mole. In spite of the fact that the two recent mole species of genus *Talpa* (i.e. *T. europaea* and *T. caeca* Savii, 1822) cannot be reliably identified on the basis of molars alone (Toškan 2002, 27 f), such a conclusion seems to be in line with the absence of the remains of the blind mole from the Late Pleistocene of Slovenia. Contrary to this, the European mole is known from several sites (Rakovec 1973; Pohar 1976; Rabeder 2004), including Divje babe I (Krvštufek 1997, 89).

Dimensions of the 1<sup>st</sup> lower molar from sample E/35 are within the range for the recent European mole from western Slovenia (and therefore exceed the maximal values for blind moles from Bosnia and Herzegovina, Montenegro and Kosovo; *Fig. 3*). The 1<sup>st</sup> upper molar from sample C/34 is fragmented and thus could not be measured.

#### Order: Bats (Chiroptera)

## **Family: Vespertilionids (Vespertilionidae)**

Material: Layer 8/10: sample C/30 (tooth); Layer 10: sample C/32 (2 teeth); Layer 13: sample D/38 (tooth).

*Tab. 1:* 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 (zgodnji in srednji holocen); 3 – subfosilni primerki iz Male Triglavce (zgodnji holocen); 4 – fosilni primerki iz Divjih bab I: izkopavanja iz let 1990–1999 (facies A do C; OIS 3 in OIS 5a); 5 – fosilni primerki iz Divjih bab I: izkopavanja iz leta 2006 (facies B; OIS 3); 6 – fosilni primerki iz Divjih bab I: izkopavanja iz leta 2006 (facies C; OIS 5a). Podatke za vzorec 2 podajata Toškan in Kryštufek (2004, tab. 15.6), za vzorec 3 Toškan (2009, 124), za vzorec 4 pa Toškan in Kryštufek (2007, tab. 10.8).

*Tab. 1:* Frequencies of morphotypes of 3<sup>rd</sup> upper molar in four bank vole (*Myodes glareolus*) samples. Samples: 1 – recent *M. glareolus* from Slovenia; 2 – subfossil specimens from Viktorjev spodmol (Early and Middle Holocene); 3 – subfossil specimens from Mala Triglavca (Early Holocene); 4 – fossil material from Divje babe I: excavation campaigns 1990–1999 (facies A to C; OIS 3 and OIS 5a); 5 – fossil material from Divje babe I: excavation campaign 2006 (facies B; OIS 3); 6 – fossil material from Divje babe I: excavation campaign 2006 (facies C; OIS 5a). Sample 2 is from Toškan & Kryštufek (2004, Tab. 15.6), sample 3 is from Toškan (2009, 124) and sample 4 from Toškan & Kryštufek (2007, Tab. 10.8).

Morfotip Morphotype	Vzorec / Sample					
	1	2	3	4	5	6
<i>Simplex</i>	5	26	3	11	6	0
<i>Complex</i>	7	10	1	1	2	1
<i>Complex-typica</i>	10	55	3	36	10	7
<i>Complex-duplicata</i>	8	12	2	18	4	2

C/36 (2 zoba), vzorec D/37 (2 zoba), vzorec D/38 (5 zob), vzorec E/37 (13 zob), vzorec E/38 (8 zob).

Gozdna (rdeča) voluharica je najbolje zastopan takson v vzorcu malih sesalcev, pridobljenih med izkopavanji leta 2006; enako velja tudi za predhodno izkopano gradivo (Kryštufek 1997, tab. 7.9; Toškan, Kryštufek 2007, tab. 10.12). Takšna percepacija je sicer nekoliko pristranska, saj značilna morfologija meljakov navedene vrste s prisotnostjo korenin in zaobljeno obliko skleninskih grebenov omogoča preprosto določitev vseh meljakov, medtem ko je bilo voluharice iz rodov *Microtus* in *Chionomys* mogoče zanesljivo identificirati le na podlagi  $M_1$ .

Rezultati metrične analize so potrdili predhodna opažanja Toškana in Kryštufka (2007, 213) o tem, da spremembe velikosti zob med klimatskimi oscilacijami niso vselej v skladu s pričakovanim pozitivnim Bergmannovim odzivom. Razlike v dolžini  $M_1$  med primerki iz OIS 5a in tistimi iz veliko hladnejšega OIS 3 namreč ne dosegajo meje statistične značilnosti (Mann-Whitneyev U-test:  $p = 0,626$ ). Analiza morfotipov  $M^3$  je pokazala na prevlado tipa *complex* (predvsem podtipa *typica*), kar je bilo sicer ugotovljeno tudi pri recentnih in subfosilnih gozdnih voluharicah iz Slovenije ter pri tistih fosilnih primerkih iz Divjih bab I, ki so bili pridobljeni med prejšnjimi izkopavanji (tab. 1).

Four isolated teeth were those of bats. The material did not allow genus/species level identification.

Order: Rodents (Rodentia)

Family: Hamsters, voles and lemmings (Cricetidae)

Subfamily: Voles and lemmings (Arvicolinae)

#### *Myodes glareolus* (Schreber, 1780)

Material: Layer 8/10: sample A/30 (5 teeth), sample C/30 (16 teeth); Layer 10: sample A/31 (4 teeth), sample A/32 (3 teeth), sample C/31 (12 teeth), sample C/32 (16 teeth), sample E/33 (mandible, 22 teeth); Layer 11: sample A/33 (4 teeth), sample A/34 (4 teeth), sample B/34 (2 teeth), sample C/33 (5 teeth), sample C/34 (8 teeth), sample E/34 (11 teeth), sample E/35 (21 teeth); Layer 12: sample A/35 (4 teeth), sample B/35 (6 teeth), sample D/36 (tooth), sample E/36 (28 teeth); Layer 12/13: sample B/36 (2 teeth); Layer 13: sample C/36 (2 teeth), sample D/37 (2 teeth), sample D/38 (5 teeth), sample E/37 (13 teeth), sample E/38 (8 teeth).

The bank vole is the most abundant small mammal taxon in the material of the 2006 campaign as well as in the assemblage revealed by previous excavations (Kryštufek 1997, Tab. 7.9; Toškan, Kryštufek 2007, Tab. 10.12). Such a perception is biased to some degree because its rooted molars with rounded salient angles allowed secure identification of all *M. glareolus* molars, contrary to *Microtus* and *Chionomys* voles, which were safely ascribed to genus/species only in the case of  $M_1$  specimens.

Metric analysis confirmed the observations previously reported by Toškan, Kryštufek (2007, 213) that the size changes during climatic oscillations did not follow Bergmann response, as the difference in the length of  $M_1$  between the material from OIS 5a and the much colder OIS 3 does not reach the level of statistical significance (Mann-Whitney U test:  $p = 0,626$ ). The predominating  $M^3$  morphotype was *complex* (particularly its *typical* expression). Such a situation accords with what has been observed in recent and sub-fossil bank voles from Slovenia as well as in fossil material of earlier campaigns undertaken in Divje babe I (Tab. 1).

#### *Arvicola ex gr. amphibious - schermann*

Material: Layer 10: sample C/32 (2 teeth), sample E/33 (tooth); Layer 11: sample E/35 (tooth); Layer 12: sample E/36 (2 teeth); Layer 13: sample E/37 (tooth).

As currently accepted (Wilson, Reeder 2005), the two long-known ecological morphotypes of the all-embracing *A. terrestris* correspond to two biological species: the amphibious *A. amphibious* (Linnaeus,

*Arvicola ex gr. amphibious - schermann*

Gradivo: plast 10: vzorec C/32 (2 zoba), vzorec E/33 (zob); plast 11: vzorec E/35 (zob); plast 12: vzorec E/36 (2 zoba); plast 13: vzorec E/37 (zob).

Po sedanjem razumevanju (*cf.* Wilson, Reeder 2005) gre dva dolgo znana ekološka morfotipa vseobsegajoče vrste *A. terrestris* obravnavati kot dve biološki vrsti: dvoživno *A. amphibious* (Linnaeus, 1758) ter manjšo, na življenje pod zemljo prilagojeno *A. schermann* (Shaw, 1801). Zaradi navedenega zanesljiva taksonomska dočleitev tukaj predstavljenih najdb iz rodu *Arvicola* do nivoja vrste ni možna.

Vzorec ostankov sesalske mikrofavne iz leta 2006 vključuje sedem izoliranih meljakov (najmanj ene od) zgoraj navedenih vrst. Primerjava dimenzij fosilnega, subfossilnega in recentnega gradiva z različnih lokacij v širši regiji je pokazala na obstoj določenih diachronih nihanj v velikosti (Mauch Lenardić 2005, 81 ss; Toškan, Kryštufek 2007, tab. 10.5; Toškan 2009, 120 s). Ugotovitev bi načeloma lahko razumeli kot indic za izmenjevanje obeh vrst,<sup>3</sup> čeprav seveda gre vzeti v obzir tudi bolj tradicionalne razlage, povezane z znotrajvrstnimi trendi. Dolžina edinega v celoti ohranjenega M<sup>3</sup> v gradivu iz leta 2006 znaša 2,58 mm in je potemtakem v okviru povprečja za fosilne voluharje iz Divjih bab I, izračunanem na podlagi najdb izkopavanj v 90. letih prejšnjega stoletja (povprečje: 2,55 mm; razpon vrednosti: 2,20–2,70 mm; N = 10; Toškan, Kryštufek 2007, tab. 10.5).

*Chionomys nivalis* (Martins, 1842)

Gradivo: plast 8/10: vzorec C/30 (3 zobje); plast 10: vzorec C/31 (zob), vzorec E/33 (2 zoba); plast 11: vzorec A/33 (zob), vzorec C/33 (2 zoba), vzorec C/34 (6 zob), vzorec E/34 (2 zoba), vzorec E/35 (3 zobje); plast 12: vzorec E/36 (zob); plast 12/13: vzorec A/36 (zob); plast 13: vzorec D/38 (2 zoba), vzorec E/37 (zob), vzorec E/38 (2 zoba).

Snežna voluharica je zastopana s 27 izoliranimi prvimi spodnjimi meljaki. Njihova največja dolžina (mediana: 2,90 mm; razpon vrednosti: 2,83–3,00 mm; N = 6) sovpada z vrednostmi pri sočasno živečih<sup>4</sup> snežnih voluharicah, ki so jih dala predhodna izkopavanja (povprečje: 2,90 mm; razpon vrednosti: 2,55–3,15; N = 98; Toškan, Kryštufek 2007, tab. 10.3).

Izmed petih morfotipov M<sub>1</sub>, kijih navaja Nadachowski (1984a), sta v vzorcu iz leta 2006 zastopana dva: *nivalid* in *nivalid-ratticepid*. Pri tem ne preseneča, da ista

<sup>3</sup> Vodni voluhar (*A. amphibious*) in podzemni voluhar (*A. schermann*) se razlikujeta v telesni masi, pri čemer je slednji manjši.

<sup>4</sup> Zobje izvirajo iz faciesov B in C in so tako datirani v OIS 5a ter v začetek OIS 3.

Tab. 2: Frekvence zastopanosti posameznih morfotipov prvega spodnjega meljaka pri fosilnih snežnih voluharicah (*Chionomys nivalis*) iz Divjih bab I. Vzorci: 1 – izkopavanja iz let 1990–1999: facies B (OIS 3); 2 – izkopavanja iz let 1990–1999: facies C (OIS 5a); 3 – izkopavanja iz leta 2006: facies B (OIS 3); 4 – izkopavanja iz leta 2006: facies C (OIS 5a). Podatke za vzorca 1 in 2 podajata Toškan in Kryštufek (2007, tab. 10.4). Tab. 2: Frequencies of morphotypes of 1<sup>st</sup> lower molar in snow voles (*Chionomys nivalis*) from Divje babe I. Samples: 1 – excavation campaigns 1990–1999: facies B (OIS 3); 2 – excavation campaigns 1990–1999: facies C (OIS 5a); 3 – excavation campaign 2006: facies B (OIS 3); 4 – excavation campaign 2006: facies C (OIS 5a). Samples 1 and 2 are from Toškan & Kryštufek (2007, Tab. 10.4).

Morfotip Morphotype	Vzorec / Sample			
	1	2	3	4
<i>Ratticepid</i>	-	1	-	-
<i>Advanced nivalid</i>	-	1	-	-
<i>Nivalid-ratticepid</i>	8	15	3	3
<i>Nivalid</i>	29	65	17	3
<i>Gud</i>	-	-	-	-
SKUPAJ/TOTAL	37	82	20	6

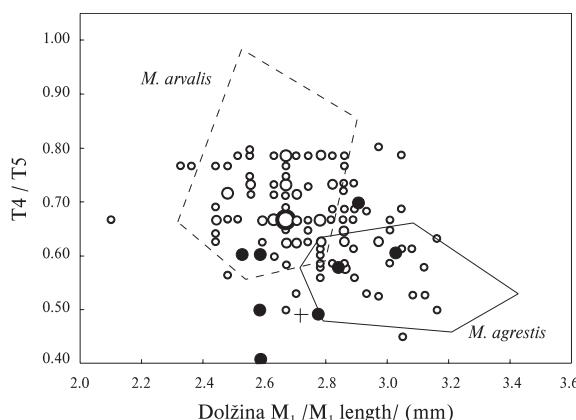
1758) and the fossorial *A. schermann* (Shaw, 1801). This renders a reliable determination of the here-presented material to the specific level impossible.

In the small mammal assemblage obtained during the campaign of 2006, seven isolated molars of Eurasian and/or montane water vole were found. Diachronic variations in teeth size shown by the fossil, subfossil and recent material from several localities in the region (Mauch Lenardić 2005, 81 ff; Toškan, Kryštufek 2007, Tab. 10.5; Toškan 2009, 120 f) might indicate the alternation of the two species,<sup>3</sup> although a more traditional interpretation related to intraspecific trends cannot be ruled out. The length of the only preserved M<sup>3</sup> in the here presented small mammal assemblage equals 2.58 mm, which coincides with the average seen in previously excavated fossil water voles from Divje babe I (average: 2.55 mm; range: 2.20–2.70 mm; N = 10; Toškan, Kryštufek 2007, Tab. 10.5).

*Chionomys nivalis* (Martins, 1842)

Material: Layer 8/10: sample C/30 (3 teeth); Layer 10: sample C/31 (tooth), sample E/33 (2 teeth); Layer 11: sample A/33 (tooth), sample C/33 (2 teeth), sample C/34 (6 teeth), sample E/34 (2 teeth), sample E/35 (3 teeth); Layer 12: sample E/36 (tooth); Layer 12/13: sample A/36 (tooth); Layer 13: sample D/38 (2 teeth), sample E/37 (tooth), sample E/38 (2 teeth).

<sup>3</sup> The Eurasian water vole (*A. amphibius*) and the montane water vole (*A. schermann*) contrast in body mass, with the former being larger.



morfotipa močno prevladujeta tudi v okviru bistveno bogatejšega vzorca, ki so ga navrgla izkopavanja konec prejšnjega stoletja (tab. 2).

#### *Microtus ex gr. agrestis - arvalis*

Gradivo: plast 8/10: vzorec C/30 (zob); plast 10: vzorec A/31 (3 zobje), vzorec A/32 (zob), vzorec C/31 (zob), vzorec C/32 (6 zobje), vzorec E/33 (7 zobje); plast 11: vzorec A/33 (3 zobje), vzorec A/44 (zob), vzorec C/34 (2 zoba), vzorec E/34 (5 zobje), vzorec E/35 (5 zobje); plast 12: vzorec E/36 (5 zobje); plast 13: vzorec C/37 (zob), vzorec D/38 (3 zobje), vzorec E/37 (2 zoba), vzorec E/38 (zob).

Na podlagi oblike anterokonidnega kompleksa z ločenima dentinskima poljem T4 in T5 je bilo mogoče 30 arvikolinskih prvih spodnjih meljakov pripisati bodisi poljski voluharici *Microtus arvalis* (Pallas, 1779) bodisi travniški voluharici *Microtus agrestis* (Linnaeus, 1761). Razlikovanje med navedenima vrstama temelji na dejstvu, da sta trikotnika T4 in T5 pri prvi približno enake velikosti, pri drugi pa je T5 značilno večji (Nadachowski 1984b). Iz grafičnega prikaza razmerja med količnikom dolžine obeh trikotnikov (T4/T5) glede na največjo dolžino  $M_1$  je bilo tako v vzorcu mogoče potrditi prisotnost obeh vrst (sl. 4). Podatek o zastopanosti travniške voluharice podkrepjujejo najdbe 17  $M^2$  z dodatnim posterolingvalnim trikotnikom (T5), čeprav je tudi ta znak sicer podvržen določeni časovni in geografski variabilnosti (npr. Kryštufek 1986, 38).

Prvi spodnji meljaki poljske oz. travniške voluharice, ki so bili pridobljeni med izkopavanji leta 2006, po svoji največji dolžini v ničemer ne odstopajo od sočasno živečih primerkov istih vrst, izkopanih v 90. letih prejšnjega stoletja (Toškan, Kryštufek 2007; Mann-Whitneyev U-test:  $p = 0,783$ ).

#### *Microtus ex gr. liechtensteini – subterraneus*

Gradivo: plast 8/10: vzorec C/30 (2 zoba); plast 10: vzorec C/31 (3 zobje), vzorec C/32 (4 zobje), vzorec

Sl. 4: Odnos med količnikom trikotnikov T4 in T5 kot imenovalcem (T4/T5) in dolžino prvega spodnjega meljaka pri *Microtus ex. gr. agrestis-arvalis* iz Divjih bab I (izkopavanja iz leta 2006, v mm). Poligona obkrožata vrednosti za 45 recentnih primerkov *M. agrestis* (sklenjena črta) in 45 recentnih primerkov *M. arvalis* (prekinjena črta) iz osrednje Slovenije. Pike (•) označujejo primerke iz facies B (tj. OIS 3), križec (+) pa edini nefragmentiran  $M_1$  iz facies C (tj. OIS 5a). Za primerjavo so ponazorjeni tudi primerki iz facies C (tj. OIS 5a), ki so bili pridobljeni med izkopavanji v letih 1990–1999 (označeno z ○; velikost znakov ponazarja število primerkov; povzeto po Toškan, Kryštufek 2007, sl. 10.2). Nepoškodovanih primerkov iz facies B omenjena izkopavanja niso dala.

Fig. 4: Bivariate plot of quotient between enamel triangles T4 and T5 ( $T4/T5$ ) against length of 1<sup>st</sup> lower molar in *Microtus ex. gr. agrestis-arvalis* from Divje babe I (excavation campaign 2006, in mm). Polygons enclose extremes for 45 recent *M. agrestis* (full line) and 45 recent *M. arvalis* (dashed line), respectively, from central Slovenia. Dots (•) indicate specimens from facies B (i.e. OIS 3), the cross (+) is the only non fragmented  $M_1$  from facies C (i.e. OIS 5a). Comparative data for specimens dated to OIS 3 revealed by earlier excavations are also shown (○; the size of points indicates the number of specimens; taken from Toškan, Kryštufek 2007, Fig. 10.2). The latter excavation did not yield any unfragmented specimen originating from facies B.

The snow vole is represented by 27 isolated 1<sup>st</sup> lower molars. Their greatest length (median: 2.90 mm; range: 2.83–3.00 mm; N = 6) conforms to what has been observed in snow voles of the same geological age<sup>4</sup> originating from other parts of the cave (average: 2.90 mm; range: 2.55–3.15 mm; N = 98; Toškan, Kryštufek 2007, Tab. 10.3).

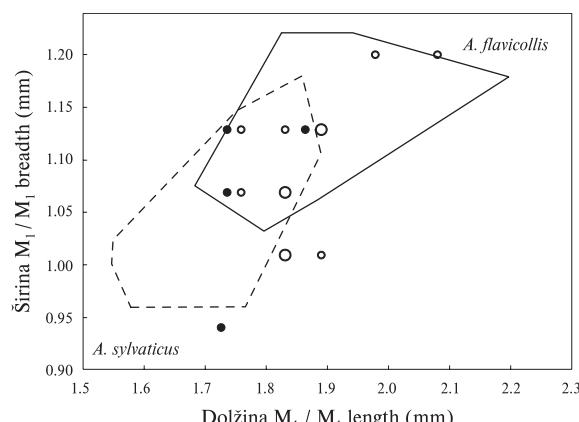
Of the five morphotypes of  $M_1$  listed by Nadachowski (1984a), the only two involved in the material obtained in 2006 are *nivalid* and *nivalid-ratticepid*. Not surprisingly, the same two morphotypes strongly predominated also in a much larger sample revealed by extensive excavations in the years 1990–1999 (Tab. 2).

#### *Microtus ex gr. agrestis – arvalis*

Material: Layer 8/10: sample C/30 (tooth); Layer 10: sample A/31 (3 teeth), sample A/32 (tooth), sample C/31 (tooth), sample C/32 (6 teeth), sample E/33 (7 teeth); Layer 11: sample A/33 (3 teeth), sample A/44 (tooth), sample C/34 (2 teeth), sample E/34 (5 teeth), sample E/35 (5 teeth); Layer 12: sample E/36 (5 teeth); Layer 13: sample C/37 (tooth), sample D/38 (3 teeth), sample E/37 (2 teeth), sample E/38 (tooth).

The shape of the anteroconid complex of  $M_1$  with separate dentine fields of triangles T4 and T5 allocated 30 arvicoline first lower molars either to a field vole *Microtus arvalis* (Pallas, 1779) or to a common vole *M. agrestis* (Linnaeus, 1761). Species identification of first lower molars is

<sup>4</sup> The teeth originate from facies B and C and are thus dated to OIS 5a and the first part of OIS 3.



E/33 (7 zob); plast 11: vzorec A/34 (zob), vzorec C/34 (3 zobje), vzorec E/34 (2 zoba), vzorec E/35 (4 zobje); plast 12: vzorec E/36 (5 zob); plast 13: vzorec D/38 (zob), vzorec E/37 (5 zob).

Pitimoidne prve spodnje meljake ( $N = 37$ ) lahko vse pripisemo vrtni voluharici *Microtus subterraneus* (de Salys-Longchamps, 1836) ali ilirski voluharici *M. liechtensteini* (Wettstein, 1927). Vrsti se razlikujeta po kromosomskem številu, morfološko pa sta si zelo podobni. *Microtus liechtensteini* je sicer večji, vendar se vrednosti dolžine njihovih izoliranih zob na veliko prekrivajo (Kryštufek 1997). Podatki o največji dolžini tukaj obravnavanih prvih spodnjih meljakov vrtne oz. ilirske voluharice se po svoji največji dolžini ujemajo s spodnjimi meljaki sočasno živečih primerkov istih vrst, izkopanih v 90. letih prejšnjega stoletja (Mann-Whitneyjev U test:  $p = 0,455$ ).

Družina: Miši (Muridae)

*Apodemus ex gr. flavicollis - sylvaticus*

Gradivo: plast 8/10: vzorec A/30 (zob), vzorec C/30 (5 zob); plast 10: vzorec A/31 (2 zoba), vzorec A/32 (3 zobje), vzorec C/31 (8 zob), vzorec C/32 (16 zob), vzorec E/33 (2 zoba); plast 11: vzorec A/33 (zob), vzorec A/34 (3 zobje), vzorec B/34 (zob), vzorec C/33 (2 zoba), vzorec C/34 (zob), vzorec E/34 (6 zob), vzorec E/35 (4 zobje); plast 12: vzorec D/36 (zob), vzorec E/36 (3 zobje); plast 12/13: vzorec A/36 (zob); plast 13: vzorec D/37 (3 zobje), vzorec D/38 (3 zobje), vzorec E/37 (2 zoba), vzorec E/38 (3 zobje).

Rod *Apodemus* je zastopan s 65 izoliranimi zobmi, ki sva jih na podlagi velikosti in morfologije pripisala dvema recentnima vrstama (sl. 5 in 6): rumenogrli miš *A. flavicollis* (Melchior, 1834) in navadni belonogi miš *A. sylvaticus* (Linnaeus, 1758). Dimasta miš *A. agrarius*

Sl. 5: Odnos med dolžino prvega spodnjega meljaka in njegovo širino pri *Apodemus ex gr. flavicollis - sylvaticus* iz Divjih bab I (izkopavanja iz leta 2006, v mm). Poligona obkrožata vrednosti za 35 recentnih primerkov *A. flavicollis* (sklenjena črta) in 35 recentnih primerkov *A. sylvaticus* (prekinjena črta) iz osrednje Slovenije. Pike (●) predstavljajo primerke iz faciesa C (tj. OIS 5a), krogi (○) pa tiste iz faciesa B (tj. OIS 3). Velikost znakov ponazarja število primerkov ( $N = 1$  oz.  $N = 2$ ). Fig. 5: Bivariate plot of breadth of 1<sup>st</sup> lower molar against its length in *Apodemus ex gr. flavicollis-sylvaticus* from Divje babe I (excavation campaign 2006, in mm). Polygons enclose extremes for 35 recent *A. flavicollis* (full line) and 35 recent *A. sylvaticus* (dashed line), respectively, from central Slovenia. Dots (●) indicate specimens from facies C (i.e. OIS 5a), open circles (○) those originating from facies B (i.e. OIS 3). The size of points indicates the number of specimens ( $N = 1$  or  $N = 2$ )

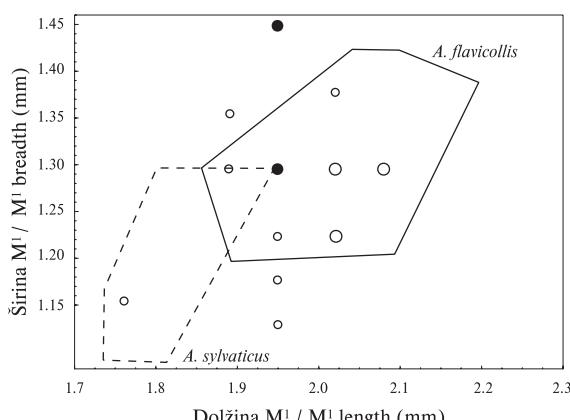
based on characters proposed by Nadachowski (1984b). Triangles T4 and T5 are subequal in *M. arvalis*, while *M. agrestis* is characterized by a larger T5 in comparison to T4. Consequently, a quotient between the lengths of these two triangles (T4/T5), when plotted against the  $M_1$  length, distinguishes fairly reliably these two voles. This approach confirmed the presence of both species in the studied material (Fig. 4). The presence of *M. agrestis* is further confirmed by the find of 17  $M^2$  displaying an additional postero-lingual triangle (T5), despite the fact that even this characteristic is subject to temporal and geographic variation (e.g. Kryštufek 1986, 38).

Specimens from the 2006 camapign conform in  $M_1$  lengths to the material of the same geological age revealed by extensive excavations in years 1990–1999 (Toškan, Kryštufek 2007, Annex 10.1F; Mann-Whitney U test:  $p = 0.738$ ).

#### *Microtus ex gr. liechtensteini – subterraneus*

Material: Layer 8/10: sample C/30 (2 teeth); Layer 10: sample C/31 (3 teeth), sample C/32 (4 teeth), sample E/33 (7 teeth); Layer 11: sample A/34 (tooth), sample C/34 (3 teeth), sample E/34 (2 teeth), sample E/35 (4 teeth); Layer 12: sample E/36 (5 teeth); Layer 13: sample D/38 (tooth), sample E/37 (5 teeth).

Pitymoid first lower molars ( $N = 37$ ) belong either to the common pine vole *Microtus subterraneus* (de Salys-Longchamps, 1836) or Liechtenstein's pine vole *M. liechtensteini* (Wettstein, 1927). The two species clearly differ in their chromosomal sets, however they resemble each other most closely in their morphologies. Although Liechtenstein's pine vole tends towards larger size, the length of isolated molars broadly overlaps (Kryštufek 1997). The *Microtus ex gr. liechtenstaini – subterraneus* material revealed by the 2006 campaign match in length of  $M_1$  the specimens originating from extensive excavations in the 1990's (Mann-Whitney U test:  $p = 0,455$ ).



Sl. 6: Odnos med dolžino prvega zgornjega meljaka in njegovo širino pri *Apodemus ex gr. flavicollis - sylvaticus* iz Divjih bab I (izkopavanja iz leta 2006, v mm). Poligona obkrožata vrednosti za 35 recentnih primerkov *A. flavicollis* (sklenjena črta) in 35 recentnih primerkov *A. sylvaticus* (prekinjena črta) iz osrednje Slovenije. Pike (•) predstavljajo primerke iz faciesa C (tj. OIS 5a), krogi (○) pa tiste iz faciesa B (tj. OIS 3). Velikost znakov ponazarja število primerkov (N = 1 oz. N = 2).

Fig. 6: Bivariate plot of breadth of 1<sup>st</sup> upper molar against its length in *Apodemus ex gr. flavicollis-sylvaticus* from Divje babe I (excavation campaign 2006, in mm). Polygons enclose extremes for 35 recent *A. flavicollis* (full line) and 35 recent *A. sylvaticus* (dashed line), respectively, from central Slovenia. Dots (•) indicate specimens from facies C (i.e. OIS 5a), open circles (○) those originating from facies B (i.e. OIS 3). The size of points indicates the number of specimens (N = 1 or N = 2).

(Pallas, 1771) v vzorcu ni zastopana, na kar kaže odnosnost tretjih zgornjih meljakov z dodatno mezialno-lateralno grbico (t3).

Zanesljivo razlikovanje med vrstama *A. sylvaticus* in *A. flavicollis* na podlagi morfologije zob ni možno (Mayhew 1978; Janžekovič, Kryštufek 2004), poleg tega pa njune populacije izkazujojo še znatno variabilnost v njihovi velikosti (Alcántra 1991). Navkljub temu sva v primeru tukaj obravnavanega gradiva na podlagi dimenzijs  $M^1$  in  $M_1$  lahko potrdila prisotnost obeh navedenih vrst (sl. 5 in 6), pri čemer naj bi bila *A. sylvaticus* pogosteje v faciesu C (tj. OIS 5a), *A. flavicollis* pa v faciesu B (tj. OIS 3). Izkopavanja konec prejšnjega stoletja so v okviru faciesov B in C dala zgolj en zob rodu *Apodemus*; primerek je bil pripisan navadni belonogi miši (Toškan, Kryštufek 2007, 200).

#### Družina. Polhi (Gliridae)

#### *Glis glis* (Linnaeus, 1766)

Gradivo: plast 10: vzorec C/32 (spodnja čeljustnica, zob\*); plast 11: vzorec C/34 (zob); plast 12: vzorec B/35 (spodnja čeljustnica, zob\*). Primerki izstopajoče bele barve glede na običajno rumenkastorjavo obarvanost drugih zob so označeni z zvezdo (\*).

Navadnemu polhu je pripadal pet ostankov. Dva<sup>5</sup> ( $P^4$ ,  $M_1$ ) izmed skupno treh izoliranih zob sta izrazito bele barve, po čemer se očitno razlikujeta od ostalih najdb malih sesalcev v obravnavanem vzorcu. V času izkopavanj v Divjih babah I so bili približno 20 cm pod površjem (torej pod sigo, ki je holocenskega izvora) dva-krat najdeni speči polhi. V luči navedenega bi lahko tako tudi v primeru obeh zgoraj omenjenih belo obarvanih zob šlo za kontaminacijo z recentnimi živalmi.

<sup>5</sup> Primerka nista bila najdena globlje od pril. 10 do 35 cm pod površino.

Family: Mice and rats (Muridae)

#### *Apodemus ex. gr. flavicollis – sylvaticus*

Material: Layer 8/10: sample A/30 (tooth), sample C/30 (5 teeth); Layer 10: sample A/31 (2 teeth), sample A/32 (3 teeth), sample C/31 (8 teeth), sample C/32 (16 teeth), sample E/33 (2 teeth); Layer 11: sample A/33 (tooth), sample A/34 (3 teeth), sample B/34 (tooth), sample C/33 (2 teeth), sample C/34 (tooth), sample E/34 (6 teeth), sample E/35 (4 teeth); Layer 12: sample D/36 (tooth), sample E/36 (3 teeth); Layer 12/13: sample A/36 (tooth); Layer 13: sample D/37 (3 teeth), sample D/38 (3 teeth), sample E/37 (2 teeth), sample E/38 (3 teeth).

The genus *Apodemus* is represented by 65 isolated teeth. On the basis of size and morphology of the available specimens they were ascribed to two recent species: yellow-necked mouse *A. flavicollis* (Melchior, 1834) and long-tailed field mouse *A. sylvaticus* (Linnaeus, 1758). The presence of the striped field mouse *A. agrarius* (Pallas, 1771) was excluded since all 3<sup>rd</sup> upper molars display the mesio-lateral cone (t3).

Reliable distinguishing between *A. sylvaticus* and *A. flavicollis* on the basis of check-teeth morphology was shown not to be possible (Mayhew 1978; Janžekovič, Kryštufek 2004). Moreover, populations of these two species are known to be characterized by a considerable size variation (Alcántra 1991). In spite of this, the size of  $M_1$  and  $M^1$  allowed us to ascertain the presence of both species, whereby *A. sylvaticus* seems to be more common in facies C (i.e. OIS 5a) and *A. flavicollis* in facies B (i.e. OIS 3, Figs. 5, 6). Excavations in 1990–1999 revealed a single tooth of the genus *Apodemus* originating from facies B and C. It has been ascribed to the long-tailed field mouse (Toškan, Kryštufek 2007, 213 f.).

## OSTANKI VELIKIH SESALCEV

Izkopavanja iz leta 2006 so dala tudi več tisoč ostankov velikih sesalcev. Taksonomsko določene kosti in zobe (NISP = 6.577) je bilo mogoče pripisati štirim vrstam iz prav tolikih družin (*tab. 3*), med katerimi je daleč največji delež (tj. > 99,9 %) pripadel jamskemu medvedu *Ursus spelaeus* Rosenmüller, 1794. Preostale tri vrste velikih sesalcev, ki so zastopane v tukaj obravnavanem gradivu, so vse recentne in še vedno naseljujejo območje Slovenije.

Jamski medved je v vzorcu zastopan s 6.544 najdbami. Rezultati razvrščanja podočnikov in dlančnic po spolu<sup>6</sup> so pokazali na višji delež samic v facies C v primerjavi s faciesom B (*tab. 4*), čeprav sama razlika sicer ni statistično značilna ( $\chi^2$  test; združen vzorec:  $p = 0,309$ ). Podobna primerjava obeh spolnih struktur, pri kateri pa primerkov iz stratigrafsko problematičnih mejnih sedimentacijskih nivojev med obema faciesoma nisva upoštevala (*tab. 5*), je pokazala na obstoj še očitnejšega odstopanja, ki se že močno približuje meji statistične značilnosti ( $\chi^2$  test; združen vzorec:  $p = 0,093$ ).

Po številu najdb jamskemu medvedu sledi kuna zlatica (*Martes martes* [Linnaeus, 1758]). Omeniti je sicer treba, da skoraj polovica ostankov rodu *Martes* iz leta 2006 ni dopuščala določitve do nivoja vrste (*tab. 6*). Ker pa od taksonomsko determiniranih najdb prav vse pripadajo kuni zlatici, enako pa velja tudi za gradivo iz predhodnih raziskovanj, se zdi pripis vseh kunjih kosti in zob iz Divjih bab I vrsti *M. martes* povsem utemeljen. Toliko bolj zato, ker naj bi bila navedena vrsta v mlajšem pleistocenu sploh edini predstavnik svojega rodu na evropskih tleh; na odprte habitate vezana kuna belica (*M. foina* [Erxleben, 1777]) naj bi se namreč na

<sup>6</sup> Postopek razvrščanja dlančnic med oba spola predstavlja Toškan (2007b, 385 s.).

*Tab. 3:* Število določenih primerkov (NISP) v fosilnih združbah velikih sesalcev iz sklopa plasti 8/10–13 iz Divjih bab I (izkopavanja iz leta 2006). Podano je tudi skupno število izkopanih in pregledanih standardnih vzorčnih enot sedimenta na posamezen sedimentacijski nivo (prostornina posamezne enote je 1 x 1 x 0,12 m oz. 0,12 m<sup>3</sup>).

*Tab. 3:* Number of Identified Specimens (NISP) in small mammal fossil assemblages from layers 8/10–13 of Divje babe I (excavation campaign 2006). Also given is the total number of excavated and analysed basic samples of sediment per sedimentation level (volume of samples is 1 x 1 x 0,12 m, i.e. 0,12 m<sup>3</sup>).

Takson Taxon	Sedimentacijski nivo / Sedimentation levels									$\Sigma$	
	FACIES B							FACIES C			
	28	29	30	31	32	33	34	35	36		
<i>Ursus spelaeus</i>	192	261	362	517	909	1310	1544	1120	329	6544	
<i>Canis lupus</i>			2	2						4	
<i>Martes martes</i>							10	4		14	
<i>Martes</i> sp.	5	1		1			3	2		12	
<i>Rupicapra rupicapra</i>								1		1	
<b>SKUPAJ / TOTAL</b>	197	262	364	520	909	1310	1557	1127	329	6575	
Št. vzorčnih enot / No. of samples	2	2	3	3	4	5	5	5	3		

Family: Dormice (Gliridae)

*Glis glis* (Linnaeus, 1766)

Material: Layer 10: sample C/32 (mandible, tooth\*); Layer 11: sample C/34 (tooth); Layer 12: sample B/35 (mandible, tooth\*). Specimens of a distinctly-white colour as compared to the usual yellowish brown are marked with an asterisk (\*).

The edible dormouse is represented by five remains. Two ( $P^4$ ,  $M_1$ ) out of three isolated check-teeth were of distinctly white colour and thus differed markedly from the rest of the small mammal teeth in the sample. During summer excavations in Divje babe I, living edible dormice were found twice at a depth of about 20 cm below the surface (Kryštufek 1997, 94 f), whereby in the case of the two<sup>5</sup> above mentioned teeth the contamination by intrusive recent dormice cannot be excluded.

## LARGE MAMMAL REMAINS

Apart from the small mammal fauna, the 2006 excavation campaign also revealed several thousand macrofaunistic remains. The taxonomically determined teeth and bones (NISP = 6,577) belonged to four species from as many families (*Tab. 3*), but the great majority (i.e. > 99,9 %) were referable to the extinct cave bear *Ursus spelaeus* Rosenmüller, 1794. The rest of the large mammal species represented in the sample are all extant and still occur in Slovenia.

The cave bear is represented by 6,544 finds. From the sexing of canines and metacarpals<sup>6</sup> a higher share of

<sup>5</sup> The two teeth were found no deeper than approx. 10 to 35 cm below the surface.

<sup>6</sup> The methodology for sexing cave bear metacarpals is presented in Toškan (2007b, 397 f).

*Tab. 4:* Frekvenca pojavljanja ostankov samcev in samic jamskega medveda iz Divjih bab I (izkopavanja iz leta 2006) po faciesih. Prikazani so podatki o številu dlančnic in podočnikov

*Tab. 4:* Abundance of remains of male and female cave bears from Divje babe I (excavation campaign 2006) per facies. Shown are the number of canines and metacarpals.

Podočniki Canines	Samci Males	Samice Females
Facies B	5	6
Facies C	2	8
Dlančnice Metacarpals	Samci Males	Samice Females
Facies B	4	4
Facies C	5	7
Združeno Pooled	Samci Males	Samice Females
Facies B	9	10
Facies C	7	15

tem prostoru pojavila šele v holocenu (Wolsan 1993; Crégut-Bonroure 1996, 191; a glej tudi Bon *et al.* 1991, 202 ss; Döppes 2004, 69).

Gams (*Rupicapra rupicapra* [Linnaeus, 1758]) in volk (*Canis lupus* Linneaus, 1758) sta v vzorcu zastopana zgolj s posameznimi najdbami. Prvemu sva tako pripisala le nartno kost iz vzorca B/37, drugemu pa dve vretenci (vzorca A/32 in C/33), sezamoidno kost (vzorec C/32) in prvo dlančnico (vzorec C/33).

*Tab. 5:* Število podočnikov in dlančnic samcev in samic jamskega medveda iz Divjih bab I (izkopavanja iz leta 2006) po faciesih brez upoštevanja najdb iz "mejnih" sedimentacijskih nivojev med obema faciesoma (tj. nivojema 33 in 34).

*Tab. 5:* Number of canines and metacarpals of male and female cave bears from Divje babe I (excavation campaign 2006) per facies, not considering the finds from interfacial boundary sedimentation levels (i.e. levels 33 and 34).

Podočniki Canines	Samci Males	Samice Females
Facies B (core)	2	3
Facies C (core)	0	5
Dlančnice Metacarpals	Samci Males	Samice Females
Facies B (core)	3	2
Facies C (core)	1	2
Združeno Pooled	Samci Males	Samice Females
Facies B (core)	5	5
Facies C (core)	1	7

females in the material from facies C relative to facies B (*Tab. 4*) has emerged, although the difference was not statistically significant ( $\chi^2$  test; pooled sample:  $p = 0.309$ ). The observed discrepancy was even more pronounced when the canines and metacarpals from the interfacial sedimentational levels 33 and 34 were excluded from the analysis (*Tab. 5*), almost skimming the boundary of statistical significance ( $\chi^2$  test; pooled sample:  $p = 0.093$ ).

In the number of finds the cave bear is followed by the pine marten *Martes martes* (Linnaeus, 1758). As a matter of fact, almost half of the remains of the genus *Martes* did not allow identification to the level of species (*Tab. 6*). Nevertheless, those which did were all referable to *Martes martes*, as was the case also with the material revealed by earlier excavations (Toškan,

*Tab. 6:* Razporeditev najdb kune zlatice (*Martes cfr. martes*) iz Divjih bab I (izkopavanja iz leta 2006) po sedimentacijskih nivojih in plasteh. Okrajšave: Mc – dlančnica, Mt – stopalnica.

*Tab. 6:* Distribution of finds of the pine marten (*Martes cfr. martes*) from Divje babe I (excavation campaign 2006) per sedimentation levels and layers. Abbreviations: Mc – metacarpus, Mt – metatarsus.

Sedimentacijski nivo Sedimentation level	Plast Layer	Mandibula	Dentes	Vertebrae	Radius	Ulna	Mc 3	Mc 4	Pelvis	Mt 3	Tarsalia	Phalanges	$\Sigma$
28	8/10				1	1	1					2	5
29	10											1	1
31	11											1	1
32	11	1											1
34	12/13 & 13		1	5	1				1	2		2	12
35	13	1	1	1	1	1					1		6
<b>SKUPAJ / TOTAL</b>		2	2	6	2	2	1	1	1	2	1	6	26

Tab. 7: Najmanjše število živali (MNI) v fosilnih združbah malih sesalcev iz sklopa plasti 6–17a1 iz Divjih bab I (izkopavanja iz let 1990–1999). Senčena polja označujejo prisotnost taksona v plasti. Podana sta tudi skupno število določenih primerkov (NISP) za posamezen takson ter skupna prostornina pregledane frakcije sedimenta velikosti 0,5 do 10 mm na plast. Podatki so povzeti po Toškan in Kryštufek (2007, tab. 10.12).

Tab. 7: Minimum Number of Individuals (MNI) in small mammal fossil assemblages from layers 6–17a1 of Divje babe I (excavation campaigns 1990–1999). Shaded cells indicate the presence of taxon in a layer. Also given are the total Number of Identified Specimens (NISP) for individual taxa and the total volume of the removed sediment fraction (particle size 0.5 to 10 mm) per layer, from which the small mammal remains were subsequently extracted. Data taken from Toškan & Kryštufek (2007, Tab. 10.12).

Takson 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	$\Sigma$ MNI	$\Sigma$ NISP
<i>Erinaceus</i> sp.				1														1	1
<i>S. araneus</i>	1			1														2	3
<i>S. alpinus</i>	1		1							1								3	4
<i>S. araneus/alpinus</i>																		–	6
<i>Talpa</i> sp.											1			1				2	5
<i>V. murinus</i>														1				1	1
<i>M. glareolus</i>	1	22	4	16	2	12	4	5		6	18	7	2	48	4		151	874	
<i>A. amphib./scherm.</i>		3		3		6			1	3	4	2	2	4	1		29	123	
<i>Ch. nivalis</i>	5	3	13	2	7		1	2	2	10	4	5	26	2	1		83	243	
<i>M. agrestis/arvalis</i>	1	1	8	1	2	1		2	3	19	9	4	53	15	3		122	226	
<i>M. multip./subterr.</i>			1		3					4			3				11	17	
Arvicollinae indet.																		–	845
<i>Apodemus</i> sp.														1				1	1
<i>Sicista</i> cfr. <i>subtilis</i>									1									1	1
<i>G. glis</i>	1																	1	1
<i>M. avellanarius</i>									1							1		2	2
SKUPAJ / TOTAL	2	33	8	44	5	30	5	6	5	16	57	22	13	137	22	5	0	410	2353
Vol. sedimenta / Vol. of sedim. (dm <sup>3</sup> )	9	194	14	34	10	29	7	8	14	4	15	6	6	25	4	1	24		

## PALEOOKOLJE

Skupno so bili v plasteh 8/10 do 13 (tj. v sedimentacijskih nivojih 28–35) Divjih bab I najdeni predmeljaki in meljaki najmanj 211 živali. Polovico (MNI = 98) so jih dala obsežna izkopavanja v 90. letih prejšnjega stoletja (tab. 7), preostanek (MNI = 113) pa je bil pridobljen med izkopavanji leta 2006 (tab. 8).

Na podlagi ostankov malih sesalcev, ki so bili izkopani konec prejšnjega stoletja, sta Toškan in Kryštufek (2007, 202 ss) poskusila rekonstruirati okolje ob nastopu srednjega würma<sup>7</sup> pred pribl. 70 do 80 tisoč leti. V skladu z njunimi domnevami naj bi na širšem območju Divjih

Kryštufek 2007, 255 f). Consequently, it is very likely that all of the fossil mustelid teeth and bones from Divje babe I are to be ascribed to this species. Even more so since the pine marten was probably the only representative of martens in Europe during the Late Pleistocene, since the open habitat preferring beech marten *Martes foina* (Erxleben, 1777) supposedly only appeared in the Holocene (Wolsan 1993; Crégut-Bonnoure 1996, 191; but see also Bon *et al.* 1991, 202 ff; Döppes 2004, 69).

The chamois *Rupicapra rupicapra* (Linnaeus, 1758) and the wolf *Canis lupus* Linnaeus, 1758 are represented by only a few remains: a tarsal bone from sample B/37 has been ascribed to the former and two vertebrae (samples A/32 and C/33), a sesamoid (sample C/32) and a first metacarpal bone (sample C/33) to the latter.

## PALAEOENVIRONMENT

In total, small mammal molars of at least 211 individuals were recovered from layers 8/10–13 (i.e. sedimentation levels 28–35) of Divje babe I. Half of them (MNI = 98) were revealed by extensive excavations

<sup>7</sup> V Divjih babah I je meja med zgodnjim in srednjim würmom sedimentološko dobro opredeljena (Turk *et al.* 2007). Postavljena je med facies C in B, pri čemer gre sedimente pod to mejo datirati v zgodnji glacial ali OIS 5 (= facies C), tiste nad njo pa v "visoki glacial" (= "pleniglacial") ali OIS 4–2 (= facies A in B). Žal kronocona OIS 4 v tukaj obravnavani jami (enako pa sicer velja za celoten vzhodnoalpski prostor; Preusser 2004) skoraj ni zastopana, saj je takrat prišlo do daljše prekinitev v sedimentaciji. Zaradi istega vzroka v Divjih babah I ni zastopana niti kronocona OIS 2.

Tab. 8: Najmanjše število živali (MNI) v fosilnih združbah malih sesalcev iz sklopa plasti 8/10–13 iz Divjih bab I (izkopavanja iz leta 2006). Senčena polja označujejo prisotnost taksona v plasti. Podana sta tudi število določenih primerkov (NISP) za posamezen takson ter skupna prostornina pregledane frakcije sedimenta velikosti 0,5 do 10 mm na stratigrafski nivo.

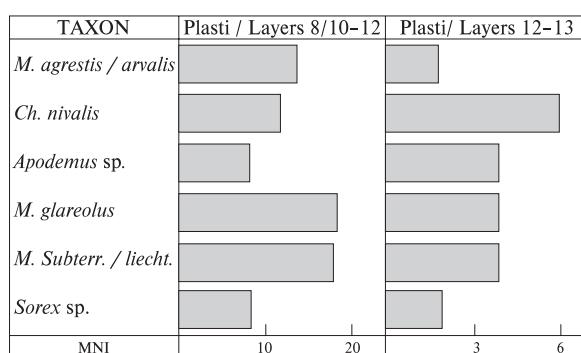
Tab. 8: Minimum Number of Individuals (MNI) in small mammal fossil assemblages from layers 8/10–13 of Divje babe I (excavation campaign 2006). Shaded cells indicate the presence of taxon in a layer. Also given are the total Number of Identified Specimens (NISP) for individual taxa and the total volume of the removed sediment fraction (particle size 0.5 to 10 mm) per sedimentation level, from which the small mammal remains were subsequently extracted.

Takson Taxon	Plast / Layer → Sed. nivo / level →	8/10	10		11		12	12/13 & 13		Σ MNI Σ NISP
		28	29	30	31	32	33	34	35	
<i>S. minutus</i>						1			1	1
<i>S. araneus</i>	1								1	1
<i>S. alpinus</i>	1		1		1			1	4	5
<i>S. araneus/alpinus</i>		1	3				1		5	16
<i>T. europaea</i>					1				1	2
Chiroptera indet.									-	4
<i>M. glareolus</i>	3	1	2	3	5	2	3	1	20	211
<i>A. amphibious/schermann</i>			2				1		3	7
<i>Ch. nivalis</i>	2	2	2	3	6	1	2	4	22	27
<i>M. agrestis/arvalis</i>		2	4	3	5	1	1	1	17	47
<i>M. liechtensteini/subterraneus</i>	1	2	6	1	6	3	3	1	23	37
Arvicollinae indet.									-	464
<i>Apodemus</i> sp.	1	2	2	3	3		2	1	14	65
<i>G. glis</i>			2						2	5
SKUPAJ / TOTAL	9	10	22	13	29	8	13	9	113	892
Vol. sedim. (dm <sup>3</sup> )	0.6	0.85	1.15	1.3	2.25	2.1	2.35	1.4		

bab I takrat razmeroma odprta travniška krajina, ki je bila zelo razširjena še ob koncu zgodnjega würma, prešla v mozaični tip habitata s pretežno iglastimi gozdovi in travniki s kameničji. Navedene spremembe sta pripisala občutnemu padcu temperatur, ki ga je spremljalo tudi znatno povišanje vlažnosti (glej povečan delež ostankov vrste *M. glareolus* in rovk iz rodu *Sorex*; tab. 7). Skladno s tem naj domnevni prevladi travnikov in kameničj nad gozdnimi habitatmi v OIS 5a ne bi botrovalo mrzlo

in the 1990's (Tab. 7); the rest of the finds (MNI = 112) originate from the campaign of 2006 (Tab. 8).

The study of the assemblage gathered in the 1990's led Toškan and Kryštufek (2007, 214 ff) to the conclusion that the onset of the Middle Würm<sup>7</sup> between 70 ka and 80 ka B.C. saw the rather open grassland habitat of the terminal part of the Early Würm evolving into a mosaic of mixed, predominantly coniferous forest, with meadows and accumulations of rocky boulders. Such a transition was thought to have been triggered by a substantial cooling of the climate accompanied by a significant increase in humidity (note the increased relative abundance of *M. glareolus* and *Sorex* shrews; Tab. 7). In line with this, the supposed prevalence of meadows and rocky sites over woodlands in OIS 5a was not seen as a consequence of low temperatures (note the presence of a mole; Tab. 7) but more probably as a reflection of



Sl. 7: Grafična predstavitev najmanjšega števila osebkov (MNI) bolje zastopanih taksonov malih sesalcev iz Divjih bab I (izkopavanja iz leta 2006) po faciesih.

Fig. 7: Bar histogram of Minimum Number of Individuals (MNI) for major small mammal taxa from Divje babe I (excavation campaign 2006) per facies.

<sup>7</sup> In Divje babe I the boundary between the Early and Middle Würm is sedimentologically well defined (Turk et al. 2007). It is set between sedimentary facies C and B. Below this boundary is the Early Glacial or OIS 5 (= sedimentary facies C), above is the "full glacial" (= "pleniglacial") or OIS 4–2 (= sedimentary facies A and B). Unfortunately, the chronozone OIS 4 is only poorly expressed in Divje babe I (and in Eastern Alps in general; Preusser 2004), since a pause in sedimentation occurred at the time. For the same reason the chronozone OIS 2 is completely missing.

podnebje (da je bilo to dejansko zmerno, med drugim dokazuje prisotnost krta, ki pozimi ne prenese globoko zamrznjenih tal; *tab. 7*), marveč prej sušnost. Najdbi vrst *Sicista subtilis* in *Vespertilio murinus* bi lahko namreč razumeli tudi kot kazalnika sušnih razmer (*tab. 7*).

Ostanki malih sesalcev iz izkopavanj leta 2006 v osnovi potrjujejo zgornje teze (*tab. 8; sl. 7*). Dejstvo sicer je, da med najdbami iz končnega dela zgodnjega glaciala (= OIS 5a) delež gozdnih vrst (*M. glareolus*, rovke iz rodu *Sorex*) v dokaj skromnem obsegu presega delež tistih, ki so vezane na odprte habitate (voluharice iz rodu *Microtus*, *Ch. nivalis*). Toliko bolj zato, ker razmeroma pogosti *M. ex gr. liechtensteini - subterraneus* (*sl. 7*) nista striktno vezani na travnike in jase, ampak lahko naseljujeta tudi listopadne in iglaste gozdove (Kryštufek 1991, 149 s; 1999). Vendar pa lahko navezeno sliko brez večjih težav zadovoljivo razložimo s podnebnimi nihanji v OIS 5a; najmanj ena od obeh tukaj obravnavanih zgodnjewürmskih plasti (tj. plast 12–13) je namreč nastala v razmeroma vlažni fazi, pravzaprav najbolj vlažni v celotnem OIS 5a-d (Turk *et al.* 2007, 101). Če gre prevlado travnikov in kamenič nad gozdovi v OIS 5a dejansko prej pripisati sušni klimi kot nizkim temperaturam (glej zgoraj), potem je ugotovljena skromna razlika med deležema zastopanosti gozdnih in travniških vrst malih sesalcev v tukaj obravnovanem gradivu pravzaprav logična.

Na (rahlo) povišanje vlažnosti ob koncu OIS 5a kaže tudi prisotnost frugivornih glodalcev (*G. glis*, *A. flavicollis*; glej *sl. 6*) in torej listavcev (vključno z bukvijo),<sup>8</sup> na katere so ti prehransko vezani. Iz skromnega deleža polha in rumenogrtle miši v primerjavi z gozdno voluharico in rovkami iz rodu *Sorex* gre sicer sklepati, da so v takratnih gozdovih vendarle prevladovali iglavci, v prvi vrsti bor (cf. Šercelj, Culiberg 1991, 135 ss; Culiberg 2007, 171).

Vrstna sestava gradiva iz faciesa B in pogostnost posameznih taksonov kažeta na prehod v obdobje razmeroma stabilnega vlažnega in hladnega podnebja (*sl. 7; tab. 8*). Povišana vlažnost (glej tudi Turk *et al.* 2007, 101) je zelo verjetno pospešila širjenje gozdov, o čemer priča dobra zastopanost gozdnih taksonov *M. glareolus*, *G. glis*, *A. flavicollis* ter rovk iz rodu *Sorex*. Sodeč po maloštevilnih najdbah frugivorov so takratne gozdove domnevno še vedno sestavljeni predvsem iglavci, kar se sicer v celoti sklada z izsledki paleobotaničnih raziskav (Šercelj, Culiberg 1991, 142; Culiberg 2007, 174). Ob vrsti *M. glareolus*, ki preferira gosto porasle čistine in robove vlažnih gozdov (Spitzenberger 1999a), na hladno in vlažno podnebje kažeta tudi povišana deleža rovk iz rodu *Sorex* (cf. Anděra 1999; Spitzenberger 1999b) ter travniške voluharice iz kompleksa *M. ex gr. agrestis - arvalis* (*sl. 4*).<sup>9</sup> Pri tem je slednji podatek pomemben zato,

<sup>8</sup> To potrjujejo tudi paleobotanične najdbe (Šercelj, Culiberg 1991, tab. 1–2; Culiberg 2007, 171).

<sup>9</sup> Skladen s tem je tudi podatek, da število arvikolinskih

arid climate (records of *Sicista subtilis* and *Vespertilio murinus* might be indicative of aridity; *Tab. 7*).

The micromammal remains yielded by the excavations of 2006 basically conform to the above thesis (*Fig. 7; Tab. 8*). It is true that as far as the OIS 5a period is concerned, the assemblage from the 2006 campaign shows only a minimal predominance of forest dwelling species (*M. glareolus*, *Sorex* shrews) over those depending on open habitats (voles of the genus *Microtus*, *Ch. nivalis*). Even more so since the relatively abundant *M. ex gr. liechtensteini - subterraneus* (*Fig. 7*) is not strictly depending on open habitats, but can be found in deciduous and coniferous woodland as well (Kryštufek 1991, 149 f; 1999). Nevertheless, such a picture can be readily explained by climatic oscillations during OIS 5a, as at least one of the two here studied early Würmian layers (i.e. layer 12–13) was formed in a rather humid phase, the most humid of all OIS 5a-d (Turk *et al.* 2007, 120). If the supposed prevalence of meadows and rocky sites over woodlands in OIS 5a is indeed to be ascribed to arid climate rather than low temperatures (see above), then the reduced discrepancy between the share of forest small mammals relative to open habitat species observed in the material excavated in 2006 seems to be logical.

Indicative of a (slightly) greater humidity at the end of OIS 5a is also the presence of frugivorous rodents (*G. glis*, *A. flavicollis*; see *Fig. 6*) and thus of deciduous trees (including beech),<sup>8</sup> although the former's low dominance relative to *M. glareolus* and *Sorex* shrews proves that the then tree vegetation has been throughout dominated by conifers, above all pine (cf. Šercelj, Culiberg 1991, 145 f; Culiberg 2007, 182).

The species composition in the material from facies B and their abundance indicate a gradual shift towards a relatively stable mesic and cold climate (*Fig. 7; Tab. 8*). The increased humidity (see also Turk *et al.* 2007, 120) is likely to have stimulated a further expansion of forest, as can be inferred from the abundance of forest-dwelling taxa *M. glareolus*, *G. glis*, *A. flavicollis* and *Sorex* shrews. Given the scarcity of frugivores, the tree vegetation of the time was supposedly still dominated by conifers, which is perfectly in line with paleobotanical data (Šercelj, Culiberg 1991, 142; Culiberg 2007, 182). Apart from *M. glareolus*, known to prefer densely covered clearings and margins of mesic forests (Spitzenberger 1999a), an environment of lower temperatures and higher humidity is also indicated by an increased share of *M. agrestis* within the group *M. ex gr. agrestis-arvalis* (*Fig. 4*)<sup>9</sup> and of *Sorex* shrews (cf. Anděra 1999; Spitzenberger 1999b). The

<sup>8</sup> This is confirmed by paleobotanical data (Šercelj, Culiberg 1991, Tabs. 1, 2; Culiberg 2007, 182).

<sup>9</sup> This is confirmed by the number of arvicoline 2<sup>nd</sup> upper molars with an additional postero-lingual enamel triangle being higher in facies B than in facies C (i.e. N = 13 vs. N = 5), as such specimens can be reliably ascribed to *M. agrestis*.

ker je vrsta *M. agrestis* bolj vezana na vlažne habitate od *M. arvalis* (Zima 1999a; 1999b).

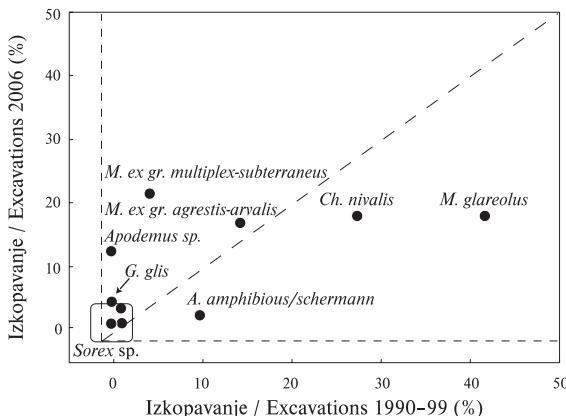
## PRIMERJAVA MED VZORCEMA

Vzorca malih sesalcev iz Divjih bab I, pridobljena med obsežnimi izkopavanji ob koncu prejšnjega stoletja in nekajdnevnim terenskim raziskovanjem v letu 2006, izkazujeta primerljive deleže zastopanosti posameznih taksonov (tab. 9, sl. 8–9). Posamezna manjša odstopanja komentirava v nadaljevanju.

Na prvi pogled bi enega takšnih odstopanj lahko predstavljal na sliki 8 jasno izražen nižji delež vrste *M. glareolus* v vzorcu iz leta 2006. Kot je to razvidno s slike 9, pa gre pri tem očitno zgolj za artefakt izbranega kazalnika količine najdb (tj. najmanjše število živali; cf. Grayson 1984; Klein, Cruz-Uribe 1984); v kolikor namreč namesto MNI uporabimo NISP, se navedena razlika med gradivoma praktično izniči (glej sl. 9).

Težje razložljive so razlike, ki so bile ugotovljene med vzorcema v deležu zastopanosti belonogih miši, vrtne oz. ilirske ter snežne voluharice. Vendar pa ta odstopanja, ki sama po sebi niti niso posebej velika, na samo rekonstrukcijo nekdanjega okolja nimajo omembe vrednega vpliva, saj v ničemer ne nasprotujejo splošnemu vtrisu o znatni širitvi gozdov ob nastopu srednjega würma.

drugih zgornjih meljakov z dodatnim posterolingvalnim skleninskim trikotnikom v okviru faciesa B presega število tistih, ki so bili najdeni v faciesu C (tj. N = 13 nasproti N = 5); navedene zobe gre namreč pripisati vlagoljubni vrsti *M. agrestis*.



Sl. 8: Delež posameznih taksonov malih sesalcev v gradivu iz Divjih bab I za vzorca z izkopavanj v letih 1990–1999 in 2006. Abundanca najdb je izražena kot najmanjše število živali (Minimum Number of Individuals; MNI).

Fig. 8: Shares of individual small mammal taxa in two samples from Divje babe I: the first revealed by the excavations in years 1990–1999 and the second yielded by the campaign of 2006. The abundance of individual taxa is expressed as the Minimum Number of Individuals (MNI).

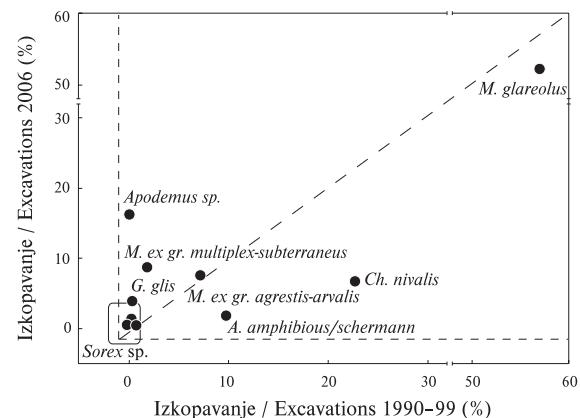
## BETWEEN-ASSEMBLAGES COMPARISON

The small mammal assemblages from Divje babe I yielded by the excavations of the 1990's and of 2006 resemble each other fairly closely in the relative abundance of various taxa (Tab. 9, Figs. 8, 9). There are, however, some minor discrepancies, which need to be commented.

At first sight such a case could be represented by a significantly lower share of *M. glareolus* in the assemblage from 2006 that can be observed in figure 8. By taking a closer look, however, this discrepancy reveals itself to be nothing but a consequence of the abundance being expressed as MNI (cf. Grayson 1984; Klein, Cruz-Uribe 1984); namely, if NISP is used instead, the difference between the two assemblages all but disappears (see Fig. 9).

Less straightforward to explain are the between-assemblages discrepancies in the relative abundances of *Apodemus* sp., *M. ex gr. multiplex-subterraneus* and *Ch. nivalis*. Nevertheless, these discrepancies – apart from being only minor – do not seem to affect the palaeoenvironmental reconstruction, as they do not in any way contradict the overall impression inferred from the two assemblages of the spread of forests with the onset of the Middle Würm.

The only notable differing point between the two assemblages is thus limited to the somewhat higher share of frugivorous rodents in the sample from 2006, indicative of a possibly more important presence of



Sl. 9: Delež posameznih taksonov malih sesalcev v gradivu iz Divjih bab I za vzorca z izkopavanj v letih 1990–1999 in 2006. Abundanca najdb je izražena kot število določenih primerkov (Number of Identified Specimens; NISP).

Fig. 9: Shares of individual small mammal taxa in two samples from Divje babe I: the first revealed by the excavations in years 1990–1999 and the second yielded by the campaign of 2006. The abundance of various taxa is expressed as the Number of Identified Specimens (NISP).

*Tab. 9:* Najmanjše število živali (MNI) in skupno število določenih primerkov (NISP) v fosilnih združbah malih sesalcev iz sklopa plasti 8/10–13 iz Divjih bab I (izkopavanja iz let 1990–1999 in 2006). Podana je tudi skupna prostornina pregledane frakcije sedimenta velikosti 0,5 do 10 mm na vsak od obeh vzorcev.

*Tab. 9:* Minimum Number of Individuals (MNI) and the Number of Identified Specimens (NISP) in small mammal fossil assemblages from layers 8/10–13 of Divje babe I: excavation campaigns 1990–1999 and 2006. Also given is the total volume of the removed sediment fraction (particle size 0.5 to 10 mm) per each of the two samples, from which the small mammal remains were subsequently extracted.

V luči navedenega tako edino zares relevantno razliko med obravnavanima gradivoma predstavlja nekoliko višji delež frugivorov v vzorcu iz leta 2006. Ugotovitev bi bila namreč lahko argument v prid domnevi o vendarle nekoliko pomembnejši zastopanosti listavcev v gozdnih vegetacijih iz rahlo toplejših faz zadnjega glaciala, kot je bilo to mogoče sklepati na podlagi doslej znanih podatkov (*cf.* Toškan, Kryštufek 2007). Navadni polh je bil tako zastopan v plasteh 10 in 11, še številčnejše pa so bile najdbe rumenogrelje miši (*tab. 8*). Ker sta obe navedeni vrsti odvisni od plodonosnih listavcev, v čistih sestojih iglavcev ne moreta preživeti. Ob tem je pomembno, da paleobotanične najdbe iz navedenih plasti zajemajo tudi pelod in/ali oglje jesena, jerebike, javorja, topola/vrbe, gabra, jelše in celo bukve (Šercelj, Culiberg 1991, tab. 1–2; Culiberg 2007, tab. 8.1), kar le še dodatno potrjuje izmenjevanje mrzlih stadialov in toplih interstadialov tudi v uvodnem delu kronocone OIS 3 (*cf.* Turk 2007a, 160 s.).

Seveda pa v kontekstu interpretacije zgornjih odstopanj ne gre pozabiti na običajne težave, povezane z nizko časovno resolucijo (*cf.* Turk 2007b, 435) in domnevnim premikanjem najdb v sedimentu (*cf.* Culiberg 2007, 171). Nadalje velja upoštevati, da so bile osrednji dejavnik kopičenja ostankov mikrofavne v Divjih babah I sove. To namreč pomeni, da sestava vzorcev med drugim odseva tudi preferenco plenilca do posameznih kategorij plena, njuno starost ter intenzivnost raztapljanja kosti uplenjenih živali v prebavnih sokovih sov (glej npr. Andrews 1990; Chaline *et al.* 1995).

## NEODVISNI KAZALNIKI NEKDANJEGA OKOLJA

Tradicionalni paleontološki pristop k paleookoljskim študijam temelji na preslikavi ekoloških toleranc današnjih populacij posameznih vrst na konspecifične populacije iz preteklih obdobjij. Ker pa so se sesalci sposobni prilagoditi različnim okoljem, ni nikoli mogoče z gotovostjo vedeti, ali niso nemara v preteklosti poseljevali (tudi) drugačnih habitatov (npr. Musil 1985; Bützler

Takson Taxon	Leta / Years 1990-1999		Leto / Year 2006	
	MNI	NISP	MNI	NISP
<i>S. alpinus</i>			1	1
<i>S. araneus/alpinus</i>			1	2
<i>M. glareolus</i>	5	29	4	38
<i>A. amphib./ scherm.</i>	1	5	1	1
<i>Ch. nivalis</i>	3	7	6	6
<i>M. agrestis/arvalis</i>	2	5	2	2
<i>M. liecht./subterr.</i>			4	6
<i>Apodemus</i> sp.			3	11
<i>G. glis</i>			0	1
SKUPAJ / TOTAL	11	46	22	68
Vol. sedimenta / Vol. of sedim. (dm <sup>3</sup> )		22		3.75

deciduous trees in the then forest vegetation during slightly warmer phases. Teeth of the edible dormouse were found in layers 10 and 11, with those of yellow-necked mouse being even more numerous (*Tab. 8*). Both species depend on seeds, fruits and similar soft, nutritional foods and cannot survive in pure conifer stands. It is thus significant that palaeobotanical finds in these layers include pollen and/or charcoal of ash, whitebeam, maple, poplar and/or willow, hornbeam, alder and even beech (Šercelj, Culiberg 1991, Tabs. 1, 2; Culiberg 2007, Tab. 8.1), confirming that even the initial part of the chronozone OIS 3 is composed of both cold stadials and warmer interstadials (*cf.* Turk 2007a, 163 f.).

When addressing the “whys and wherefores” of the above presented differences between the two studied assemblages originating from facies B, one should also consider the usual problems of low temporal resolution (*cf.* Turk 2007b, 453) and putative mobility of the finds in the sediment (*cf.* Culiberg 2007, 181). In addition to this, the fact that owls were evidently responsible for the bulk of accumulated bones and teeth should also be taken into account. This means that the composition of samples reflects, among others, preferences of the predator towards various prey categories, the age of both predator and prey, the differential solubility of various prey items during digestion etc. (see e.g. Andrews 1990; Chaline *et al.* 1995).

## INDEPENDENT PALAEOENVIRONMENTAL INDICATORS

The traditional 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

1986; Van Kolfschoten 1995; Phoca-Cosmetatou 2002). Za gamsa je bilo tako npr. ugotovljeno, da je v pozrem glacialu na območju južne Hercegovine naseljeval tudi nealpinska območja, kot je npr. lokalni ekvivalent t. i. "jeznega" krasa ("angry" karst; Miracle, Sturdy 1991). Dodaten dokaz za ekološko prilagodljivost gamsa pa je ne nazadnje tudi njegova nedavna znatna širitev na gozdnata območja (t. i. ekotip gozdnega gamsa; Pedrotti, Lovari 1999). Nič boljši kazalnik nekdanjega okolja ni volk. Čeprav danes v Evropi naseljuje predvsem prostrane gozdne pokrajine in gorovja, ga lahko najdemo tudi na barjanskih območjih, goličavah in v tundri (Sulkava, Pulliainen 1999).

Za rekonstrukcijo nekdanjih okolij je izmed štirih vrst velikih sesalcev, ki so zajeti v obravnavanem vzorcu iz Divjih bab I, najbrž še najprimernejša kuna zlatica. Gre namreč za vrsto, ki se izogiba negozdnim habitatom. Njeno zastopanost v več sedimentacijskih nivojih v skupku plasti 8/10–13 bi lahko torej razumeli kot razmeroma zanesljiv kazalnik obstoja listopadnih in/ali iglastih gozdov v bližini Divjih bab I tako v zaključku kronocone OIS 5a kot v začetnem delu OIS 3 (morda pa celo tudi ob koncu OIS 4; cf. Turk 2007a, 160). Ugotovitev je pomembna, saj se v celoti ujema z rezultati paleobotaničnih analiz (Šercelj, Culiberg 1991; Culiberg 2007) ter analiz zgoraj predstavljenega vzorca malih sesalcev. Je pa v zvezi s tem vendarle treba opozoriti, da je praviloma na gozd vezano kuno zlatico na zahodnem Irskem ter na Balearih mogoče najti tudi v grmičasti pokrajini, ki jo drugje sicer naseljuje tu manjkajoča kuna belica (Bright 1999). V izboru habitata obeh navedenih vrst torej očitno pomembno vlogo igra tudi kompetitivno izključevanje. Glede na tezo o kuni belici kot holocenskem prišleku v (srednji) Evropi se torej navezava kune zlatice na gozdne habitate za obdobje mlajšega pleistocena vendarle ne zdi več povsem samoumevna.

## JAMSKI MEDVED

Iz podatkov o razširjenosti jamskega medveda bi težko sklepali na pretekle klimatske spremembe, saj je bila vrsta na večjem delu svojega območja razširjenosti prisotna tako v glacialnih kot tudi v interglacialnih razmerah (cf. Kurtén 1976, 47 ss). Je pa iz najdb te izumre zveri na nekdanje podnebje domnevno mogoče sklepati nekoliko bolj posredno, tj. preko vedenjskih vzorcev (cf. Kurtén 1976, 47 ss) in diachronih nihanj v telesni velikosti (npr. Germonpré, Sablin 2001; Toškan 2007b, 386 ss). Slednjega žal v danem primeru ni bilo mogoče spremljati, saj je razpoložljiv vzorec najdb iz leta 2006 za kaj takega preskromen, je pa bil na drugi strani pridobljen vsaj podatek o deležu samcev in samic med ohranjenimi podočniki in dlančnicami.

Po ugotovitvah Toškana (2006, 152 ss) naj bi podnebne razmere odločilno vplivale na intenzivnost

today (e.g. Musil 1985; Bützler 1986; Van Kolfschoten 1995; Phoca-Cosmetatou 2002). This seems to have occurred with chamois *Rupicapra rupicapra* (Linnaeus, 1758), which was shown locally to have inhabited also non-alpine environments as was the case with the Late Glacial equivalent of "angry karst" in southern Herzegovina (Miracle, Sturdy 1991). The recently occurring substantial dispersal of this species into forested areas (forest chamois ecotype; Pedrotti, Lovari 1999) further demonstrates its ecological adaptability. No better indicator of past environments is the wolf *Canis lupus* Linnaeus, 1758. Namely, although in present-day Europe it occurs mainly in the wide open woodlands and mountains, it can be found also in large bog areas, fells and tundra (Sulkava, Pulliainen 1999).

As far as palaeoenvironmental reconstructions are concerned, of the four large mammal species represented in the here studied assemblage from Divje babe I the most indicative seems to be the pine marten *Martes martes* (Linnaeus, 1758), known for its avoidance of non-forest habitats (cf. Bright 1999). The presence of the pine marten in several of the sedimentation levels within the complex of layers 8/10–13 is thus to be considered as a rather reliable indicator of the existence of broad-leaved and/or coniferous forest habitats in the vicinity of Divje babe I, both during the final stages of OIS 5a and the initial part of OIS 3 (possibly even the final stage of OIS 4; cf. Turk 2007a, 163). Such a claim is noteworthy for it is perfectly in line with the results of palaeobotanical analyses (Šercelj, Culiberg 1991; Culiberg 2007) as well as with what has been inferred from the above presented small mammal assemblage. Still, it is worth noting that in western Ireland and the Balearics the otherwise forest-dwelling pine marten occurs also in shrub, that elsewhere would be occupied by the here missing beech marten (Bright 1999). It may thus well be possible that the choice of habitat in these two species is significantly linked to niche release. In view of the supposition that the latter species is a Holocene newcomer to (Central) Europe, the dependence of *M. martes* on forest habitats during the Late Pleistocene might thus not have been complete after all.

## THE CAVE BEAR

Far from being a good indicator species of climate change, given its persistence over most of its areal in both glacial and interglacial conditions (cf. Kurtén 1976, 47 ff), the cave bear might still be indicative of past climate through its size (Toškan 2008) and ethology (e.g. Germonpré, Sablin 2001; Toškan 2007b, 398 ff) rather than its distribution. While in the case of the material revealed by the 2006 campaign a detailed study of diachronic variations in body size was rendered impossible by the relatively modest number of collected measurable bones per facies, a large enough

medspolnega tekmovanja za zimske brloge. Tako naj bi splošno poslabšanje klime (kot je bilo npr. tudi na prehodu iz OIS 5a v OIS 4) skupaj z bolj izraženo sezonsko razpoložljivostjo hrane vplivalo na relativno povečanje števila samcev, ki so prezimovali v jamah s podobno lego in velikostjo kot Divje babe I, in to na škodo samic. V tej luči relativno višji delež njim pripisanih najdb v gradivu iz faciesa C (tj. OIS 5a) v primerjavi s faciesom B (OIS 4? in OIS 3; *tab. 4*) ne bi smel biti presenetljiv. Navsezadnje se takšno stanje lepo ujema tako z izsledki študije ostankov jamskega medveda iz predhodnih izkopavanj (Jambrešić, Turk 2007, sl. 16.4; Toškan 2006, 152 ss 2007b, 386 ss; 2007c, 358) kakor tudi z zgoraj predstavljenou paleoklimatsko rekonstrukcijo, ki temelji na najdbah malih sesalcev.

Rezultati statističnega testiranja so pokazali, da razlika med tukaj predstavljenima (*tab. 4*) spolnima strukturama jamskih medvedov iz obeh obravnavanih kronocon ni statistično značilna, kar pa se pravzaprav niti ne zdi problematično. Takšen rezultat gre namreč po vsej verjetnosti pripisati skromnosti razpoložljivega vzorca. Navsezadnje je bil višji delež samcev med primerki iz faciesa B ugotovljen tako pri podočnikih kot tudi pri dlančnicah, kar seveda zavrača možnost naključja. Poleg tega so podatki v *tabeli 4* do neke mere problematični, saj razmejitev med faciesoma B in C ni popolnoma ostra (Turk 2007c, sl. 1.4). V luči navedenega je seveda uvrstitev podočnikov in dlančnic iz mejnih stratigrafiskih nivojev 33 in 34 v enega od obeh faciesov do neke mere arbitarna. V tem smislu se zdijo tako zelo izpovedni rezultati primerjave obeh spolnih struktur, pri kateri primerki iz stratigrafsko problematičnih mejnih sedimentacijskih nivojev niso bili upoštevani (*tab. 5*). Razlika med medvedjima vzorcema iz obeh faciesov postane namreč ob takšnem pristopu še očitnejša in skoraj že dosega mejo statistične značilnosti.

## SKLEP

Izrazito interdisciplinarno zastavljeno raziskovanje Divjih bab I ponuja dobre možnosti za kombiniranje paleoklimatskih (paleookoljskih) približkov, temelječih na posameznih najdbah malih sesalcev, s tistimi, ki izhajajo iz drugih paleontoloških, paleobotaničnih in sedimentoloških podatkov. Čeprav ujemanje med posameznimi skupinami najdb kot nosilk informacij ni vedno popolno, pa sama umestitev meje med toplo in suho klimo na eni strani ter mrzlo in vlažno na drugi v obdobje med 70 in 80 tisoč leti pred sedanjostjo<sup>10</sup> ne bi smela biti vprašljiva. Pri tem relativna številčnost na odprte habitate vezanih malih sesalcev (*tab. 7–8*) in peloda trav (Šercelj, Culiberg 1991) v plasteh pod navedeno razmejitvijo priča o prevladi travnatih in

number of sexed metacarpals and canines allowed for the sex ratio to be assessed.

These data are important since the severeness of the climatic conditions is supposed to have influenced the intensity of intersexual competition for winter lairs in the way that the general deterioration of the weather (such as the one occurring at the transition of OIS 5a to OIS 4) together with the increased seasonality of food availability resulted in relatively more males hibernating in caves of the size and position of Divje babe I at the expense of females (Toškan 2006, 152 ff). A more female biased sex ratio observed in the material from facies C (i.e. OIS 5a) relative to facies B (OIS 4? and OIS 3; *Tabs. 4–5*) is thus not to be seen as surprising. After all, it perfectly conforms to the situation observed while studying cave bear remains revealed by earlier excavations (Jambrešić, Turk 2007, Fig. 16.4; Toškan 2006, 152 ff; 2007b, 398 ff; 2007c, 364) as well as to the palaeoclimatic reconstruction based on the small mammal assemblage (see above).

The here (*Tab. 4*) observed difference in the sex ratio estimates not reaching the level of statistical significance is not to be viewed as problematic, since it is most probably an artefact of small sample size. After all, a larger share of males in facies B relative to facies C has been observed in both canines and metacarpals, which speaks against it being fortuitous. Moreover, the results shown in *table 4* are partially corrupted by the fact that the boundary between facies B and C is obviously not perfectly sharp (Turk 2007c, Fig. 1.4), making the attribution of canines and metacarpals originating from interfacial boundary sedimentation levels 33 and 34 to each of the two facies partially arbitrary. It seems thus to be worth noting that the difference emerging from the comparison between facies B and C, from which the remains found in the latter two levels were not taken into account, are indeed substantially more pronounced (*Tab. 5*).

## CONCLUSION

The all-round manner to deal with the Divje babe I cave site provides a good opportunity to combine palaeoclimatic (palaeoenvironmental) approximations based on individual remains of mammal microfauna to those emerging from other palaeontological, paleobotanical and sedimentological data. Although individual groups of finds as a source of information are not always synchronized, the setting of the boundary between moderate and cold climate, between dry and humid ones, in the period between 70,000 and 80,000 years ago<sup>10</sup> does not seem to be questionable. Below this boundary the relative abundance of small mammals

<sup>10</sup> Stratigrafsko je ta meja postavljena na stik med nivojema 33 in 34 (oz. med plastema 12 in 12/13).

<sup>10</sup> Stratigraphically this boundary is set at the contact of sedimentation levels 33 and 34 (i.e. layers 12 and 12/13).

Sl. 10: Korelacija med izbranimi biostratigrafiskimi podatki in približki paleotemperature v profilu Divjih bab I, kjer so kot približek nihanja paleotemperature služili podatki o porazdelitvi talnih zmrzlinskih klastov (t. i. kongelirfraktov; cf. Turk et al. 2007, 74 ss). Modificirano po Turk (2007a, sl. 7.3).

Fig. 10: Correlation between selected biostratigraphical data and palaeotemperature proxies in the profile of Divje babe I; for approximation of variation of palaeotemperature soil congelifracts were used (cf. Turk et al. 2007, 110 ff). Modified from Turk (2007a, Fig. 7.3).

skalnih habitatov nad gozdnimi. Temu najbrž niso botrovale nizke temperature<sup>11</sup>, ampak sušnost. Prehod v vlažnejšo klimo v sklepnu delu OIS 5a izpričujejo sedimentološki podatki (Turk et al. 2007, sl. 5.6.1) pa tudi prisotnost rovk iz rodu *Sorex*, travniške voluharice in frugivornih glodalcev (*G. glis*, *A. flavicollis*). Pri tem najdbe navadnega polha in rumenogrle miši kažejo na prisotnost listavcev, kar so potrdili tudi izsledki paleobotaničnih raziskav (*Fagus*; sl. 10).

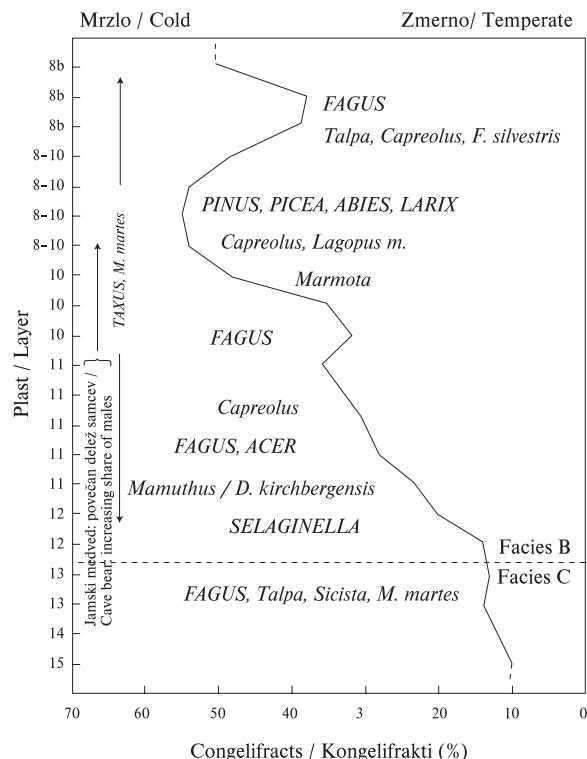
Nastop mrzle faze na samem začetku srednjega würma dokazujojo najdbe spor alpske drežice (*Selaginella selaginoides*) kot značilnega arktoalpinskega elementa, na padec temperatur pa kažejo tudi sedimentološki podatki (sl. 10). Navedenemu mrzlemu dogodku je sledilo obdobje z nekoliko milejšo klimo, o čemer pričajo najdbe vrst *G. glis*, *A. flavicollis* in *T. europaea* kot tudi bukve in javorja. Naslednjo, nekoliko izraziteje mrzlo fazo označujejo najdbe peloda in oglja skoraj izključno iglavcev (bora, smreke, jelke, macesna) kakor tudi prisotnost ostankov snežnega jereba (*Lagopus mutus*) in svizca (*Marmota marmota*) v plasti 8–10. Omembne vredne so tudi najdbe srne (*Capreolus capreolus*), ki kažejo na zgolj zmerno debelino snežne odeje<sup>12</sup> navkljub sicer očitnemu povečanju vlažnosti v OIS 3 glede na OIS 5. Vlažnejšo klimo dokazujojo tudi sedimentološki (Turk et al. 2005), paleobotanični<sup>13</sup> in paleontološki<sup>14</sup> podatki. Prav tako bi lahko v to smer kazal večji delež podočnikov in dlančnic samcev jamskega medveda iz facies B glede na stanje iz facies C (cf. Toškan 2006), kar tudi lahko pripisemo prav obilnejši in dlje časa trajajoči snežni odeji. V takšnih razmerah so namreč živali obej spolov v fazo hibernacije prehajale bolj ali manj sočasno, kar

<sup>11</sup> Glej prisotnost krta ter klimatsko-kronološko shemo, temelječe na sedimentoloških podatkih (sl. 10).

<sup>12</sup> Opazovanja srnjadi na Norveškem so pokazala, da ta neko lokacijo sezonsko zapusti, še preden pride do odložitve trajne snežne oddeje. Pri tem se zadnje živali praviloma umaknejo takrat, ko višina snežne oddeje preseže 50 cm (Mystrerud 1999, 483).

<sup>13</sup> Glej prisotnost tise v celotnem obdobju OIS 3 (sl. 10).

<sup>14</sup> Izpovedni sta relativna pogostost vrste *M. agrestis* v primerjavi z *M. arvalis* in prisotnost rovk iz rodu *Sorex* (glej zgoraj).



depending on open habitats (Tabs. 7-8) as well as of herbaceous pollen (Šercelj, Culiberg 1991) indicates the prevalence of grassland and rocky habitats over forests. Such an environment was unlikely a consequence of low temperatures<sup>11</sup> but possibly reflects an arid climate. The transition to a more humid phase is evidenced by sedimentological data (Turk et al. 2007, Fig. 5.6.1) as well as by the presence of *Sorex* shrews, *M. agrestis* and frugivorous rodents (*G. glis*, *A. flavicollis*) at the end of OIS 5a. The edible dormouse and the yellow-necked mouse are indicative of the presence of deciduous trees, which is confirmed also by palaeobotanical data (*Fagus*; Fig. 10).

The transition to the cold phase at the beginning of the Middle Würm is marked by spores of a typical arctoalpine element as is the lesser club moss *Selaginella selaginoides*. Lower temperatures are indicated also by sedimentological data (Fig. 10). This cold event is followed by an improved climate marked by finds of *G. glis*, *A. flavicollis*, *T. europaea* as well as *Fagus* and *Acer*. The following, more explicitly cold phase is characterised by pollen and charcoal of almost exclusively conifers (pine, spruce, fir, larch) as well as by the finds of rock ptarmigan *Lagopus mutus* and marmot *Marmota marmota* in layer 8–10. Noteworthy is the presence of roe deer *Capreolus capreolus* indicating a moderate thickness of

<sup>11</sup> Note the presence of a mole and the climate-chronological scheme based on selected sedimentological data (Fig. 10).

je seveda značilno povečalo medspolno tekmovanje za potencialne jamske brloge. In ker so se samice pri iskanju prezimovališča samcem praviloma izogibale, je opisana zaostritev klime v tem pogledu najbrž favorizirala samce.

Navedeni mrzli fazi za časa nastajanja plasti 8–10 je sledila otoplitev, izpričana z najdbami oglja bukve in drugih listavcev ter krta, divje mačke in srne v plasti 8b. Ker pa so bili v tem obdobju nastali sedimenti na območju izkopnega polja iz leta 2006 odstranjeni že med izkopavanji s konca 90. let prejnjega stoletja, interpretacija živalskih ostankov iz navedene plasti presega namen tega prispevka.

snow cover,<sup>12</sup> despite the climate in OIS 3 being damper relative to OIS 5. The increase of humidity is evidenced by sedimentological (Turk *et al.* 2005), as well as palaeobotanical<sup>13</sup> and palaeontological<sup>14</sup> data. Moreover, the greater share of male cave bear remains originating from facies B relative to those from facies C might also be indicative of damper climates (*cf.* Toškan 2006). With more abundant and longer-lasting snow cover, males supposedly anticipated their entrance into hibernation to match those of pregnant females, thus significantly increasing intersexual competition for appropriate lairs. Since the latter most probably avoided solitary males when choosing a lair, the onset of climatically severe conditions favoured males.

A new warming following the cold event documented in layer 8–10 is indicated by charcoal of beech and other deciduous trees as well as by the finds of mole, wildcat and roe deer in layer 8b. Nevertheless, since sediments deposited during this phase were removed already by the excavation campaigns of the 1990's, the interpretation of the faunistic remains originating from that layer falls beyond the scope of this paper.

<sup>12</sup> Roe deer in Norway have been observed to seasonally migrate from a location well in advance of a permanent snow cover, with the latest animals migrating typically when snow depth exceeded 50 cm (Mysterud 1999, 483).

<sup>13</sup> Note the presence of yew throughout OIS 3 (*Fig. 10*).

<sup>14</sup> Indicative is the relative abundance of *M. agrestis* relative to *M. arvalis* as well as the presence of *Sorex* shrews (see above).

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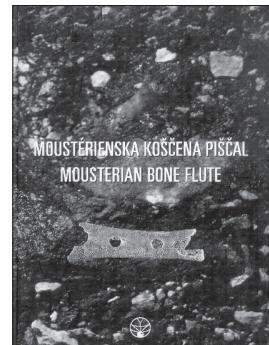
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Ivan Turk (ur. / ed.)

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



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

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

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The most topical Middle Paleolithic site in Slovenia is presented in full and discussed in detail in this series. The Divje Babe I cave site became famous for the archaeological discovery of what current investigations indicate could be the oldest flute, made of the bone of a cave bear, yet discovered. The principal part of the compilation is dedicated to a typological, technological, acoustic and musical discussion of the remarkable find. Individual chapters present the stratigraphy, chronology, fauna and flora from the site, in addition to the Paleolithic material finds (however, only up to the layer including the bone flute).

The book incorporates the first abridged and summarized determinations from the current archaeological excavations, which are not yet concluded. In addition to the editor, who is also the author and coauthor of the majority of chapters, the following individuals also provided contributions to the series: G. Bastiani, M. Culiberg, J. Dirjec, B. Kavur, B. Kryštufek, T.-L. Ku, D. Kunej, D. E. Nelson, M. Omrzel-Terlep and A. Šercelj.

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

Ivan Turk (ur. / ed.)

### Viktorjev spodmol in / and Mala Triglavca

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

V zborniku, prvem s področja mezolitika v Sloveniji, sta obravnavani dve izjemno bogati najdišči na Krasu v zahodni Sloveniji: Viktorjev spodmol in Mala Triglavca. Viktorjev spodmol je novo odkrito najdišče, kjer so se raziskave komaj začele, v Mali Triglavci pa potekajo že dalj časa. Odrobno je obdelan predvsem Viktorjev spodmol. Pomembna je primerjava rezultatov različnih terenskih in poterenskih metod, uporabljenih v Mali Triglavci in predvsem v Viktorjevem spodmolu.

V posameznih poglavjih so obdelana mikrolitska orodja, ki pripadajo sovterjensko-kastelnovjenskemu (sauveterrien-castelovien) kompleksu, njihova tipologija in odnosi z drugimi najdišči tega kompleksa s posebnim poudarkom na kronologiji in kronoloških povezavah mezolitskih najdišč v severni Italiji, vključno s Tržaškim krasom, in zahodni Sloveniji (I. Turk in M. Turk). V drugih poglavjih so sistematsko prikazani redki rastlinski ostanki (M. Culiberg), izjemno bogate favne mehkužcev (R. Slapnik, V. Mikuž), ektotermnih vrtenčarjev (M. Paunović) in malih sesalcev (B. Toškan, B. Kryštufek) ter ostanki velikih sesalcev (B. Toškan). Samo v Viktorjevem spodmolu je bilo na površini dveh kvadratnih metrov v mezolitski plasti najdenih 58.000 ostankov slepca in 6.076 ostankov, ki pripadajo 103 živalskim vrstam. Na isti površini je bilo 72 tipološko opredeljivih mikrolitov, 104 makrolitska orodja in 12.708 kamnoseških odpadkov.

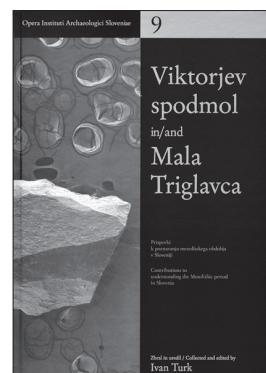
2004, (Opera Instituti Archaeologici Sloveniae 9), 247 str. + 20 tabel, 64 črno-belih risb, fotografij in zemljevidov, 20 x 29,5 cm, trda vezava, ISBN 961-6500-54-6.

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The monograph, the first regarding the Mesolithic in Slovenia, presents a discussion of two exceptionally rich sites in the Karst in western Slovenia: Viktorjev spodmol and Mala Triglavca. Viktorjev spodmol is a newly discovered site, where only test excavations have been done, while research has been underway at Mala Triglavca for already a while. The compilation primarily presents a detailed review of Viktorjev spodmol. The comparison of results from various field and post-field methods, which were applied at both Mala Triglavca and especially at Viktorjev spodmol, is particularly important.

Individual chapters address the topic of microlithic tools attributed to the Sauveterrien-Castelovien complex, their typology and relations with other sites from this complex, and with a special emphasis on the chronology and chronological correlations between Mesolithic sites in northern Italy, including the Trieste karst, and western Slovenia (I. Turk in M. Turk). The remaining chapters systematically present rare vegetal remains (M. Culiberg), the exceptionally rich collections of mollusc fauna (R. Slapnik, V. Mikuž), ectothermic vertebrates (M. Paunović) and small mammals (B. Toškan, B. Kryštufek) as well as the remains of large mammals (B. Toškan). At Viktorjev spodmol about 58,000 remains of slowworm and 6,076 remains attributed to 103 other animal species were discovered upon a surface of two square metres in the Mesolithic layer. The same surface revealed 72 typologically classifiable microliths, 104 macrolithic tools and 12,708 debris.

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



Ivan Turk (ur. / ed.)

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

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

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

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

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

