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DROBCI LEDENODOBNEGA OKOLJA

ZBORNIK OB ŽIVLJENJSKEM JUBILEJU IVANA TURKA

FRAGMENTS OF ICE AGE ENVIRONMENTS

PROCEEDINGS IN HONOUR OF IVAN TURK'S JUBILEE

Uredil / Edited by
Borut Toškan



LJUBLJANA 2011

Ivanu!

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NEANDERTALSKA PIŠČAL IZ DIVJIH BAB I: STARA IN NOVA SPOZNANJA

NEANDERTHAL FLUTE FROM DIVJE BABE I: OLD AND NEW FINDINGS

Matija TURK, Ljuben DIMKAROSKI

Izvleček

Preluknjana stegnenica jamskega medveda iz jamskega paleolitskega najdišča Divje babe I (zahodna Slovenija) je bila od odkritja leta 1995 dalje predmet mnogih polemik, ali gre za izdelek neandertalca ali za posledico zverskih ugrizov. Poskusi luknjanja svežih stegnenic rjavega medveda z odlitki zverskih zobovij, ugotovitve eksperimentalne arheologije in računalniška tomografija sporne piščali, so potrdili umetni izvor lukenj. Dodatno ga potrjujejo nove muzikološke raziskave, ki prinašajo nova spoznanja o glasbenih zmogljivostih piščali. Potekale so na avtentični repliki piščali, kjer je bil ožji, proksimalni del uporabljen kot ustnik, širši, distalni del pa kot kot odmevnik. Razporeditev luknjic in ohranjena dolžina najdbe tvorijo sistem, ki omogoča široko paletto zvočnosti in melodiskskega gibanja, in kaže, da gre za glasbilo v pravem pomenu besede. V zvočnem zaporedju dvanajst tonske lestvice doseže dve oktavi in pol, v prepihavanju pa njegov obseg znaša več kot tri oktave. Tehnične zmogljivosti glasbila v smislu izraznosti ne dopuščajo domneve o slučajnosti nastanka luknjic in njihove razporeditve na instrumentu. Plast, v kateri je bila najdena piščal, je z metodo ESR datirana v čas med 60.000 in 50.000 leti pred sedanjoščo (= p. s.). Piščal iz Divjih bab je danes najstarejše glasbilo in prvo, ki ga poznamo iz rok neandertalca. S svojo tehnološko dovršenostjo kaže na visoke kognitivne sposobnosti neandertalcev.

Ključne besede: Slovenija, Divje babe I, srednji paleolitik, neandertalci, koščena piščal, glasba

Abstract

The perforated femur of a cave bear, found in 1995 in the Palaeolithic cave site of Divje babe I (western Slovenia), has been the subject of many a heated discussion on its origin since its discovery. Whereas some advocate a natural origin of holes, the consequence of carnivore gnawing, others argue for an artificial origin and see in it the product of a Neanderthal. The results of experimental piercing of fresh brown bear femurs using casts of carnivore teeth, the results of experimental archaeology as well as computer tomography of the disputed flute confirm the latter, that is artificial origin of the holes. This is further confirmed by the latest musical research, which brings new findings on the musical capacity of the flute. This research was carried out on an authentic replica of the flute, whereby the proximal part of the flute served as the mouthpiece and the distal, broader part as the bell. The disposition of holes and the preserved length of the flute form a system, which enables a wide range of sonority and melodic motion and thus reveals the object as an instrument in the proper sense of the word. In the sound sequence of a twelve-tone scale, the instrument has a two and a half octave compass, which extends to over three octaves by over-blowing. The technical capacity of the instrument in terms of expression thus leaves no doubt as to the artificial origin of holes and their deliberate alignment. The layer, in which the flute was found, is ESR dated to between 60 and 50 ky in the past. The flute from Divje babe I is today considered the oldest instrument and the first known to have been made by Neanderthal hands. Its technological perfection points to high cognitive abilities of Neanderthals.

Keywords: Slovenia, Divje babe I, Middle Palaeolithic, Neanderthals, bone flute, music

Slovenski paleolitik je širšo prepoznavnost dosegel že na samem začetku raziskav, z odkritjem visokogorske mlajšepaleolitske orinajsenske postojanke v jami Potočki zijalki v Karavankah leta 1928 (Brodar, S. in M. 1983). Z odkritjem kulturnih ostankov paleolitskega človeka je postala Potočka zijalka prvo odkrito paleolitsko najdišče na slovenskem, njen raziskovalec Srečko Brodar pa velja za nestorja slovenske paleolitske arheologije. V najdišču, ki je poleg svoje visokogorske lege posebno predvsem po izjemnem številu koščenih konic, so izkopali tudi spodnjo desno čeljust jamskega medveda s tremi luknjami, interpretirano kot orinajsensko piščal (Omerzel-Terlep 1996).

Skoraj sedemdeset let pozneje je slovenski paleolitik znova pretresel paleolitsko znanstveno srenjo, tokrat ne samo v evropskem, temveč v svetovnem merilu. V jami Divje babe I (zahodna Slovenija) je bila leta 1995 v srednjepaleolitski plasti najdena preluknjana stegnenica mladega jamskega medveda: neandertalska piščal. V nadaljevanju bomo predstavili prispevek Ivana Turka k odkritju in razjasnitvi nastanka lukenj na prvi najdeni neandertalski piščali. Na koncu kot novost predstavljamo muzikološke ugotovitve akademskega glasbenika Ljubena Dimkaroskega, ki piščal iz Divjih bab I postavlajo v novo luč.

PALEOLITSKO NAJDIŠČE DIVJE BABE I IN OKOLIŠCINE ODKRITJA NEANDERTALSKIE PIŠČALI

Skoraj vsa slovenska paleolitska najdišča so bila odkrita v jamah, kjer med favnističnimi ostanki prevladuje jamski medved. Najdbe fosilnih ostankov jamskega medveda v Divjih babah I so bile tudi povod za prvo arheološko sondiranje, ki ga je na pobudo Mitje Brodarja z Inštituta za arheologijo ZRC SAZU leta 1978 opravil prav I. Turk (*sl. 1*). Na podlagi rezultatov sondiranja se je M. Brodar odločil za sistematična arheološka izkopavanja, ki jih je na terenu vodil I. Turk. Ko je M. Brodar odšel v pokoj, je celotno vodenje prepustil I. Turk. Izkušnje, pridobljene z dolgoletnim terenskim delom, so mu narekovale lastno vizijo raziskav in uporabo interdisciplinarnih metod, usmerjenih v čim bolj natančno in objektivno pridobivanje vseh razpoložljivih informacij o najdišču. Na prvi pogled je bilo to predvsem vidno z uvedbo mokrega sejanja vseh izkopanih sedimentov ter z arbitrarnim izkopavanjem po režnjih debeline 12 cm. Slednje mu je omogočilo razvrstitev plasti v sedimentacijske nivoje in skupaj z radiometričnimi datacijami oceniti hitrost odlaganja sedimentov v jami (Turk 2003; 2007a). Radiometrično datiranje vseh paleolitskih horizontov in analize zmrzlinskih klastov (kongelifraktov) so bili podlaga za izdelavo regionalne klimatske krivulje za obdobje mlajšega pleistocena (Turk 2007b; Blackwell *et al.* 2009). Prava vrednost predanega dela I. Turka in



Sl. 1: Jama Divje babe I v času izkopavanj. Foto: Ivan Turk.
Fig. 1: The cave of Divje babe I during excavation. Photo: Ivan Turk.

The Slovene Palaeolithic achieved wide recognition at its very beginning, with the 1928 discovery of a Upper Palaeolithic (Aurignacian) site in the high alpine cave of Potočka zijalka in the Karavanke Mountains (Brodar, S. & M. 1983). The discovery of cultural remains of the Palaeolithic man made Potočka zijalka the first uncovered Palaeolithic site in Slovenia and Srečko Brodar, its excavator and researcher, nestor of the Slovene Palaeolithic archaeology. The site, characterized by its location in the high Alps, but even more so by the extraordinary number of bone points, has also revealed the right mandible of a cave bear with three holes in it, interpreted as an Aurignacian flute (Omerzel-Terlep 1996).

Nearly seventy years on, the Slovene Palaeolithic again provided a find that reverberated across the Palaeolithic scientific community, this time not only in Europe, but across the world. The find is a perforated femur of a juvenile cave bear, a Neanderthal flute, which was found in 1995 in the cave of Divje babe I (western Slovenia), in a Middle Palaeolithic layer. The paper below focuses on Ivan Turk and his contributive role in the discovery of the flute and the explanation of how the holes on the first uncovered Neanderthal flute were made. The paper concludes with a presentation of musicological

številnih sodelavcev različnih strok pa je danes predvsem v tem, da so Divje babe I paleolitsko najdišče z najbolje izdelano kronologijo in stratigrafijo v Sloveniji in kot tako idealno referenčno najdišče v regiji. Arheološka izkopavanja v Divjih babah I so se končala leta 1999.

Paleolitski lovci in nabiralci, ki so jamo Divje babe I občasno uporabljali kot zavetišče, so za seboj pustili okoli 700 kamenih artefaktov, izdelanih predvsem iz lokalnega tufa in roženca, 14 koščenih artefaktov in 20 kurišč (Turk, Kavur 1997; Horusitzky 2007; Culiberg 2007). Na podlagi koncentracije arheoloških ostankov je bilo določenih 14 paleolitskih horizontov. Vsi paleolitski horizonti razen najvišje ležečega pripadajo srednjemu paleolitiku (musterjenu), ki ga povezujemo z neandertalcem. Najvišje ležeči paleolitski horizont pripada mlajšemu paleolitiku (orinasjenu), ki ga povezujemo z anatomskega modernim človekom. Časovni razpon paleolitskih horizontov, določen z ESR-datiranjem, sega od 40.000 do 116.000 let v preteklost.

Značilnost srednjepaleolitskih orodij iz Divjih bab I je, da so majhnih dimenzij, kar je posledica velike obrabe. Med kamenimi orodji, ki so sicer tipološko težko določljiva, prevladujejo strgala, izjede in nazobčana orodja. Prisotni so tudi mlajšepaleolitski tipi orodij, kot so praskala in vbadalo. Robovi orodij so intenzivno retuširani z izmenično strmo ali polstrmo retušo. Preučevanje retuše in poškodb na vzorcu kamenih artefaktov skupaj s poskusnimi preverjanji nakazuje, da so neandertalci z njimi verjetno intenzivno obdelovali les (Bastiani *et al.* 2000).

V srednjepaleolitskih horizontih je bilo odkritih več odlomkov koščenih konic ter atipičnih koščenih šil (Horusitzky 2007; Turk *et al.* 2001, t. 1: 1–8, t. 2: 1–6). Najstarejši fragment koščene konice je bil odkrit v plasti 20, stari okoli 110.000 let. V edinem mlajšepaleolitskem horizontu je bilo odkritih le nekaj kamenih in koščenih orodij, med njimi konica z razcepljeno bazo (Turk, Kavur 1997, t. 10.1: 1).

Vsa kurišča so bila odkrita v srednjepaleolitskih horizontih. Bila so brez posebnih struktur, le nekatera so bila plitvo vkopana v tla. V njih je prevladovalo oglje borovca (*Pinus*) in drugih iglavcev, pojavlja pa se tudi oglje listavcev, z bukvijo (*Fagus*) vred. Med ogljem je bilo ugotovljeno veliko oglja tise (*Taxus*), ki so jo v paleolitiku uporabljali za izdelavo sulic (Turk, Kavur 1997; Culiberg 2007).

Jama je bila v mlajšem pleistocenu stalen brlog jamskega medveda (*Ursus spelaeus*), ki mu pripada kar 99 % vseh favnističnih ostankov v najdišču. Posebnost so fosilizirane dlake jamskega medveda, ki so se ohranile v zlepiljenih skupkih zemlje (aggregatih). Med ostalimi zastopanimi zvermi velja omeniti volka (*Canis lupus*), rjavega medveda (*Ursus arctos*), jamskega leva (*Panthera spelaea*), leoparda (*Panthera pardus*), risa (*Lynx lynx*) in polarno lisico (*Alopex lagopus*) (Toškan 2007).

findings by Ljuben Dimkaroski, an academic musician, which shed new light on the flute from Divje babe I.

THE PALAEOLITHIC SITE OF DIVJE BABE I AND THE FLUTE'S FIND CIRCUMSTANCES

Almost all Slovene Palaeolithic sites were uncovered in caves, where fauna remains are predominantly represented by those of the cave bear. The finds of fossil cave bear remains led to the first archaeological trial trenching also at Divje babe I, conducted in 1978 by Ivan Turk on the incentive of Mitja Brodar from the Institute of Archaeology of the Scientific Research Centre, Slovene Academy of Sciences and Arts (Fig. 1). Based on the trenching results, Brodar decided on systematic archaeological excavation conducted on the field by I. Turk. When Brodar retired, I. Turk took over as head of the entire operation. Experience, gained through the long years of field work, dictated a particular vision of how to conduct the investigation and the use of interdisciplinary methods aimed at as accurate and objective gathering of all available data on the site as possible. This is primarily visible in the introduction of wet sieving of all excavated sediments and the arbitrary excavation method with 12 cm thick spits. The latter enabled the distribution of layers into sedimentation levels and, together with radiometric dates, assessment of the speed of sedimentation in the cave (Turk 2003; 2007a). Radiometric dates of all the Palaeolithic horizons and analyses of congelifracts constituted the basis for the production of a regional climate curve for the Late Pleistocene (Turk 2007b; Blackwell *et al.* 2009). The real value of the devoted work by I. Turk and numerous collaborators of different professions, however, is today primarily discernible in that Divje babe I represents the Palaeolithic site with most elaborate chronology and stratigraphy in Slovenia and is, as such, the ideal reference site for the region. Archaeological excavation in Divje babe I was concluded in 1999.

The Palaeolithic hunters and gatherers, who occasionally used the cave as a shelter, left behind around 700 stone artefacts, made predominantly of local tuff and chert, furthermore 14 bone artefacts and 20 fireplaces (Turk, Kavur 1997; Horusitzky 2007; Culiberg 2007). The concentration of archaeological remains enabled 14 Palaeolithic horizons to be defined. With the exception of the topmost, all layers date to the Middle Palaeolithic (Mousterian), which is tied to Neanderthals. The topmost layer dates to the Upper Palaeolithic (Aurignacian), which is tied to the anatomically modern man. The Palaeolithic horizons span from 40,000 to 116,000 years in the past, as determined by ESR dating.

The characteristic of the Middle Palaeolithic tools from Divje babe I is their small size as the consequence



Sl. 2: Originalna piščal iz Divjih bab I in njena rekonstrukcija, izdelana na fosilni stegnenici jamskega medveda, na katere igra Ljuben Dimkaroski (zgoraj posteriorna, spodaj anteriorna stran). Foto: Tomaž Lauko, Narodni muzej Slovenije.

Sl. 2: The original flute from Divje babe I and its reconstruction made on a fossil femur of the cave bear. The latter played by Ljuben Dimkaroski (posterior side above, anterior below). Photo: Tomaž Lauko, National Museum of Slovenia.

Piščal (sl. 2) je odkopal Turkov dolgoletni sodelavec Janez Dirjec med izkopavanjem v notranjosti jame (Turk *et al.* 1995). Ležala je zacementirana v breči v srednjepaleolitski plasti 8a (paleolitski horizont D-1). Plast 8a se je odložila v zmerni in vlažni klimatski fazi v prvi polovici OIS 3. Ohranjena dolžina piščali je 11,5 cm. Izdelana je iz leve stegnenice mladega jamskega medveda. Na posteriorni strani sta dve luknji ohranjeni v celoti in ena delno. Na anteriorni strani je delno ohranjena še četrta luknja. Na obeh koncih površinsko inkrustirane kosti, ki je povsem brez spongioze, manjkata epifizi. Metafizi sta zалomljeni do obeh delno ohranjenih lukenj.

Najdba je ob odkritju vzbudila pozornost zaradi lukenj, razporejenih v ravni vrsti na sredini diafize. Kot tako je bila na videz povsem podobna mlajšepaleolitskim piščalim, izdelanim iz cevastih kosti (Leocata 2000–2001). V času odkritja je bila na voljo le radio-

of heavy use-wear. The typological determination of the stone tools is very difficult, nevertheless there is a predominance of side scrapers, notches, and denticulated tools. Also present are Upper Palaeolithic tool types, such as endscrapers and a burin. The tool edges are intensely retouched using the alternate abrupt or semi-abrupt retouch. The study of retouches and damage on a selection of stone artefacts together with the experimental tests indicates that Neanderthals probably used these tools to work wood (Bastiani *et al.* 2000).

The Middle Palaeolithic horizons revealed several fragments of bone points and atypical bone awls (Horusitzky 2007; Turk *et al.* 2001, T. 1: 1–8, T. 2: 1–6). The oldest fragment of a bone points was uncovered in layer 20, which is roughly 110,000 years old. The only Upper Palaeolithic horizon revealed only a few stone and bone tools, among which include a split-based point (Turk, Kavur 1997, T. 10.1: 1).

The fireplaces were all uncovered in the Middle Palaeolithic horizons. They did not reveal any particular structure, with the exception of some being slightly sunken into the ground. The predominant wood remains uncovered in them, in the form of charcoal, belong to pine (*Pinus*) and other conifers, also appearing is the charcoal of deciduous trees including beech (*Fagus*). There was furthermore a lot of charcoal of yew (*Taxus*), used in the Palaeolithic for making spears (Turk, Kavur 1997; Culiberg 2007).

During the Late Pleistocene, the cave served as a permanent lair to the cave bear (*Ursus spelaeus*), represented with as much as 99 % of all the site's fauna remains. A special find at the site is the fossilized cave bear hair, preserved within clusters of soil or aggregates. Other carnivores present in the cave include wolf (*Canis lupus*), brown bear (*Ursus arctos*), cave lion (*Panthera spelaea*), leopard (*Panthera pardus*), Eurasian lynx (*Lynx lynx*) and arctic fox (*Alopex lagopus*) (Toškan 2007).

The flute (Fig. 2) was excavated by Janez Dirjec, I. Turk's long-time co-worker, in the cave's interior (Turk *et al.* 1995). It lay cemented within breccia, in Middle Palaeolithic layer 8a (Palaeolithic Horizon D-1). The layer was deposited in a temperate and humid climate phase in the first half of OIS 3. The preserved length of the flute is 11.5 cm. It is made of the left femur of a juvenile cave bear. The posterior side shows two completely and one partially preserved hole. The anterior side has a fourth hole, partially preserved. The bone has surface incrustation and is completely devoid of spongiosis. Neither of the epiphyses are preserved. The metaphyses on both sides are fractured up to the partially preserved holes.

The find immediately attracted attention due to the holes perforated in a straight line along the diaphysis. It looked very similar to the Upper Palaeolithic flutes made on tubular bones (Leocata 2000–2001). At the time of discovery, only the radiocarbon date of the layer, in which the flute was found, was available, which pointed

karbonska datacija plasti, v kateri je ležala piščal, ki je pokazala starost 46.000 let. Nove, radiometrične datacije ESR plast s piščaljo postavljajo globlje v preteklost, v čas med 60.000 in 50.000 leti p.s. (Blackwell *et al.* 2009).

VPRAŠANJE NASTANKA LUKENJ

Odkritje preluknjane kosti, domnevne neandertalske piščali, v Divjih babah I je pritegnilo veliko pozornost strokovnjakov iz Evrope in ZDA. Umetniški in drugi izdelki neandertalcev, ki presegajo potrebe vsakdanje borbe za preživetje in imajo drugačen, abstractni pomen, so izredno redki, njihov umetni izvor pa pogosto postavljen pod vprašaj (Bednarik 1994; Soressi, D'Errico 2007). Ohranjene arheološke najdbe nam dejansko dajejo vtis, da se je paleolitska umetnost v Evropi pojavila šele s prihodom anatomske modernih ljudi. Po ustaljenem prepričanju naj bi bil anatomska moderni človek tudi prvi, ki je izvajal glasbo. Dokaz za to naj bile številne mlajšepaleolitske koščene piščali. Najstarejše med njimi, najdene v nemških najdiščih Geissenklösterle, Hohle Fels in Vogelherd, so stare med 30.000 in 40.000 let (Conard *et al.* 2009).

Najdba iz Divjih bab I bi lahko bila prvi dokaz o glasbenem ustvarjanju neandertalcev. Problem je nastal, ker na luknjah ni bilo vidnih sledov izdelave s kamenimi orodji, na obeh koncih odlomljene kosti pa so bile prisotne poškodbe, ki bi lahko nastale pri zverskem grizenu. Na mlajšepaleolitskih piščalah so sledovi umetne izdelave vidni, saj so bile luknje izdolbene ali izvrte s kamenimi orodji. Kljub neobičajni legi in številu lukenj na diafizi je večina znanstvene javnosti zavzela stališče, da so luknje posledica zverskega griznenja in da najdba ni artefakt oz. piščal (Chase, Nowell 1998; D'Errico *et al.* 1998; Albrecht *et al.* 2001). V takšnem prepričanju je izzvenela tudi znanstvena konferanca, ki jo je leta 1998 I. Turk organiziral v Spodnji Idriji (Kavur 1998). Strokovnjaki, ki so nasprotovali hipotezi o piščali, so kot temeljni dokaz za zverski izvor lukenj navajali sledove griznenja. Pri tem niso izpostavili možnosti, da bi zver lahko kost obgrizla, preden so bile ali potem ko so bile luknje umetno izdelane. Kategorično so zanikali možnost, da bi luknje izdelal človek, zato tudi niso razmišljali, kako bi bilo možno na umeten način izdelati ustrezne luknje. Nezadovoljen s takšnimi enostranskimi in poenostavljenimi razlagami se je I. Turk odločil, da bo s pomočjo praktičnih poskusov preveril možnost naravnega (zver) in umetnega (neandertalec) nastanka lukenj na sporni kosti. Problematike se je lotil nepristransko, zato je najdbo, vse dokler ni imeli dovolj argumentov v prid umetnega izvora lukenj, vedno in povsod dosledno imenoval domnevna piščal.

to the age of 46,000 years. New, ESR dates have since then set the layer with the flute further back into the past, in the time between 60,000 and 50,000 years ago (Blackwell *et al.* 2009).

ON HOW THE HOLES WERE MADE

The discovery of the perforated bone, the presumed Neanderthal flute, at Divje babe I, attracted a great deal of attention of experts from both Europe and the United States. Art objects as well as other artefacts made by Neanderthals that surpass the daily survival needs and have a different, abstract significance, are extremely rare and their artificial origin is often questioned (Bednarik 1994; Soressi, D'Errico 2007). The archaeological finds uncovered so far rather give the impression that art in the Palaeolithic only appeared in Europe with the arrival of the anatomically modern man. It is also an accepted belief that it was the latter that was the first to practice music, an evidence of which is seen in the numerous Upper Palaeolithic bone flutes. The oldest flutes, found in the German sites of Geissenklösterle, Hohle Fels and Vogelherd, are between 30,000 and 40,000 years old (Conard *et al.* 2009).

The find from Divje babe I could offer the first evidence of musical creativeness of Neanderthals. There are, however, certain features of the flute that give doubts about its artificial origin. One is the absence of stone tool marks around the holes and the damage on both broken ends of the bone that could have occurred by carnivores gnawing on the bone. The Upper Palaeolithic flutes bear visible tool marks, since the holes were either carved out or bored in using stone tools. In spite of the unusual position and number of holes on the diaphysis, therefore, most in the scientific community interpreted the holes as the consequence of carnivore gnawing and the find not an artefact and thereby not a flute (Chase, Nowell 1998; D'Errico *et al.* 1998; Albrecht *et al.* 2001). It was in this spirit that proceeded the scientific conference that I. Turk organized in 1998 in Spodnja Idrija, Slovenia (Kavur 1998). The experts opposed the flute hypothesis, with gnawing traces as their basic argument for a carnivore origin, whereby the possibility of a carnivore gnawing on the bone before or after the holes being made artificially was not mentioned. They categorically dismissed the possibility of the holes as man-made and, consequentially, did not consider how the appropriate holes could have been made artificially. Dissatisfied with such one-sided and simplified explanations, I. Turk decided to verify the possibility of natural (carnivore) versus artificial (Neanderthal) origin of the holes on the bone in question by conducting practical experiments. He approached the problem unbiased and consistently addressed the find as the supposed flute until he had enough arguments in favour of the artificial origin.

HIPOTEZA O NARAVNEM IZVORU LUKENJ

V Divjih babah I so bili odkriti fosilni ostanki jamskega in rjavega medveda, volka, leoparda in jamskega leva, ki bi hipotetično lahko naredili luknje v stegnenico mladega jamskega medveda. Zagovorniki zverskega potekla lukanj so izpostavili še jamsko hijeno, čeprav njeni ostanki v najdišču niso bili odkriti. Zveri, kot sta jamska hijena in volk, kosti glodata in drobita z namenom, da prideta do hranljivega kostnega mozga. Ostale zveri se s kostmi ne prehranjujejo, lahko pa jih poškodujejo med lovom, razkosavanjem ali hranjenjem. Jamska hijena in volk kosti glodata z derači. Glodati jih začneta vedno na epifizi in se z drobljenjem epifize in metafize postopno približata diafizi. Na epifizi in metafizi je kostna kompakta najtanjsa in kost zaradi spongioze najbolj elastična, zato je večina lukanj in sledov grizenja tako na fosilnih kot na recentnih kosteh ohranjena prav na epifizah in metafizah (Brodar 1985). Diafiza je zaradi debele kostne kompakte toga in se pri grizenju hitro razkolje, kar je tudi glavni namen zveri, ki uživajo kostni mozeg. Zato so lukanje na diafizah skrajno redke, kar je razvidno tudi na fosilnih kosteh iz Divjih bab I. Med izkopavanji v notranjosti jame je bilo pobranih skupaj 1.009 juvenilnih stegnenic jamskega medveda (963 fragmentiranih in 46 z ohranjenim proksimalnim in distalnim delom). Med njimi sta samo dva primerka z lukanjami: piščal in stegnenica s preluknjano proksimalno metafizo. Med skoraj 90.000 pregledanimi določljivimi kostmi iz notranjega dela jame sta to še vedno edina primerka z lukanjami (Turk, Dirjec 2007).

Že ta pregled fosilnih ostankov je pokazal, da so lukanje na diafizi nekaj neobičajnega. V primeru, da bi lukanje na piščali naredila zver, bi vsekakor pričakovali več podobno preluknjanih kosti. Kljub temu je I. Turk želet natančno preveriti, kakšne so možnosti zverskega nastanka lukanj na diafizi. S kovinskimi odlitki zobovij jamskega medveda, hijene in volka je v sodelovanju s Strojno fakulteto v Ljubljani opravil poskusno lukanjanje recentnih juvenilnih medvedjih stegnenic (*sl. 3*) (Turk *et al.* 2001). Glede na obliko lukanj na piščali se je pokazalo, da bi bile te lahko narejene edino s kanini. Poizkusne lukanje, narejene z derači volka in jamske hijene, so bile bolj ovalne ali romboidne oblike.

Poskusno lukanjanje je pokazalo, da volk nima dovolj močne čeljusti in kaninov, da bi predrl 3–4 mm debelo kostno kompakto diafize. Hijena ima dovolj močno čeljust in zobovje, da bi lahko preluknjala kost, vendar razdalje med lukanjami ne ustrezajo razmiku in okluziji kaninov. Enako velja za ugriz leoparda in jamskega leva. Ker med favnističnimi ostanki daleč najbolj prevladuje jamski medved, je med zagovorniki zverskega izvora lukanj obveljal kot najverjetnejši "krivec".

Pri skoraj polovici poskusnih lukanjanj z odlitkom zobovja jamskega medveda je kostna kompakta na

HYPOTHESIS ON THE NATURAL ORIGIN OF THE HOLES

The Divje babe I site revealed fossil remains of the cave bear, brown bear, wolf, leopard and cave lion, which could all hypothetically pierce holes in the femur of a juvenile cave bear. The advocates of a carnivore origin also mentioned cave hyena, though its remains had not been found at the site. Carnivores such as cave hyena and cave lion gnaw on and crush bones so as to get to the nutritious bone marrow. Other carnivores do not feed on bones, but can damage them through hunting, dismemberment or feeding. Cave hyena and cave lion gnaw on bones with their carnassials. They always begin gnawing on the epiphysis and gradually, by crushing the epiphysis and metaphysis, move towards the diaphysis. The compact bone is thinnest on the epiphysis and metaphysis and the bone there is most elastic due to the spongiosis. For that reason, most holes and gnaw marks on both fossil and recent bones is preserved on epiphyses and metaphyses (Brodar 1985). The diaphysis is stiff due to the thick compact bone and is prone to splitting when gnawed on; this is also the main intention of the carnivore that feeds on bone marrow. Holes on diaphyses are therefore extremely rare, which is also visible on the fossil bones uncovered at Divje babe I. The excavation in the cave's interior revealed 1009 juvenile cave bear femurs (963 fragmented and 46 with preserved proximal and distal parts). Only two of those had holes, namely the flute and a femur with perforated proximal metaphysis. Among the almost 90,000 inspected determinable bones from the cave's interior, these two are still the only examples of bones with holes (Turk, Dirjec 2007).

This alone clearly shows that bones with holes on the diaphysis are unusual finds. In the case of carnivores making the holes, we would certainly expect more similarly perforated bones. Searching for further proof, I. Turk continued to explore the possibility of a carnivore origin of the holes on the diaphysis. In co-operation with the Faculty of Mechanical Engineering in Ljubljana, he conducted a test perforation of recent juvenile bear femurs using metal casts of the teeth of the cave bear, hyena and wolf (*Fig. 3*) (Turk *et al.* 2001). The test showed that the form of the holes on the flute could only have been produced by canine teeth. Test holes made with carnassials of a wolf and cave hyena were more oval or rhomboid in shape.

The test perforation showed that a wolf does not possess jaws and canines strong enough to pierce through the 3-4 mm thick compact bone of the diaphysis. A hyena does have the necessary strength, but the spaces between the holes do not match the distance between and the occlusion of its canines. The same goes for the leopard and cave lion. Attention was then directed towards the cave bear, the remains of which largely predominate among the site's fauna and is there-



Sl. 3: Luknjanje svežih stegnenic rjavega medveda z odlitki zverskih zobovij na Strojni fakulteti v Ljubljani. Foto: Ivan Turk.

Sl. 3: Piercing fresh brown bear femurs with casts of carnivore teeth at the Faculty of Mechanical Engineering in Ljubljana. Photo: Ivan Turk.

diafizi po celotni dolžini počila na obe straneh. Da je topi medvedji kanin preluknjal recentni femur rjavega medveda, je bila potrebna sila 6.493 N, za zgolj razločen odtisek zoba pa 3.308 N. Glede na izračune moč ugriza kanina jamskega medveda pri odraslih samcih ni presegla 1.476,2 N (Grandal-d'Anglade 2010). To je podatek, ki vsekakor ne govoriti v prid zverskemu izvoru lukanj na diafizah cevastih kosti.

Bistvena ugotovitev teh poskusov je bila, da je praktično neverjetno, da bi medved na diafizi naredil dve luknji ali več, ne da bi se kost zdrobila. Izkazalo se je, da ni verjetno, da bi medvedu ali kateri koli drugi zveri, ki bi kost grizla samo s kanini, uspelo pri več zaporednih ugrizih poravnati vse luknje v ravno vrsto, tako kot so na piščali. Spodnja in zgornja kanina zaradi različne dolžine in ukrivljenosti nista v osi. Zato sveža ovalna kost pri takšnem grizenju med zobmi spodrava, kar dodatno onemogoča razporeditev lukanj v ravno vrsto.

fore considered as the most probable “culprit” by the advocates of the holes’ carnivore origin.

In almost half of the test perforations using metal casts of cave bear teeth, the compact bone on the diaphysis broke along the entire length on both sides. For the blunt bear canine to pierce through a recent brown bear femur, it took the force of 6493 N, while it took 3308 N for it to only leave a discernible tooth impression. According to calculations, the bite force of a cave bear canine in adult males did not exceed 1476.2 N (Grandal-d'Anglade 2010). This information does not speak in favour of a carnivore origin of holes on the diaphyses of tubular bones.

The key finding of these experiments is that it is practically impossible for a bear to make two or more holes into a diaphysis without breaking it. Furthermore, it showed it to be improbable for a bear or any other carnivore, gnawing the bone only with canines, to succeed in aligning the holes made in several successive bites, as is the case on the flute. The upper and lower canines do not stand in axis due to different lengths and curvatures. This, together with the fact that oval bone is slippery when fresh, makes it even harder to align holes.

HYPOTHESIS ON THE ARTIFICIAL ORIGIN OF HOLES

The absence of stone tool marks on the flute's holes is not yet evidence of the object not being an artifact. Tool marks on some of the Upper Palaeolithic points from Divje babe I as well as bone artifacts from other sites are also either not visible or not preserved, and yet no one doubts in their anthropogenic origin. What has to be taken into account here is that the flute was subjected to heavy abrasion, as is visible on the rounded fractures on both ends of the diaphysis. Abrasion could also be the reason why eventual tool marks on the flute have not been preserved.

The explanation of the holes' artificial origin is mostly credited to Giuliano Bastiani, experimental archaeologist, and François Zoltán Horusitzky, archaeologist. The first step in favour of the hypothesis of artificial origin was made by Bastiani (*Fig. 4*) (Bastiani, Turk 1997). Using replicas of pointed stone tools, found also in the layer with the flute, he perforated a recent bear bone in a manner thus far unknown to archaeologists. He used the tool both as a chisel and a piercing tool that he hit by a wooden mallet. By combining chiselling and piercing he was able to produce holes similar to the ones on the flute. The important finding of this experiment was that the method used left no visible tool marks on most of the holes, which meant that it was possible to make holes without visible tool marks. However, the interior side of the holes made by Bastiani showed no distinct tapering, such as is visible on the holes of the flute.

HIPOTEZA O UMETNEM IZVORU LUKENJ

Odsotnost sledov izdelave oz. sledov kamenih orodij na luknjah piščali še ne dokazuje, da predmet ni artefakt. Na nekaterih mlajšepaleolitskih konicah iz Divjih bab I kot tudi na koščenih izdelkih iz drugih najdiš sledovi izdelave niso vidni oz. ohranjeni, pa kljub temu nihče ne dvomi o njihovem antropogenem poreklu. Upoštevati moramo, da je bila piščal podvržena močni abraziji, kar kažejo zaobljeni prelomi na obeh koncih diafize. Abrazija je lahko vzrok, da se morebitni sledovi orodij niso ohranili.

Pri pojasnitvi umetnega nastanka lukanj imata zasluge predvsem eksperimentalni arheolog Giuliano Bastiani in arheolog François Zoltán Horusitzky. Prvi korak v prid hipotezi o umetnem izvoru lukanj je uspel G. Bastianiju (*sl. 4*) (Bastiani, Turk 1997). Z replikami koničastih kamenih orodij, ki so bila najdena tudi v plasti s piščaljo, je preluknjal recentno medvedjo kost na način, ki arheologom doslej ni bil znan. Koničasto kameno orodje je uporabil kot dleto in hkrati kot prebijač, po katerem je udarjal z lesenim tolkačem. S kombinacijo klesanja in prebijanja je izdelal podobne lukanje, kot so na piščali. Pomembno je bilo spoznanje, da sledovi orodij niso bili vidni na večini tako izdelanih lukanj, kar je pomenilo, da je možno izdelati lukanje brez sledov izdelave. Vendar na notranji strani lukanj, ki jih je izdelal Bastiani, ni bilo izrazitega lijaka, ki je prisoten na lukanjih na piščali.

Pri lukanjanju z eksperimentalnimi kamenimi koničastimi orodji je na njih prišlo do makroskopskih poškodb ter do zlomov terminalnih delov konic. Takšne poškodbe so prisotne na srednjepaleolitskih koničastih orodjih iz Divjih bab I, kar lahko skupaj z najdenimi terminalnimi odlomki konic štejemo za posreden dokaz, da so neandertalci z njimi lukanjali tudi kosti (Turk *et al.* 2001, t. 3-7).

Do novih pomembnih ugotovitev glede umetne izdelave lukanj je prišel F. Z. Horusitzky (Horusitzky 2003; Turk *et al.* 2003), saj mu je uspelo izdelati lukanje, ki do potankosti ustrezajo tistim na piščali. Horusitzky je najprej s koničastim kamenim orodjem in lesenim tolkačem izklesal v recentno kost plitvo vdolbinico, ne da bi kost do konca preluknjal. Na mestu vdolbine je nato s koščenim prebijačem in lesenim tolkačem prebil kostno kompakto. Končasto ošljene kosti, ki so jih našli v Divjih babah I, so tako dobile nov pomen (*sl. 5*). Tudi na teh atipičnih domnevnih koščenih izdelkih ni ohranjenih nobenih sledov izdelave, vendar so lahko služili kot prebijači pri izdelavi lukanj. Koščen prebijač in zob delujeta na kost kot klin, zato lahko kost ob lukanji vzdolžno poči. Pri lukanjanju s koščenim prebijačem lahko poči samo na strani, ki jo lukanjamo, pri poskusnem lukanjanju z odlitki zverskih zobovij pa je počila na obeh straneh. Nепrekinjena, komaj vidna vzdolžna razpoka je na piščali prisotna na ploski



Sl. 4: Giuliano Bastiani in Ivan Turk med izdelavo lukanj v svežo stegnenico rjavega medveda.

Sl. 4: Giuliano Bastiani and Ivan Turk piercing holes in a fresh brown bear femur.

Piercing holes with experimental pointed stone tools created, on the latter, macroscopic damage and fractures of the terminal parts. Such damage was observed on Middle Palaeolithic pointed tools from Divje babe I, which could be considered, together with the uncovered terminal fragments of points, as indirect evidence of Neanderthals also piercing bones with them (Turk *et al.* 2001, T. 3-7).

New important findings concerning the artificial origin of holes were provided by Horusitzky (Horusitzky 2003; Turk *et al.* 2003). He was able to make holes that match those on the flute in detail. He began by carving a shallow indentation into the recent bone using a pointed stone tool and a wooden mallet. He proceeded by piercing through the compact bone on the spot of the indentation using a bone piercing tool and a wooden mallet. The bones sharpened into a point, found at Divje babe I, have thus taken on a new meaning (*Fig. 5*). These atypical and supposed bone products have also not revealed any tool marks, but could have served as piercing tools in making holes. Both a bone piercing tool and a tooth act on the bone as a wedge, whereby the bone around the hole can break. If piercing by using a bone piercing tool, the bone can break on the perforated side only, while it broke on both sides by test piercing with casts of carnivore teeth. The flute bears an uninterrupted, hardly



Sl. 5: Orodje s katerim so bile lahko izdelane luknji na piščali: koničasto kameno orodje in koščen prebijač iz Divjih bab I. Foto: Fototeka Inštituta za arheologijo ZRC SAZU.

Sl. 5: Tools used to pierce holes of the flute: bone piercing tool and pointed stone tool from Divje babe I. Photo: Archive of the Institute of Archaeology, Slovene Academy of Sciences and Arts.

posteriorni strani, kjer sta ohranjeni dve popolni luknji in ena delna. Razpoka je lahko nastala med izdelavo ali uporabo, lahko pa tudi postsedimentno.

Po iskanju praktičnih možnosti za nastanek lukanj v luči obeh hipotez je bila piščal analizirana še z večrezinsko računalniško tomografijo (Turk *et al.* 2005). Na podlagi 228 CT-rezin, posnetih vzdolž diafize, je bilo ugotovljeno, da debelina kostne kompakte ni vplivala na položaj lukanj. Zver, ki pri grizenju preizkuša kost in išče njene šibke točke, bi kost preluknjala na mestih, kjer je kostna kompakta najtanjsa. Vendar sta obe v celoti ohranjeni lukanji na posteriorni strani nastali na mestu, kjer je kompakta najdebelejša, čeprav se v bližini obeh lukanj občutno stanjša. Za človeka in njegova orodja debelina kompakte ni bila ovira, saj jo je lahko stanjal z brušenjem. V območju ene izmed obeh v celoti ohranjenih lukanj je dejansko opazno rahlo postmortalno stanjšanje kostne kompakte, ki ga ne moremo pripisati delovanju zveri. S predhodnim stanjšanjem (brušenjem) kompakte si je neandertalec olajšal izdelavo lukanje. Temeljna ugotovitev večrezinske računalniške tomografije je, da lukanje in zverske poškodbe niso istočasne. Najprej so nastale štiri lukanje in šele nato večina poškodb, ki bi jih lahko pripisali zverem.

S pomočjo praktičnih poskusov, eksperimentalne arheologije in večrezinske računalniške tomografije je

visible crack along the flat posterior side of the bone, where two complete and one partial holes are preserved. The said crack could have occurred either in production or in use, but also during post-sedimentation.

After looking for practical possibilities for the origin of the holes in light of the two proposed hypotheses, the flute was also analyzed with multi-slice computer tomography (Turk *et al.* 2005). The 228 CT slices, taken along the diaphysis, revealed that the thickness of the compact bone did not have a bearing on the position of the holes. An animal that gnaws the bone testing it for its weak spots, would pierce where the compact bone was thinnest. On the flute, however, both completely preserved holes on the posterior side were made on the spot where the compact bone is thickest despite the fact that the bone thins out considerably in their vicinity. The thickness of the compact bone thus did not represent an obstacle for man and his tools, since he could thin the bone out by grinding. The surrounding area of one of the completely preserved holes actually shows a slight post-mortual thinning of the compact bone that cannot be attributed to carnivore activity. By thinning (grinding) the compact bone, Neanderthals facilitated the perforation of the bone. The basic finding of the multi-slice computer tomography, however, was that the holes and carnivore damage are not contemporary;

I. Turk in sodelavcem uspelo pojasniti izvor lukenj, ki so nastale umetno. Šele po opravljeni računalniški tomografiji se je I. Turk končno odločil, da predmet proglaši za artefakt, interpretiran kot neandertalsko piščal.

NOVA MUZIKOLOŠKA SPOZNANJA

Medtem ko je arheologija potrebovala skoraj deset let, da je prišla do ključne ugotovitve, da je preluknjana kost iz Divjih bab I artefakt, je bila med etnomuzikologi, ki so prvi preučevali njene glasbene zmogljivosti, precej hitro sprejeta kot paleolitska piščal (Omerzel-Terlep 1996; 1997; Kunej 1997; Kunej, Turk 2000). Študija glasbenih zmogljivosti piščali je pritegnila tudi širši krog strokovnjakov (Fink 1997; Horusitzky 2003; Atema 2004). Nova spoznanja glede glasbene zmogljivosti piščali nam prinašajo raziskave akademskega glasbenika Ljubena Dimkaroskega. V nadaljevanju podajamo njegovo besedilo s ključnimi ugotovitvami. V širšo muzikološko razpravo, ki bo del nekega drugega članka na to temo, se na tem mestu ne bomo spuščali.

Svetovno znana najdba iz Divjih bab I je danes po zaslugu slovenskih in nekaterih tujih strokovnjakov arheološko dobro opredeljena, zato sem želel preizkusiti njen glasbeno funkcionalnost. Naredil in preizkusil sem več kot 30 rekonstruiranih lesenih in koščenih kopij piščali v želji, da najdem pravi zvok piščali. Vse kopije so bile narejene na podlagi rekonstrukcije piščali, ki so jo podali I. Turk et al. (2005, sl. 14). Raziskave sem izvajal na stegnenicah mladih rjavih medvedov, ki mi jih je priskrbela Lovska zveza Slovenije, ter na telečjih, kozjih, svinjskih, srninih in jelenovih kosteh. Naposled sem raziskavo usmeril predvsem v igranje na kopijo, narejeno iz stegnenice mladega jamskega medveda iz Divjih bab I. Fosilno kost sem izbral z namenom, da se čim bolj približam dimenzijam originalne piščali (sl. 2). Kopiji sem dodal še dele, ki so bili na originalu očitno odlomljeni (glej Turk et al. 2005).

Na glasbilo¹ igram z obema rokama v naravni, neprisiljeni drži, tako da se dolžina (113,6 mm) in oblika glasbila (torziska zavitost kosti okoli 20°) anatomsko prilegata dlani in prstom rok. Glasbilo je netemperirano, z njim v zvočnem zaporedju dvanajsttonske lestvice dosegam dve oktavi in pol. V prepihavanju njegov obseg znaša več kot tri oktave. Je aerofono glasbilo, pihalo. V glasbenem jeziku lahko na njem izvajam: legato, stakato, dvojni in trojni jezik, frulato, glisando, kromatiko, razložene akorde, intervalske skoke ter melodična zaporedja od najnižjega do najvišjega tona. Dinamične zmožnosti segajo od piano do forte kot pri sodobnih inštrumentih. Intervalski skoki so možni v celotnem obsegu glasbila. V

¹ Medtem ko se v dosedanjih arheoloških objavah uporablja beseda piščal (v angleščini flute, francoščini flûte, nemščini Flöte), bom odslej sam uporabljal ustreznejši izraz: glasbilo. Zakaj sem se tako odločil, je razvidno iz nadaljevanja.

first the four holes were made, followed by most of the damage attributable to carnivores.

Practical tests, experimental archaeology and multi-slice computer tomography enabled I. Turk and his collaborators to explain the origin of the holes, which were made artificially. After the computer tomography results, I. Turk finally decided to proclaim the object as an artefact, interpreted as a Neanderthal flute.

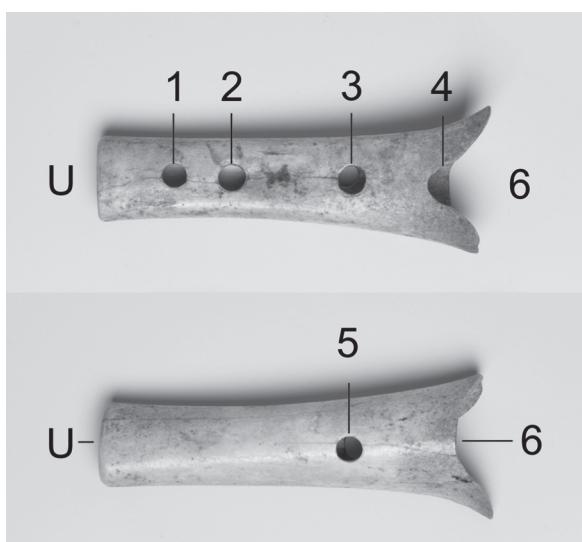
NEW MUSICOLOGICAL FINDINGS

Contrary to archaeologists, who took almost a decade to conclude that the perforated bone from Divje babe I was an artefact, the ethnomusicologists who were the first to study its musical capabilities accepted it quite rapidly as a Palaeolithic flute (Omerzel-Terlep 1996; 1997; Kunej 1997; Kunej, Turk 2000). The study of the flute's musical capabilities attracted an even wider circle of experts (Fink 1997; Horusitzky 2003; Atema 2004). New findings on the subject have been provided by the research of Ljuben Dimkaroski, academic musician, whose paper with key findings is presented below. A wider musicological discussion will be part of another paper and will therefore not be discussed here.

The world renowned find from Divje babe I is today, through the work of Slovene and certain foreign scientists, archaeologically well determined. I have therefore wished to test its musical functionality. In order to do so, I created over 30 wooden and bone replicas of the flute and experimented with them. All replicas were based on the reconstruction of the flute put forward by I. Turk et al. (2005, sl. 14). Replicas were made on femurs of juvenile brown bears provided by Hunters Association of Slovenia, but also calf, goat, pig, roe and red deer bones. In the end, I concentrated the research on playing a replica made on a femur of a juvenile cave bear from Divje babe I. I chose the fossil bone so as to come as close as possible to the dimensions of the original flute (Fig. 2). The replica was added parts obviously broken off on the original (see Turk et al. 2005).

I played the instrument¹ with both hands in a natural, relaxed posture so that the length (113.6 mm) and form of the instrument (torsion of the bone is around 20°) anatomically fit the palm and fingers. The instrument encompasses range of two and a half octaves, which can be extended to three octaves by over-blowing. It is an aerophone, a woodwind instrument. In musical terms it allows the playing of non-tempered or tempered steps and leaps, broken chords, as well as any melodic sequences between the lowest and the highest tone. It enables legato and staccato playing, double

¹ While archaeological publications thus far use the word flute (piščal in Slovene, flûte in French, Flöte in German), I shall henceforth use a more appropriate word, namely instrument. This choice will be explained below.



Sl. 6: Replika piščali iz Divjih bab I. Oštevilčenje odprtin in oznake posameznih delov tu sledijo drži glasbila pri igranju in njihovi funkciji, za razliko od številk in oznak, ki so jih uporabljali I. Turk *et al.* (2005, sl. 1). Foto: Tomaž Lauko, Narodni muzej Slovenije.

Sl. 6: Replica of the flute from Divje babe I. Hole numbers and markings of individual parts follow here the positions of fingers on the instrument during playing and, consequentially, their function. These differ from the numbering and marking used by I. Turk *et al.* (2005, Fig. 1). Photo: Tomaž Lauko, National Museum of Slovenia.

naravi slišnost glasbila dosega več 100 metrov premera, odvisno od vremenskih razmer, v zaprtih prostorih pa je slišnost podobna sodobnim pihalom.

Pradavni izdelovalec glasbila je v zvočnem pomenu dodoobra izkoristil zmožnosti stegnenice mladega jamskega medveda, saj mu je širši, distalni del kosti služil kot **odmevnik**, ožji, proksimalni pa kot **ustnik**. Zrak v glasbili poteka v isti smeri, kot je potekala življenska energija živali v žilah mladega jamskega medveda od srca proti udom, tako kot pri rastlinah od korenin proti vejam in listom.

Umetno preoblikovana stegnenica, ki nam jo je zapustil neandertalec, jasno kaže namen zvočnega izražanja, saj razporeditev luknjic in ohranjena dolžina najdbe tvorita **sistem**, ki omogoča široko paleto zvočnosti in melodiskskega gibanja in kaže, da gre za glasbilo v pravem pomenu besede. Poleg tega glasbilo s svojo bogato zvočnostjo omogoča glasbeno sporočanje tudi v jeziku današnjega časa. Menim, da glede na tehnične in izrazne zmogljivosti bistveno presega preprosto signalno funkcijo, zato je mogoče, da so ga uporabljali v obredne in druge namene. Pri določenih tonih glasbilo omogoča pomožne prijeme predvsem v visokem registru. Pri raziskovanju zvočnosti glasbila nisem uporabljal pomagal, kot so čepi, jezički in razna polnila.

Preseneča tudi zmogljivost zvenenja dvoglaska in troglaska. Njegove tehnične zmogljivosti v smislu izraznosti

and triple tonguing, frulatto, and glissando. The dynamic capabilities range from piano to forte, as with modern instruments. Interval leaps are possible within the entire melodic range of the instrument. In nature, the audibility of the instrument reaches over 100 m in diameter depending on weather conditions, while in the interior it is similar to that of modern woodwind instruments.

The prehistoric instrument maker has thoroughly put to use the musical possibilities offered by the femur of a juvenile cave bear. The wider, distal part of the bone, served as **the bell** and the narrower, proximal part, as **the mouthpiece**. The air in the instrument flew in the same direction as the life force in the veins of the animal, from the heart towards the limbs, same as in plants, from the roots to the branches and leaves.

The artificially altered femur, as left to us by Neanderthals, clearly shows the intent of musical expression, since the disposition of the holes and the preserved length of the find constitute **a system**, which enables a wide range of sonorities and melodic motions and reveals the object as an instrument. Apart from that, the instrument with its rich sonority enables musical communication also in today's musical languages. Considering its technical and expressional capabilities, I am of the opinion that it substantially surpasses a simple signalling function and was therefore possibly used for ritual or other purposes. The research of the instrument's sonority was conducted without the aids such as plugs, reeds and various fillings.

Also surprising is the possibility to produce two or three simultaneously sounding pitches. The instrument's technical capabilities in terms of expression refute the supposition of the holes' accidental origin and distribution on the instrument. The functional representation of the instrument is illustrated on figure 6.

The size of the instrument's mouthpiece corresponds to the size of human lips. The sound is created by directed blowing against the sharp edge. Careful observation of the original revealed that the left edge in the interior of the mouthpiece is lightly bevelled in the direction of blowing, which opens up the possibility of artificial intervention (Fig. 7).

Hole 1, which is not completely preserved on the original and is closest to mouthpiece U, is smaller than other holes with a reason: the wavelengths of harmonics are shorter at higher notes and a smaller hole thus enables more precise intoning. Holes 2 and 3 fall into the middle register of the instrument. They are of the same size and they enable the most balanced sounds with rich coloration. The notch on the upper side of the bell can be transformed into Hole 4 by holding it with the right hand². Hole 5, which is not completely preserved on the original and which I call **palm hole**, is situated on the lower part

² If the left hand were used for holding, the instrument would have to be made of the right femur instead of the left. Most publications up to now show that researchers used the notch on the upper part of the bell (Hole 4) as the mouthpiece.

ne dopuščajo domneve o naključnosti nastanka luknjic in njihove razporeditve na inštrumentu. Funkcionalni prikaz rekonstruiranega glasbila je razviden na sliki 6.

Velikost ustnika glasbila ustreza velikosti človeških ustnic. Zvok ustvarjam z usmerjenim pihanjem na rezilni rob. Pri pozornem opazovanju originala sem opazil, da je levi rob ustnika v smeri pihanja na zunanjih strani rahlo posnet, kar dopušča možnost človekovega posega (sl. 7).

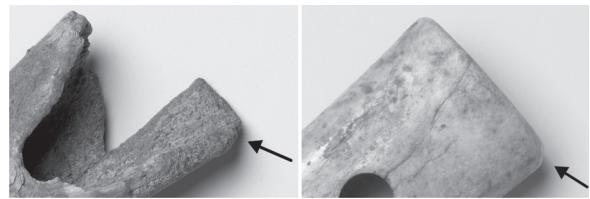
Luknjica 1, ki na originalu ni v celoti ohranjena in je najbližja ustniku U, je manjša kot ostale z razlogom: valovne dolžine alikvotov so v višinah krajše, zato manjša luknjica omogoča točnejše intoniranje. Luknjici 2 in 3 spadata v srednji register inštrumenta, sta zvočno najbolj dorečeni in enako veliki, z bogato barvitostjo. V tem registru zveni glasbilo zelo jasno. Izjeda na zgornji strani odmevnika se s prijemom desne roke preoblikuje v luknjico². Luknjica 5, ki na originalu ni v celoti ohranjena in jo imenujem **dlančna**, leži na spodnjem delu inštrumenta, rahlo ekscentrično od luknjice 3³. Je največja skrivenost in **duša** glasbila. Podaljša dolžino zračnega stebra in valovanje zraka v inštrumentu. Pripomore k večjemu obsegu glasbila in oblikuje del nizkega registra, ki dopolnjuje njegov značaj. Odporna inštrumenta nasproti ustnika U, luknja 6, je nastala po odstranitvi kostnega tkiva, kompakte in spongioze distalne metafize. Imata vlogo **odmevnika in zapiralnika**. Omogoča igranje v spodnjem registru.

Zvočni zapisi, ki sem jih opravil do sedaj, potrjujejo zgoraj omenjeno vsebino in so glasbeni artefakti, ki jih bom v prihodnosti nadgrajeval. Cilj mojega raziskovanja ni bil zgolj eksperimentiranje, temveč odkrivanje optimalnih tehničnih zmogljivosti glasbila in osebno izpovedna kreativnost. Način igranja je zato v veliki meri odvisen od instrumentalista. Raziskovanja glasbila sem se lotil brez vsakršnega vedenja o predhodnih raziskavah, torej popolnoma neobremenjen. Ko sem naposled pregledal objave, sem pri skoraj vseh, ki so preučevali najdbo z glasbenega vidika, opazil, da pri uporabni rekonstrukciji niso upoštevali luknjice na anteriorni strani femurja. Za ustnik je vsem služil razširjeni distalni del kosti. Tehnika njihovega igranja je bila v podrobnostih zelo različna od moje. V danem primeru pa so prav podrobnosti bistvene. Temu primerni so bili rezultati zvočnega preizkušanja najdbe.

Najnovejša rekonstrukcija, podprtta z izsledki računalniške tomografije (Turk et al. 2005), je najdbo s pomočjo glasbenega eksperimentiranja opredelila kot izvirno oblikovano glasbilo z vsemi lastnostmi modernih glasbenih inštrumentov. Zato menim, da poimenovanje

² Če bi za prijem uporabili levo roko, bi moralo biti glasbilo namesto iz leve stegnenične kosti izdelano iz desne. Večina dosedanjih objav kaže, da so raziskovalci izjedo na zgornjem delu odmevnika (luknjica 4) uporabljali kot ustnik za vzbujanje zvoka v glasbilo.

³ To luknjico oz. njen ostanek so nekateri napačno povezovali s t. i. palčno luknjico (glej Omrzel-Terlep 1996; Atema 2004).



Sl. 7: Možni rezilni rob na originalu in rezilni rob na repliki. Foto Tomaž Lauko, Narodni muzej Slovenije.

Sl. 7: Possible sharp edge on the original and sharp edge on the replica. Photo Tomaž Lauko, National Museum of Slovenia.

of the instrument, slightly eccentrically to Hole 3³. It is the biggest mystery and the **soul** of the instrument. It extends the length of the air column and vibration of air within the instrument. It widens the range of the instrument and forms part of the lower register that enhances its character. The opening of the instrument opposite to mouthpiece U, namely Hole 6, appeared after the removal of bone tissue, both the compact bone and the spongiosis of the distal metaphysis. Its role is that of a **bell** and **closure**. It enables playing in the lower register.

The sound records that I have done so far confirm the above mentioned observations and are musical artefacts that I will be upgrading in the future. The aim of my research is not merely experimenting on, but also exploring the optimal technical capabilities of the instrument and a personally expressive creativity. The manner of playing therefore largely depends on the instrumentalist. I began researching the instrument without any knowledge of the previous research on the topic and thus completely unbiased. When I finally did peruse the publications, I noticed that almost none of the researchers of the instrument from a musical standpoint considered the hole on the anterior side of the femur in their reconstruction of use. All considered the widened distal part of the bone as the mouthpiece. Their playing techniques were, in detail, very different from the one I employed. However, in this case it is the details that make all the difference. Consequentially, the results of the find's sound tests were also very different.

The latest reconstruction, supported by the findings of computer tomography (Turk et al. 2005) and musical experiments, recognized the find as an original instrument with all the characteristics of modern musical instruments. I am therefore of the opinion that the name flute is not appropriate, since it is actually an instrument. Tests show that the find acts as a complete instrument only in the form that was reconstructed. Any change in the number and disposition of holes would cause its system to fail.

³ This hole or what is left of it has been wrongfully tied to the so-called thumb hole (see Omrzel-Terlep 1996; Atema 2004).

pišcal ni ustrezno, ker gre dejansko za glasbilo. Poskus kažejo, da najdba deluje kot popolno glasbilo samo v obliki, kot jo poznamo oz. smo jo rekonstruirali. Vsaka sprememba v številu in razporeditvi luknij ima za posledico rušenje sistema.”

SKLEP

Preluknjana kost iz Divjih bab I, ki je danes na ogled v stalni razstavi Narodnega muzeja Slovenije, je v marsičem edinstvena. Ne le da gre za najstarejšo piščal, kot kaže, gre za pravo glasbilo, ki so ga izdelali naši predhodniki, neandertalci. Nobena arheološka najdba iz Slovenije ni bila podvržena tako vsestranskim analizam kot glasbilo iz Divjih bab I. Nobena arheološka najdba iz naše dežele ni v svetu povzročila toliko laičnega in znanstvenega zanimanja. Zavzeto delo I. Turka in njegova odprtost in pripravljenost za sodelovanje z ljudmi različnih strok in poklicev so v veliki meri pripomogli, da se naše vedenje o neandertalcih korenito spreminja.

Glede na vse ugotovitve menimo, da lahko neandertalca sprejmemo kot bitje, sposobno tako prefinjenega umetniškega izražanja, kot je glasba. Njegove kognitivne sposobnosti radi podcenjujemo, čeprav so, kot je to razvidno tudi na primeru glasbila iz Divjih bab I, poznali učinkovitejše tehnike za izdelavo luknij kot njihovi nasledniki. Na način, kot ga je ugotovil Horusitzky (2003), je neandertalec izdelal luknjo v nekaj minutah. Anatomsko moderni človek, ki je luknje vrtal, je za izdelavo porabil neprimerno več časa in energije. Poleg obdelave in uporabe kosti je v srednjem in celo starejšem paleolitiku izpričana uporaba in obdelava lesa (najdbe leseni osti ali sulic). Ni si težko predstavljati, da je bila večina piščal v paleolitiku izdelana iz votlega lesa, do danes pa so se ohranile le tiste iz kosti (Otte 2000).

Vsi, ki smo sodelovali pri izkopavanjih v Divjih babah I, smo imeli veliko željo, da odkrijemo fosilne kosti neandertalca. I. Turk je za takšno najdbo ponujal celo denarno nagrado. Ali je mislil resno ali ne, nismo imeli priložnosti izvedeti. Odkritje neandertalske piščali je bilo nekaj povsem nepričakovanega. Upamo, da bodo za slovenski paleolitik kmalu nastopili boljši časi in da bo želja po odkritju neandertalskih fosilnih ostankov zopet aktualna.

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CONCLUSION

The perforated bone from Divje babe I, now on permanent display in the National Museum of Slovenia, is unique in many ways. Not only is it the oldest known flute, it also appears to be a complete instrument made by Neanderthals. No archaeological find from Slovenia has so far been subjected to so varied an array of analyses as this instrument from Divje babe I. Furthermore, no archaeological find from Slovenia has aroused so much general as well as scientific interest across the world. It is the dedicated work of Ivan Turk and his openness and readiness to cooperate with scientists of different professions that have greatly contributed to the radically changing knowledge on Neanderthals.

All the findings lead us to conclude that Neanderthals should be accepted as beings capable of a refined artistic expression such as music. Their cognitive capabilities are readily underestimated despite the fact that they knew, as is evident also from the instrument form Divje babe I, more effective technique of hole making as the people that came after them. Using the method defined by Horusitzky (2003), a Neanderthal could make a hole in a matter of minutes. The anatomically modern man bore holes and thereby used substantially more time and energy. Apart from working and using bone, the use and working of wood is attested through finds of wooden spears, in the Middle and even Lower Palaeolithic. It is therefore not difficult to imagine that most flutes in the Palaeolithic were made of hollow wood, though only those made of bone have been preserved until today (Otte 2000).

All that participated in the excavations at Divje babe I had a great desire to uncover fossil remains of Neanderthals. I. Turk even offered a pecuniary reward for such a find, though we were never able to find out whether this was a serious offer or not. The find of a Neanderthal flute was completely unexpected. It is our hope that Slovene Palaeolithic research will soon see better times and that the desire to uncover fossil remains of Neanderthals will again become topical.

Translation: Andreja Maver

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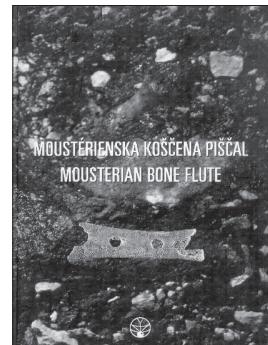
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Ivan Turk (ur. / ed.)

**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

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.

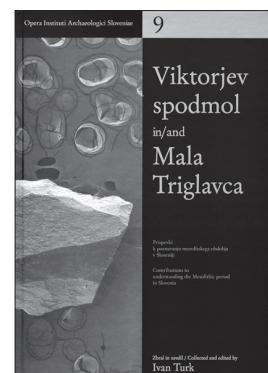
V posameznih poglavjih so obdelana mikrolitska orodja, ki pripadajo sovterjensko-kastelnovjenskemu (sauveterrien-castelovien) kompleksu, njihova tipologija in odnosi z drugimi najdišči tega kompleksa s posebnim poudarkom na kronologiji in kronoloških povezavah mezolitskih najdišč v severni Italiji, vključno 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. Kryšufek) 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.

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. Kryšufek) 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.

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.

