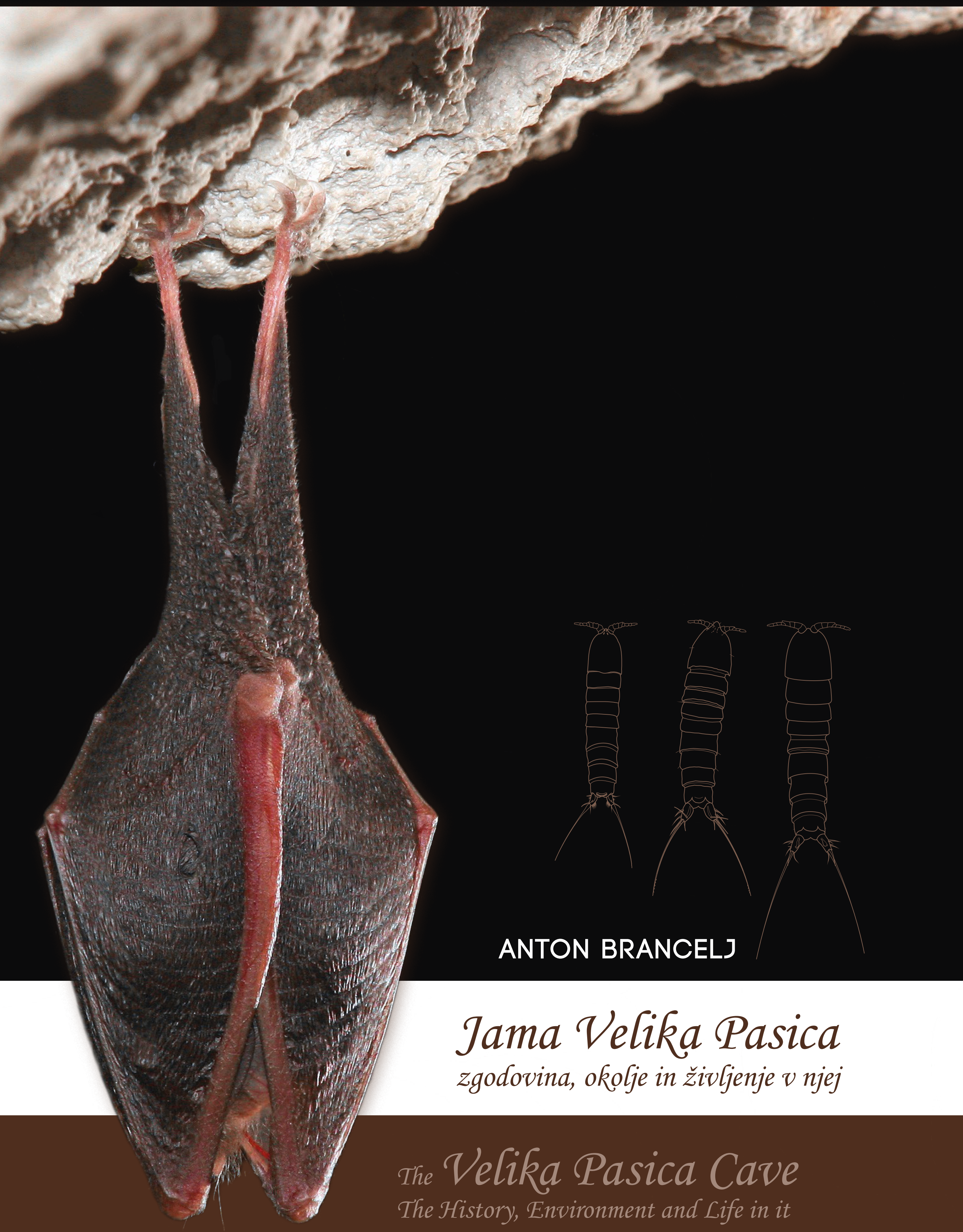

ANTON BRANCELJ

Jama Velika Pasica

zgodovina, okolje in življenje v njej

The Velika Pasica Cave

The History, Environment and Life in it

Jama Velika Pasica - zgodovina, okolje in življenje v njej
The Velika Pasica Cave - The History, Environment and Life in it

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Anton Brancelj

JAMA VELIKA PASICA

zgodovina, okolje in življenje v njej

THE VELIKA PASICA CAVE

The History, Environment and Life in it

Založba ZRC in Nacionalni inštitut za biologijo
ZRC Publishing and *National Institute of Biology*

V trajen spomin na mojo ljubljeno ženo Ireno.

In eternal memory of Irena, my beloved wife.

KAZALO

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PREDGOVOR

Jama Velika Pasica je kljub imenu za slovenske razmere pravzaprav majhna. V dolžino, vključno s stranskimi rovi, meri 105 m in v globino nekaj več kot 12 m. Podatki so iz katastra Društva za raziskovanje jam Ljubljana. Jama je bila kot jamski objekt uradno registrirana 15. maja 1927, ko je bil narejen "Zapisnik terenskih ogledov" (med jamarji bolj znan kot "jamarski zapisnik") z opisom jame in dostopa ter izrisanim načrtom. Jama ima zaporedno številko 75 in zapisano ime kot "VELIKA PASICA pri Zgornjem Igu". Avtorji zapisnika in načrta so bili E. Gorskij, Vs. Gorskij, A. Hadži, R. Kenk, M. Klemenčič, R. Klemenčič, A. Nučič. V njeni neposredni bližini je jama Mala Pasica s katastrsko številko 76. V geološki preteklosti sta bili jami del enotnega sistema, danes pa sta to dve jami, vsaka s svojim vhodom, saj se je del jamskega stropa med njima porušil.

V preteklosti je bila jama zlasti priljubljen cilj zbirateljev jamskih hroščev, saj je bilo v njej najdenih in nato opisanih nekaj vrst in podvrst. Bila pa je tudi cilj bolj ali manj turističnih obiskov, ki so v jami pustili negativne posledice v obliki počrnelih sten in stropov zaradi bakel, s katerimi so si obiskovalci svetili. Žal so si ti za spomin odlomili tudi prenekateri kapnik, tako da je dandanašnje jamsko okrasje močno okrnjeno oziroma polomljeno.

Jama se uvršča v kategorijo hidrološko neaktivnih jam, saj v njej ni tekoče vode. Edina voda, ki se pojavlja, je prenikajoča voda, ki skozi drobne razpoke v stropu ali ob dnu jamskih rovov priteka v jamo kot posledica dežja oziroma talečega se snega. Že v preteklosti so obiskovalci poleg nekaterih kopenskih jamskih živali, v večjih lužicah na dnu jamskih rovov opazili tudi bele in slepe, kakšen centimeter velike rakce iz skupine slepih

FORWORD

Although the name of the cave "Velika Pasica" (lit. *the Big Dog's Cave*) characterises it as big, it is for Slovenian circumstances rather small. It is 105 m long and 12 m deep, including the side corridors. The data was provided by the cadastre of the Society for Cave Exploration Ljubljana (Slov.: *Društvo za raziskovanje jam Ljubljana*). The cave was officially registered as a cave on 15th May 1927 upon the completion of the "field survey log" (known as "the caving log" among the cavers) with a detailed description of the cave, the access to the cave, and a cave plan. The cave was registered under the cadastral number 75 and named "VELIKA PASICA pri Zgornjem Igu". The authors of the document and the cave plan were E. Gorskij, Vs. Gorskij, A. Hadži, R. Kenk, M. Klemenčič, R. Klemenčič, A. Nučič. In the immediate vicinity of the cave is the Mala Pasica cave, registered under the cadastral number 76. In geological history, the caves were a part of the same cave system, but are separated today, each with its own entrance, as a part of the roof had collapsed.

The cave used to be a popular cave-beetle collecting spot, as several species and subspecies had been collected and described from there. It was also a more or less popular tourist destination, which unfortunately left a great deal of negative consequences, such as blackened walls and roof as a result of torches having been used during the visits. Furthermore, many a stalactite had been broken off and taken away as souvenirs, consequently leaving the cave in a half-ruined state today.

The cave is categorised as a hydrological non-active cave, as there is no running water in it. The only water in the cave is drip water, which enters the cave through the small cracks on the roof or on the floor of the corridors as a result of precipitation or snow melting. However, in the past visitors had noticed, besides some terrestrial cave-dwelling postranic, natančneje iz rodu *Niphargus*. Vendar vodnim živalim dolgo niso posvečali posebne pozornosti, saj v suhi jami in tako visoko v hribih kakšnih posebnosti ni bilo pričakovati.

To prepričanje se je spremenilo v novoletnem obdobju leta 2000, ko sem s 6-letnim sinom naključno obiskal jamo, kjer sem z vodno mrežo bolj iz radovednosti kot z namenom resnih raziskav odvzel tudi nekaj vzorcev živali iz lužic na dnu rovov. Bila je nenavadno močna odjuga, tako da so bile luže polne vode. Do takrat sta bili iz jame pravzaprav poznani le dve vrsti vodnih živali: drobni ceponožni rak *Speocyclops infernus* (Kiefer 1930) ter že prej omenjena kapniška slepa postranica *Niphargus stygius* (Schiödte 1847). Po pregledu vzorcev v laboratoriju sem odkril še vrsto drugih živali iz skupine ceponožnih rakov (Copepoda), ki jih tam nisem pričakoval. Med njimi so bili celo primerki nove, do takrat nepoznane vrste.

To je bil povod za večletne raziskave prenikajoče vode in živalstva v njej, katerih rezultat je več znanstvenih člankov ter doktorat. Rezultati hidroloških in kemijskih meritev so prikazani in razloženi izključno s stališča ekoloških razmer, v katerih živijo vodni organizmi v zelo posebnem okolju, ki je v nadaljevanju obravnavano oziroma poimenovano kot epikras. Reševanje podrobnejših in/ali specifičnih problemov z vidika drugih strok pa naj ostane kot izziv specialističnih študij za naslednja obdobja.

Že kmalu po začetku raziskav sem razmišljal o pripravi nekoliko obširnejše in ne zgolj ozko specializirane publikacije, ki bi prikazala pomen in mesto te razmeroma majhne jame v znanosti. Upam, da sem s pričujočo knjižico to idejo uspešno izpeljal. Knjigo posvečam tudi svojemu očetu, ki je bil rojen sedem mesecev po tem, ko je bila jama uradno zavedena v jamarski kataster, in sicer v hiši, oddaljeni le 190 m severo-severo-vzhodno od vhoda vanjo.

Še o imenu jame oziroma njegovem zapisu. Izvora imena domačini ne znajo natančno pojasniti. Eni trdijo, da so v jamo metali mrtve pse, drugi pa da so se psi v jamo le občasno zatekali. V večini besedil je jama navedena kot Velika Pasjica, čeprav je v njenem "krstnem " oziroma "rojstnem listu", to je v "zapisniku terenskih ogledov" navedena kot "Velika Pasica" oziroma v originalu kot "VELIKA PASICA pri Zgornjem Igu". V tem delu sem se iz spoštovanja do jamarjev, ki

animals, a few around one-cm-long blind white shrimps belonging to the genus *Niphargus* in the pools on the floor of the corridors. For a long time, the aquatic animals in those pools attracted no special attention, as in a relatively dry cave on such a high altitude in the hills no particular aquatic fauna were expected to be found.

This changed significantly during the New Year period in 2000, when I visited the cave by chance with my 6-year-old son. Out of curiosity, I collected a few samples of aquatic fauna from the pools with a hand net. It was unsually warm weather, and snow melted intensively, filling the pools with water. At that time, only two known species were supposed to dwell in those pools: the tiny *Speocyclops infernus* (Kiefer 1930) belonging to copepods and to the above mentioned blind cave-dwelling *Niphargus stygius* (Schiödte 1847), belonging to amphipods. Upon examining the samples in the laboratory, I found many specimens belonging to different species of copepods (Copepoda), which I had not expected to find there. Among them were also representatives of the new, so far unknown species.

This was the reason behind a several-year-long research on drip water and fauna dwelling in it, resulting in numerous scientific papers and a PhD thesis. The results of hydrological and chemical measurements are presented and explained principally from the view of ecological conditions which determine the life of aquatic organisms in that very specific environment. This environment shall hereafter be named as the epikarst. Solving more detailed and specific problems from the point of view of other disciplines shall be left to more in-depth studies in the future.

Soon after the beginning of my intensive research, I started thinking of preparing a more extensive and not only a narrow, specific publication, which would enable the cave to find its place in science. I hope that with this book I have successfully achieved my aim. The book is also dedicated to my father, who was born seven months after official registration of the cave in the house located only 190 m north-north-east from the cave entrance.

I would also like to say a few words about the origin of the cave's name and its spelling. No villager could explain the exact origin of the name. Some say that dead dogs used to be thrown into it, while others say that the cave was occasionally used by dogs as a shelter. In most of texts the name of the cave is spelled as "Velika Pasjica," although in its "birth certificate," i.e. "the caving log" it is registered as "Velika Pasica". Out of respect to the cavers so jamo strokovno opisali odločil, da jo poimenujem tako, kot je bilo zapisano ob njeni registraciji, – Velika Pasica.

Anton BRANCELJ
V Ljubljani, 30. marca 2015

who had registered the cave, I decided to use the original name of the cave in the book, as written in the original document – thus "Velika Pasica".

Anton BRANCELJ
In Ljubljana, 30th March 2015

BESEDE RECENZENTOV

Knjiga o jami Velika Pasica, s podnaslovom zgodovina, okolje in živalstvo, je zanimiva znanstvena monografija. Tako lahko trdimo, čeprav gre za razmeroma majhno jamo in ne obsežno pokrajino. Menim, da je največja odlika knjige prav v kompleksnosti njene vsebine. Pričakovali bi, da nam bo avtor, ki je po osnovni usmeritvi biolog, le podrobno naštel in opisal najdeno živalstvo iz te jame. Da, to je storil, vendar se s tem ni zadovoljil.

Predgovoru sledi kratek opis teoretičnih osnov opredelitve in razdelitve krasa. Morda bi lahko rekli, da to ni potrebno, vendar temu ni tako; teoretična razlaga namreč omogoča boljše razumevanje življenja v jami. V prvem poglavju nas popelje v posebnosti krasa in svet raziskovanja te jame. Nato oriše problem nabiranja jamskih hroščev, kajti Velika Pasica je postala med krasoslovci posebej znana prav po njih. Zelo pohvalno je, da se je avtor v sodelovanju z lokalno skupnostjo, to je občino Ig, lotil zaščite in zavarovanja te jame, iz katere so v preteklosti odnašali številne jamske živali, se podpisovali na stene in lomili kapnike. Vhod v jamo so zaprli z železnimi vrati, kar je omogočilo postavitev merilnih pripomočkov.

Sledi dokaj podroben in celovit opis lege jame, površja nad jamo in podroben opis načrta jame. Uvodni del je razmeroma obsežen in prav tako kot celotna knjiga opremljen s številnimi fotografijami, risbami in preglednicami. To gradivo je bogato in izjemno kakovostno ter oprijemljivo dopolnjuje pripoved. Sledijo poglavja o fizičnih značilnostih jame in osnovi življenja v njej, kar je temelj za ekološko oznako in biodiverziteto življenja v njej. Opisi so temeljiti, kar je izjemno pohvalno ter pomembno za razumevanje življenja v jami.

Pisanje knjige krasi jasna in razumljiva govorica, v katero so vpleteni tudi pogovori z domačini, kar je navsezadnje tudi avtor, saj se je njegov oče rodil le malo stran od jame. Morda prav zato iz knjige veje nekaj simpatične osebne note in sproščenosti. Želimo si lahko le še več podobnih celovitih pisanj o jamah v Sloveniji.

V Ljubljani, 6. aprila 2015
izr. prof. dr. Milan OROŽEN ADAMIČ, univ. dipl. prof. geogr. in biol.

THE WORDS OF THE REVIEWERS

The book on the Velika Pasica cave, along with its subheading "the history, environment and life in it," is an interesting scientific monograph, even though it represents only a small cave and not an extensive landscape. In my opinion, the best quality of the book is a complex approach to its contents. It would be expected that the author, a biologist by profession, would simply list and describe in details the fauna living in the cave. Not only did the author meet the challenge, but he also achieved much more.

The introduction is followed by a short description of the theoretical basis of the definition and structure of the karst. Some would deem this unnecessary, but it is not true; the theoretical explanation is necessary for a better understanding of life in the cave. The first chapter introduces the specific karst environment and its research. Then, the problem of collecting cave-dwelling beetles is outlined as the Velika Pasica cave has become very popular among the speleologists, particularly due to its rich and specific beetle fauna. It is very praiseworthy that the author cooperated with the local community, i.e. the community of the Ig village, and initiated the cave protection project; as the cave visitors used to take the cave-dwelling animals with them, sign their names on the walls and destroy the stalagmites. The entrance of the cave is now protected by iron gates, which enabled the setting up of the research equipment.

The next chapter is quite a detailed and complex presentation of cave's position, its surface and the cave plan. The introduction is extensive and, like the rest of the book, is rich with numerous high quality photos, figures and tables, supporting the text perfectly. This section is followed by physical characteristics of the cave and the basis of life in it, which is the foundation for its mark of ecology and biodiversity. The descriptions are detailed, which it is praiseworthy and important to understand life in the cave.

The book is written in a clear and understandable tone, also including the interviews with the locals, among which the author's father belongs, born just a stone's throw away from the cave. Perhaps this fact gives the book a more personal note, making in more approachable and enjoyable to the reader. In conclusion, more such complex works about the caves in Slovenia would be appreciated.

In Ljubljana, 6th April 2015
Associate professor Milan OROŽEN ADAMIČ, PhD

Avtor besedila se je lotil raziskave za naš kras sorazmerno majhne, toda zato nič manj zanimive podzemne jame Velika Pasica. Jama leži na podnožju gore Krim v bližini naselja Gornji Ig. Že od sredine 19. stoletja je bila Velika Pasica zbirateljski cilj številnih amaterskih obiskovalcev in strokovnjakov, saj so v njej odkrili nove vrste jamskih hroščev in polžev. Glede na majhnost je bogata z jamskim živalstvom. Vse do leta 2006 je bila javno dostopna. Tega leta pa je bil vhod vanjo na predlog avtorja uradno zaprt z rešetkastimi vrati, ki omogočajo prehodnost le živalim (npr. netopirjem). Odločitev o zaprtju je bila povsem smiselna, saj je bila s tem zbiralcem in preprodajalcem jamskih živali (npr. slepih jamskih hroščev itd.) preprečena „plenitev“ ter spreminjanje oziroma uničevanje jamskega biotopa. Hkrati je bilo dr. Branclju omogočeno načrtovati in opravljati speleobiološka opazovanja z namestitvijo ustrezne raziskovalne opreme.

Osemletna raziskava abiotskih parametrov in sistematičnih zooloških zbiranj daje doslej v našem okolju najbolj popolno ekološko podobo dogajanj v prenikli vodi, ki se pretoči s površine skozi jamski strop in curlja v notranjščino jame. Skrito živalsko združbo spoznavamo skozi „nesrečnike“, ki jih je naplavilo iz njihovega pravega biotopa v sekundarni biotop jamskih lužic. Delo je zato pomemben prispevek k poznavanju ekologije epikraškega območja.

Posebnost dr. Brancljevih raziskovanj so odkritja treh, za znanost novih, poprej neopaznih (drobnih) živalskih vrst iz skupine ceponožnih rakov (Copepoda) in dveh vrst epibiontsko živečih praživali (Suctoria).

Zbiranje fizikalno-kemičnih podatkov v prenikajoči vodi omogoča presojanje ekoloških danosti za živi svet v epikraškem območju. Hkrati pa je vse to uporaben indikator za odkrivanje in presojanje onesnaženosti okolja, na kar opozarja tudi avtor. Vodoprepustnost epikrasa opozarja na premišljeno in skrbno ravnanje s površinskimi kraškimi ekosistemi, tudi z agrikulturnimi. Prav tu pa vidim vrednost takih raziskav tudi za praktično rabo. Temeljna znanost in uporabnost lahko delujeta z roko v roki.

Monografija "*Jama Velika Pasica*", ki je po zasnovi znanstveno delo, je berljiva vsem, ki jih zanima kraški podzemni svet.

V Ljubljani, 10. aprila 2015
prof. dr. Kazimir TARMAN, univ. dipl. biol.

The author of this text started researching the Velika Pasica cave, which from the Slovenian point of view would be considered to be rather small. However, this does not mean it has no interesting value. The cave is located at the foot of Mt. Krim, near the Gornji Ig village. Since 19th century, the Velika Pasica cave was a destination for the amateur as well as expert collectors of cave-dwelling beetles, as they had discovered a new species of the cave-dwelling beetles and snails there. In proportion to its small size, it is surprisingly rich in cave fauna. It has been open to public until 2006. In the same year, the author intiated the closing of the cave with iron gates, enabling the entrance only to animals such as bats. The decision on closing the cave was logical, as with that action, the "pillaging" of cave-dwelling animals (such as beetles, etc.) by the collectors and dealers, as well as the modification or even the destruction of the cave environment had finally been brought to its end. At the same time, Dr. Brancelj was enabled to plan and perform speleobiological observations with the installation of relevant research equipment.

Eight years of observations of abiotic parameters and systematic zoological samplings have enabled so far the most complete insight into ecological processes in drip water, which flows from the surface through the cave ceiling into the interior. The less known fauna was studied with the help of the "unfortunate ones," the specimens, which were washed away from their primary habitat and put into the secondary habitat of the pools on the floor of the corridors. From this aspect, this work is an important contribution to the ecology of the epikarst.

The distinguishing feature of Dr. Brancelj's research in this cave was the discovery of three new species of (tiny) representatives from the Copepoda group and two unicellular epibionts from the Ciliata/Suctoria group.

Collecting data on the physicochemical parameters of drip water has enabled the study of ecological conditions for life in the epikarst zone. At the same time it is a useful indicator for discovery and evaluation of environmental pollution, as highlighted by Dr. Brancelj. The hydrological conductivity of the epikarst is an indicator of prudent and careful management with the surface karst ecosystem, including agricultural ones. This is the point where such kind of research could be put into a practice. Basic science and applicability can work hand in hand. The Monograph "*The Velika Pasica Cave,*" which is in principle a scientific work, is easily understandable to all the karst subterranean world afficionados.

Professor Kazimir TARMAN, PhD

Pričujoče delo je monografski, predvsem biospeleološki opis Velike Pasice. V knjigi avtor najprej predstavi celotno jamo. To je skromni, zadnji ostanek nekoč veliko večjega jamskega spleta, ki ga je oblikovala majhna podzemna reka. Ta si je našla drugo pot, jama pa se je zaradi odlaganja sige in zasipavanja razčlenila na več ločenih segmentov. Ko je kraška denudacija površje približala jami, se je udrl še tanki strop. Nastal je vhod, ki je dovolj velik, da lahko človek vstopi v podzemlje, a tudi dovolj majhen, da se v podzemlju ohrani za jamsko živalstvo primerno okolje.

Tako dostopna jama avtorju služi kot veliko okno v živi svet podzemlja. Biologija je bila pri Veliki Pasici v ospredju že od prvih omemb jame in najdb prvih živali v njej, to je bilo že v 19. stoletju, zato je Velika Pasica tudi pomembno tipsko nahajališče. Velikega pomena je bila tudi za jamarske raziskave od sredine prejšnjega stoletja dalje. Pred nekaj leti pa je začel z biospeleološkimi raziskavami v jami tudi sam avtor. V njej je odkril vrsto novih živalskih vrst, povečini vezanih na življenje v tanki epikraški coni nad jamo. Vzpostavil je več let trajajoč monitoring za življenje v jami pomembnih parametrov in spoznal vrsto zakonitosti tega življenjskega prostora. To raziskovanje mu je dalo dovolj podatkov za znanstveno obdelavo jame z vidika ekologije in prilagoditve vodnih živali za življenje v epikrasu.

Delo je opremil s številnimi fotografijami in tabelami, ki odlično ilustrirajo jamo, lastnosti jamskega okolja in bližino površja, s katerega se spira hrana za živali spodnjega sveta. Tabele v knjigi izpričujejo pomen Velike Pasice za pomembne speleobiološke raziskave. Spoznanja tega znanstvenega dela so bila objavljena v številnih znanstvenih revijah, tu pa so zbrana skupaj in predstavljajo solidno znanstveno delo, posvečeno jami in njenemu živemu svetu.

V Postojni, 16. aprila 2015
izr. prof. dr. Andrej MIHEVC, univ. dipl. geogr.

This work is monographic, above all, a biospeleological description of the Velika Pasica cave. Firstly, the book presents the entire cave, which is a modest remnant of what used to be a larger cave system, formed by a small subterranean river. The river found its way into other channels, and the cave was fragmented due to speothems deposits and backfilling on several separated segments. When the karst denudation drew the surface to the cave, the thin ceiling finally collapsed. Thus, an entrance was formed, large enough to enable a person to enter the cave, but small enough to sustain the appropriate subterranean environment for cave fauna.

This way, the accessible cave serves the author as a large window into the subterranean life. Biology has played an important role in the Velika Pasica cave since the first records were made on animal findings in 19th century. For that same reason, the Velika Pasica cave is also a type locality for several species. It has been of great importance for cave research since the middle of the last century. Several years ago, even the author started conducting biospeleological research, discovering several new animal species in the cave, most of which were connected to the thin epikarstic zone above the cave. He has been studying life in the cave for several years in order to establish the observations important for life and recognised several characteristics of that environment. The research gave him enough data for scientific analyses of the cave, not only from the ecological point of view, but also from the point of view of animal adaptations to life in the epikarst.

The book is supplemented with numerous photos and tables which illustrate the cave well; the properties of the cave environment and the closeness of the surface from where food is washed in for the animals in the subterranean environment. The tables in the book testify to the importance of the Velika Pasica cave to speleobiological research. The results of the recent scientific work have been published in several scientific journals, and are furthermore presented here as a whole, and represent a solid scientific contribution, dedicated to the cave and its life.

In Postojna, 16th April 2015
Associate professor Andrej MIHEVC, PhD

UVOD

TEORETIČNE OSNOVE – OPREDELITEV IN RAZDELITEV KRASA

Geomorfološko je kras pokrajina, kjer so prisotne oblike, ki so nastale s kemičnim raztapljanjem in fizičnim preoblikovanjem karbonatnih kamnin, kot sta apnenec in dolomit. Za kras je značilen splet podzemnih vodnih kanalov, ki so tesno povezani z zanj značilnimi in lahko prepoznavnimi površinskimi ali podzemnimi oblikami, kot so ponori, vrtače in jame oziroma brezna. Za kraško pokrajino je značilno, da v njej ni površinskih rek ali jezer ali pa so le-te lokalno zelo omejene (povzeto po Wikipedia, 2015). Priznani slovenski krasoslovec Ivan Gams v svoji knjigi o krasu k definiciji krasa doda še pojem kraških polj (Gams, 2003). V osnovi je kras tip pokrajine, ki se je razvil na kamninah, ki jih padavinske in tekoče vode zaradi njihove topnosti in slabe mehanske odpornosti razmeroma lahko kemijsko in mehansko preoblikujejo. Obenem je za kraške pokrajine značilno, da se voda nahaja pod površjem in se le v redkih primerih pojavlja na površju, na primer na območju kraških polj v obliki ponikalnic oziroma občasnih jezer.

Čeprav je na krasu voda na površini le redko vidna, to ne pomeni, da se kraške pokrajine nahajajo v suhih predelih. Nasprotno, kraška pokrajina in voda sta zelo tesno povezani. Brez vode namreč ne bi bilo kraških pojavov, kot jih poznamo, le da je razporejena na nekoliko drugačen način kot v drugih pokrajinah.

Voda se v krasu v obilici nahaja v globinah, nekaj deset ali sto metrov pod površjem, ki jo hidrogeologi imenujejo freatična oziroma z vodo zasičena cona, ki leži nad nepropustno podlago krasa (Gams, 2003). V freatični coni so kraški rovi popolnoma zaliti z vodo

INTRODUCTION

THE THEORETICAL BACKGROUND – THE DEFINITION AND STRUCTURE OF THE KARST

Geomorphologically, the karst is a landscape characterised with formations which are the result of chemical dissolution and physical transformation of carbonates, predominantly limestone and dolomite. The karst is characterized by a labyrinth of interconnected water channels, closely connected with typically and easily recognised epigean or subterranean formations, like sinkholes, dolines, caves and shafts. The karst landscape is also characterised with the absence of surface rivers or lakes or they are locally very limited (summarised according Wikipedia, 2015). A renowned Slovenian karstologist Ivan Gams added to the definition of karst in his book on karst a phenomenon called "karst polje" (Gams, 2003). The karst is basically a type of landscape, which has been developed on the limestone bedrock with high solubility and poor resistance to rainwater and running water, enabling it relatively easy to be chemically and mechanically modified. At the same time, it is typical for a karst landscape that water is below the surface, and only in rare cases does it come to the surface, for example in the areas of karst poljes in the form of intermittent streams and lakes.

Although water is rarely seen on surface, it does not mean that the karst landscape is present in dry areas. On the contrary, the karst landscape and water are closely interconnected. There would be no karst phenomena, known nowadays without water, the difference would have been only in the distribution of water.

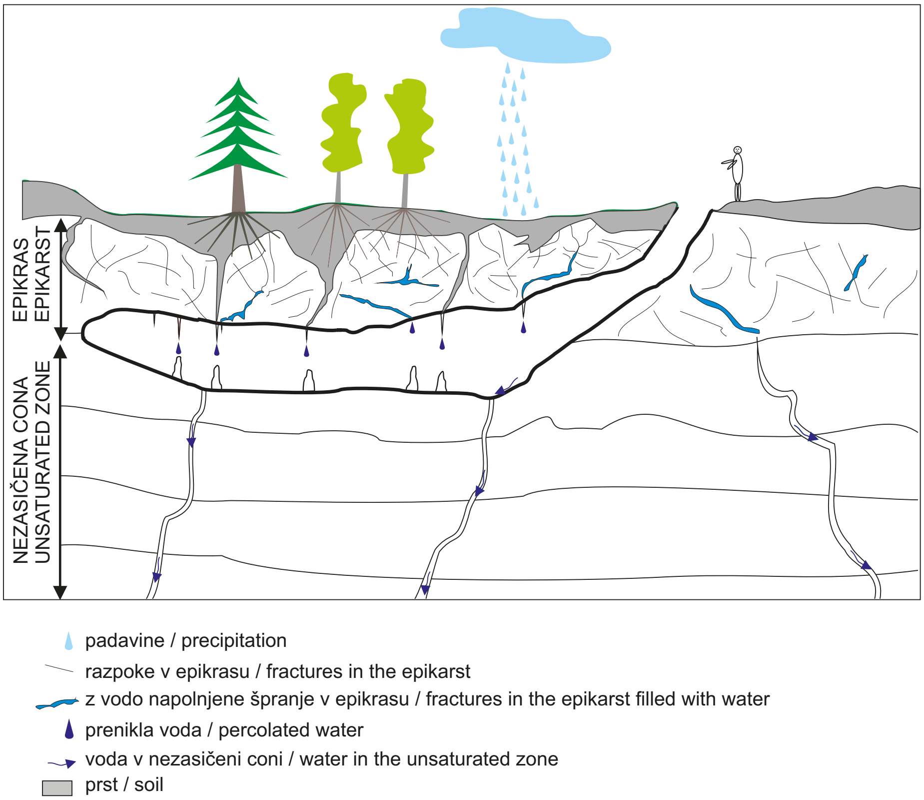
Water is present in larger quantities in deeper layers, some tenth or hundreds meters below the surface, in the zone the hydrogeologists call "the phreatic zone," the zone saturated with water, above impermeable geological layers (Gams, 2003). In the phreatic zone, the corridors are completely filled in so, kadar so dovolj veliki, dostopni le jamskim potapljačem. Zgornjo mejo freatične cone oziroma nivoja podtalnice označujejo gladina zalitih rovov, sifonov in stalni ali občasni kraški izviri. Raven te cone je delno odvisna tudi od padavin. Ob povečanih padavinah se gladina kraške vode dvigne, del vode odteka skozi občasne višje ležeče kraške izvire, medtem ko stalni izviri označujejo najnižjo lego nivoja podtalnice. Razlika med najnižjo in najvišjo ravnijo je lahko nekaj metrov ali celo več deset metov (Gams, 2003).

Nad freatično oziroma stalno zalito cono se nahaja vadozna cona. To je z vodo neprežet/aeracijski/zračnen sloj (Gams, 2003). Predstavljajo jo jamski rovi, ki jih jamarji ali turisti lahko bolj ali manj neovirano obiskujemo, in se nahaja med zemeljskim površjem in ravnijo kraške podtalnice (Wilson in sod., 1994: povzeto po Wikipedia, 2015). Voda se v tem predelu zadržuje bodisi zaradi adhezijskih ali kapilarnih sil in v njej vladajo pritiski, podobni (oziroma manjši) kot so atmosferski. Ta predel ne vključuje vode, ki je prisotna v prsti (Freeze in Cherry, 1979). Voda se v jamskih rovih pojavlja kot kapljanje ali curki s stropa, manjše ali večje luže ali celo jezerca na dnu jamskih rovov ter potočki in reke, ki se lahko nahajajo že tik nad zasičeno cono. Glavni vir vode v nezasičeni coni

with water and are, when large enough, accessible only to the divers. The upper level of the phreatic zone, called also the water table, is characterized by free water surface in corridors, siphons or temporary and permanent karst springs. The position of the water table is partly dependant on precipitation, too. After heavy rain or snowmelt, the water table rises and a part of it is discharged through temporary karstic springs, while the permanent springs indicate lower level of the water table. The difference between high and low level of the water table can range from only a few metres to tenths of metres (Gams, 2003).

Above the phreatic zone there is zone called "vadose zone" (according to Ivan Gams: "with water unsaturated" or "aerated zone") (Gams, 2003). In the zone are corridors, which are more or less easily accessible to cavers as well as tourists with no special equipment. They are located between the surface and the water table (Wilson *et al*., 1994: summarised according Wikipedia, 2015). Water is present in the zone due to either adhesive or capillary forces and the pressure there is similar or slightly lower than the atmospheric one. The vadose zone does not include the water present in the soil (Freeze and Cherry, 1979). Water is present in the corridors in the form of dripping or permanent water jets falling from the ceiling, smaller or larger pools on the floor of the corridors, even lakelets, brooks and rivers which could be located just above the saturated zone. The main source of

Foto 1: Profil epikrasa v kamnolomu pri Senožečah / Foto: A. Brancelj/.
Photo 1: The cross-section of the epikarst in a query near Senožeče /Photo: A. Brancelj/.



Slika 1: Shematični prerez epikrasa in nezasičene (vadozne) cone ter spremembe kakovosti vode od padavin do prenikle vode.
Figure 1: The schematic cross-section of the epikarst and unsaturated, i.e. the vadose zone and the modification of the water quality, from precipitation to drip water.

so padavine, ki skrbijo tudi za obnavljanje vodonosnika v zasičeni coni.

Zgornji del nezasičene cone se imenuje epikras (Klimchouk, 2004; Bakalowicz, 2005). Zanjo se pogosto uporablja tudi izraz "koža krasa". Je območje, "kjer klimatske razmere, drevesne korenine in kraški procesi lomijo in povečujejo stike in razpoke v kamnini in s tem oblikujejo bolj propustno in porozno cono tik nad kompaktnimi apnenčastimi skladi, v katerih je prisotnih le nekaj večjih navpičnih razpok oziroma brezen in mreža manjših razpok" (Bakalowicz, 2005). V območje epikrasa nekateri štejejo še vrtače (Wiliams, 1983). Epikraška cona se tako nahaja le v razmeroma plitvi plasti nekaj metrov pod površjem, ki je lahko pokrito s prstjo ali pa je golo (Foto 1; Slika 1). V drobnih razpokah in špranjah, ki so delno ali povsem zalite z vodo in kjer vodni režim določajo izključno padavine, je v epikrasu oblikovan tako imenovani "razpršeni vodonosnik", ki igra pomembno vlogo tako pri hidrologiji kot tudi ekologiji krasa (Bakalowicz, 2005; Brancelj in Culver, 2005). Vodonosnik predstavlja znatno zalogo vode, ki se zaradi kapilarnosti le počasi sprošča

water in the vadose zone is precipitation, which is a source for renewing of the aquifer in the saturated zone, as well.

The topmost part of the vadose zone is called the epikarst (Klimchouk, 2004; Bakalowicz, 2005), sometimes, also known as the "skin of the karst". It is a zone "in which climate conditions, tree roots, and karst processes fracture and enlarge rock joints and cracks, creating a more permeable and porous zone over the compact carbonate rock in which only few open vertical joints and fine cracks occur" (Bakalowicz, 2005). Some include in the epikarst zone also dolines (Wiliams, 1983). The epikarst zone is thus located in a shallow layer, just a few meters below the surface, where it can be covered either with soil or is bare (Figure 1; Photo 1). In tiny cracks and fissures in the epikarst which are partly or completely filled with water and where the water regime is determined exclusively by precipitation, the so-called "perched aquifer" is formed, playing an important role in hydrology, as well as in the ecology of karst (Bakalowicz, 2005; Brancelj and Culver, 2005). The aquifer represents a considerable water storage, which is only slowly released into deeper parts of karst, due to its capillarity, and thus enables a long-term renewing of the phreatic zone as well as karstic springs.

From the biological aspect, the first animal species from v globlje predele krasa in tako omogoča dolgotrajnejše napajanje nižjih plasti, vključno s kraškimi izviri.

Z vidika biologije so bile prve živalske vrste iz epikrasa opisane že v 30. letih 20. stoletja, vendar takrat niso bile prepoznane kot "epikraške". Med prvimi sta bili dve od njih opisani iz Škocjanskih jam, in sicer sta bila to ceponožna raka vrste *Morariopsis scotenophila* (Kiefer 1930), v originalu opisan kot *Moraria scotenophila*, ter *Speocyclops infernus* (Kiefer 1930), v originalu opisan kot *Cyclops infernus* (Kiefer, 1930).

Prvi, ki je z ekološkega stališča prepoznal epikras kot posebno življenjsko okolje podzemeljskih vodnih živali, je bil francoski speleobiolog Raymond Rouch (Rouch, 1968). Raziskovalci so to njegovo delo večinoma spregledali in so še vedno opisovali nove vrste iz curkov prenikle vode v jamah, ne da bi podrobneje opredelili njihovo pravo življenjsko okolje. Večina med njimi so bili drobni ceponožni raki. Izjema je bila le več milimetrov velika postranica vrste *Niphargobates orophobata* Sket 1981, opisana iz curka v Planinski jami (Sket, 1981).

Premik v razumevanju epikrasa kot posebnega življenjskega okolja se je po naključju dogodil v jami Velika Pasica, kjer je bilo v letih 2000 in 2001 odkrito bogato živalstvo v lužicah, ki so jih polnili curki s tankega stropa nad jamo (Brancelj, 2002).

Takoj za raziskavami v Veliki Pasici je mlada raziskovalka Tanja Pipan z Inštituta za raziskovanje krasa v Postojni pod mentorstvom avtorja te knjižice začela v okviru svoje doktorske naloge raziskovati vrstno sestavo in razširjenost ceponožcev v lužah prenikle vode v šestih turističnih jamah v Sloveniji (Pipan, 2003). Vendar je njena naloga zajemala podatke tudi iz vadozne cone, saj je bil strop nad večino lokacij, kjer je zbirala živali in merila fizikalne in kemijske lastnosti vode, debel nekaj deset metrov, najpogosteje med 40 in 60 m. To je veliko več kot obsega definicija za epikras in so zato njeni rezultati le delno primerljivi z razmerami v epikrasu.

the epikarst were described in 1930s, however, were not recognised as "epikarstic" at that time. Two species from the Škocjan caves in Slovenia (at that time known as "Grotta di St. Canzian/Höhle von St. Canzian") were among the first ones to be described. Both were copepods, namely *Morariopsis scotenophila* (Kiefer 1930), in original described as *Moraria scotenophila* and *Speocyclops infernus* (Kiefer 1930), in original described as *Cyclops infernus* (Kiefer, 1930).

The first person to recognize the epikarst from the ecological point of view as specific living environment for subterranean aquatic animals was a French speleobiologist Raymond Rouch (Rouch, 1968). Many researchers had overlooked his paper and they continued to describe new species from the water jets in the caves without specifically defining the specific habitats occupied by those animals. Most of them belong to the group of tiny crustaceans named Copepoda. An exception was a several millimetres long crustacean *Niphargobates orophobata* Sket 1981, the member of a group Amphipoda, described from a water jet in the Planinska Jama cave in Slovenia (Sket, 1981).

Noticeable progress was made in understanding of the epikarst as a specific living environment for the aquatic animals, in the Velika Pasica cave, in 2000 and 2001, where, according to an anecdote, rich fauna was found in small pools filled by the water jets from the thin ceiling above the cave (Brancelj, 2002).

Immediately after the conducted research in the Velika Pasica cave, a young researcher, Tanja Pipan, from the Karst Research Institute in Postojna, started to study within the framework of her PhD thesis, and under the mentorship of the author of this book, the fauna structure and its distribution in six touristic caves in Slovenia (Pipan, 2003). However, her study contained the data also from the vadose zone, as the ceiling was several tenths of metres thick, on average between 40 and 60 metres, above most of the sampling points, where she collected fauna and measured physical and chemical characteristics of the drip water. This definition is more than comprehensive for the epikarst and consequently, her results were only partially comparable with the situation in the epikarst.

PROBLEM NABIRANJA JAMSKIH HROŠČEV

Po odkritju novih in tudi redkih slepih jamskih hroščev v sredini 19. stoletja je Velika Pasica postala cilj

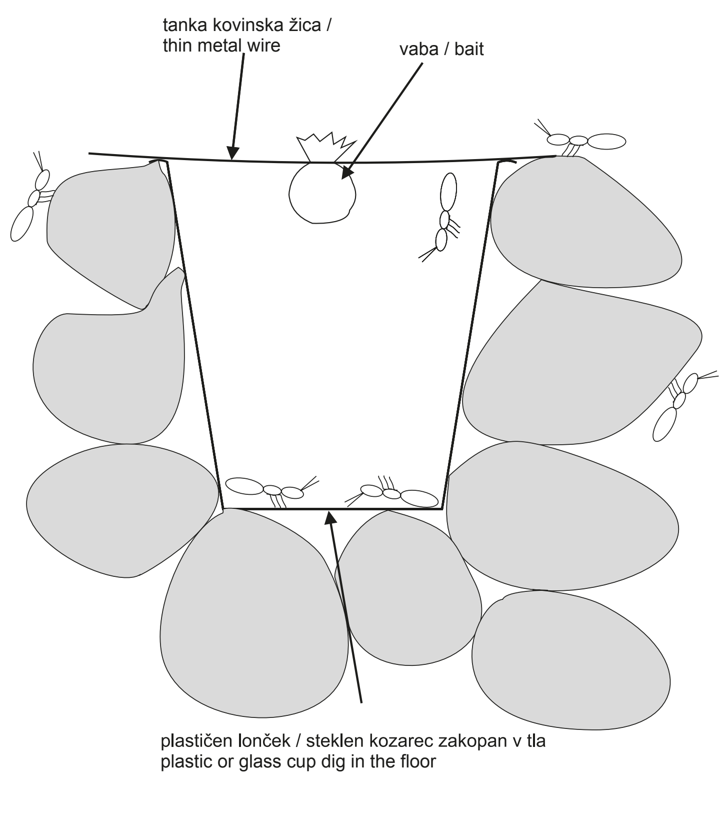
THE PROBLEM OF COLLECTING CAVE-DWELLING BEETLES

After the discovery of new and rare blind cave-dwelling beetles in mid-19th century, the Velika Pasica cave has become a številnih raziskovalcev in zbiralcev hroščev. Prvi slepi jamski hrošč na svetu je bil leta 1831 najden in po primerkih iz Postojnske jame opisan *Leptodirus hochenwartii* Schmidt 1832 (drobnovratnik). Z jamskimi hrošči se je dalo v preteklosti dobro zaslužiti, saj so zbiralci za redke hrošče ponujali visoke zneske. Že v primeru drobnovratnika je bila razpisana velika nagrada za nov osebek, potem ko se je prvi primerek nekam izgubil (Sket in sod., 2003).

Ker je Velika Pasica razmeroma blizu mesta, enostavna za dostop in tudi notranjost je nezahtevna za obisk, je bila privlačen cilj tako za turiste kot za zbiratelje hroščev. Koliko obiskovalcev s takimi nameni je prišlo v jamo, sicer ni znano, vsekakor pa jih ni bilo malo. O tem pričajo polomljeni kapniki in počrnjene stene, sajaste zaradi osvetljevanja z baklami. Številne izkopane luknje v sigasti prevleki ter stekleni in plastični lončki, ki so bili raztreseni po jami pred njenim zaprtjem, so bili nema priča, kako intenzivno so jamo obiskovali in iz nje nosili živali in kose kapnikov. Hrošče so namreč lovili tako, da so ob prvem obisku izkopali v dno rova plitvo jamico, vanjo postavili steklen kozarec ali kasneje plastičen lonček, na dno pa kot vabo postavili koščk gnijočega mesa (Slika 2). Je pa vsak zbiralec imel svoj lasten recept za vabo, saj so

destination for many researchers and collectors of the beetles. The first blind cave-dwelling beetle in the world was found in 1831 and was described according to the specimens collected from the Postojnska Jama cave in Slovenia, as a *Leptodirus hochenwartii* Schmidt 1832 (the so-called "thin-neck"). The cave-dwelling beetles were a source of good income, as the collectors used to pay large amounts of money for such rare specimens. In the case of the "thin-neck", a high award was offered for the new specimens, as the first one had soon been lost (Sket *et al*., 2003).

The Velika Pasica cave is located rather close to the city, easily accessible and has a simple interior, so it became a tourist, as well as a beetle collector attraction. How many beetle collectors had visited the cave is not known, but there were certainly many of them. The broken stalactites and sooty walls as a result of lit torches during the visits can testify to that. Many small man-made holes in the floor of the corridors and glass or plastic cups, scattered around in the cave before it had been closed, were silent witnesses to many visitors who had taken away pieces of stalactites and cave-dwelling animals. The beetles were collected in such a way that a collector would make a small hole on the floor during his first visit and put a small glass with rotten meat in it as bait (Figure 2). Actually, each collector had his own recipe for bait and ingredients varied from sherry or rum



Slika 2: Past za lov hroščev.
Figure 2: A pit-fall trap for collecting the beetles.

sestavine obsegale vse od sherryja oziroma ruma do gnijočih jeter ali sardel iz konzerv. Jamski hrošči, ki se hranijo tudi z mrhovino, so sledili vonju, padli v lonček, iz katerega pa niso mogli pobegniti, in so jih zato zbiralci ob naslednjem obisku zlahka pobrali. Če se niso vrnili v kratkem času, je to seveda pomenilo množični pomor hroščev.

Domačini se še danes spominjajo avtomobilov s tujimi registrskimi tablicami, katerih vozniki so spraševali za pot v jamo. Omenjali so tudi "nočne luči", kar namiguje, da so se obiskovalci verjetno skrivali v zavetju noči, saj je bilo v zadnjem času nabiranje jamskih hroščev z zakonom prepovedano (Ur. l. RS, 2004).

ZAPRTJE VHODA V JAMO IN POSTAVITEV INFORMACIJSKE TABLE

Predlog za postavitev železnih rešetk na vhod jame je podal avtor te knjižice, in sicer z namenom, da bi se uredil center za meritve okoljskih parametrov v jami. Te naj bi obsegale neprekinjene meritve pretokov štirih stalnih curkov v jami, njihove temperature in temperature okoliškega zraka. Meritve so bile predvidene kot del širšega raziskovanja ekologije jamskih živali, ki živijo v posebnem okolju nad jamo, to je v epikrasu. V rednih časovnih razmikih naj bi se zbirali tudi vzorci živali, ki jih izpira voda iz špranj v jamskem stropu. Za spremljanje navedenih parametrov je bilo potrebno v jamo postaviti meteorološko opremo, z računalnikom oziroma shranjevalnikom podatkov (data-logger) in opremo, ki je bila ustrezno prirejena za zbiranje vodnih živali. Omogočala je zbiranje podatkov iz vseh štirih stalnih curkov, in sicer vsako uro.

Po predstavitvi namena in usklajevalnem sestanku pri županu občine Ig Janezu Cimpermanu in s predstavniki KS Gornji Ig, Francem Brancljem in Mirkom Čampo v februarju 2006, je bil sprejet dogovor, da se na vhod v jamo postavi železna rešetka. Predhodno je bil opravljen ogled terena in ob tej priliki si je župan jamo tudi ogledal in bil nad njo zelo navdušen (Foto 2). Vrata je nato mesec dni kasneje v skladu s predpisi in dovoljenji Agencije RS za okolje (ARSO) postavil Jože Kraševec iz Tomišlja (Foto 3; Slika 3). Namen rešetke je bil, da se prepreči nepooblaščen dostop obiskovalcev v jamo, kjer so bili postavljeni merilni instrumenti.

to rotten livers or canned fish. The cave-dwelling beetles, which feed on carcasses, followed the smell, fell into the cup, not being able to escape from there, and so the collector picked them up easily during the following visit. If they had not returned soon, this could have been the cause for the mass-killing of the beetles.

The villagers of Gornji Ig still remember cars with foreign number plates and drivers who used to ask them for the directions to the cave. They also mentioned seeing "night lights," indicating that visitors of the cave used to hide in the dark, as collecting the cave-dwelling beetles had been illegalized about a decade ago (Ur. l. RS, 2004).

THE CLOSING OF THE CAVE'S ENTRANCE AND THE SETTING UP OF THE INFORMATION SIGN

The initiative for the construction of iron gates at the cave entrance was given by the author. The main reason behind the idea was the setting-up of a station for collecting environmental parameters in the cave. Measurements would run continuously and measure the discharge of four permanent water jets in the cave, water temperature and the surrounding air temperature. The measurements were planned as a part of a wider research on ecology of cave-dwelling animals, living in specific environment just above the surface, *i.e.* in the epikarst. In regular time intervals samples of fauna are also to be collected, washed away from the cracks in the ceiling. To observe the above mentioned parameters, a meteorological station needed to be put into the cave, along with a computer, *i.e.* a data-logger, and specially designed equipment for collecting fauna from the water. Such equipment enabled the study of data in all four permanent water jets, on every hour.

In February 2006, when this idea was presented to the mayor of the Ig county Janez Cimperman, along with the representatives of the Gornji Ig village, France Brancelj and Mirko Čampa, an agreement was reached, that an iron gate be constructed at the cave entrance. A field survey had also been made beforehand, and the mayor was invited to visit the cave. He was very pleased during the visit (Photo 2). The gates were constructed one month later by Jože Kraševec from the Tomišlje village, upon having acquired the permission of the Environmental Agency of RS (ARSO) (Photo 3; Figure 3). The aim of the gate was to prevent unauthorised access into the cave, where the measuring equipment is located.

Foto 2: Obisk jame Velika Pasica z županom Janezom Cimpermanom (levo), Tomažem Kraševcem (desno) in Antonom Brancljem (spredaj) (fotografirano: 6. decembra 2006) /Foto: D. Tome/.
Photo 2: The visit of the Velika Pasica cave with the mayor of the Ig county Janez Cimperman (left), Tomaž Kraševec (right) and Anton Brancelj (in front) (Photo made on 6th December 2006) /Photo: D. Tome/.

Foto 3: Vhod v jamo Veliko Pasico z nameščeno rešetko / Foto: A. Brancelj/.
Photo 3: The entrance to the Velika Pasica cave, protected with iron gates /Photo: A. Brancelj/.

Istočasno z zaprtjem jame in s postavitvijo merilnih inštrumentov smo s sodelovanjem članov Društva za raziskovanje jam Ljubljana in prostovoljcev iz jame odstranili smeti, ki so jih vanjo v preteklosti zmetali bodisi domačini ali pa so jih tja zanesli obiskovalci (Foto 4). Bilo je za dve večji vreči odvrženih kovinskih posod, steklenih črepinj ter plastičnih lončkov in vrečk. V začetku leta 2007 so člani Društva za raziskovanje jam Ljubljana jamo ponovno natančno izmerili in izdelali nov načrt (Foto 5). Lego jamskih rovov smo nato povezali tudi s situacijo na površju, da smo dobili jasno predstavo o tem, kje pod površjem ležijo

During the closure of the cave and setting the measuring equipment there, it was decided, in cooperation with members of the Society for Cave Exploration Ljubljana and some volunteers, to remove the garbage from the cave as well, which used to be thrown away into the cave by the locals or visitors (Photo 4). Two large plastic bags were filled with old metal pans, pots, broken glass and plastic bags. At the beginning of 2007, the members of the Society for Cave Exploration Ljubljana made a detailed measuring of the cave, making a new plan (Photo 5). The location and length of corridors was connected to the situation on the surface, thus obtaining detailed information on the epigean

Foto 4: Odstranjevanje smeti iz jame Velika Pasica (fotografirano: 13. januarja 2007) /Foto: D. Tome/.
Photo 4: Picking up the garbage from the Velika Pasica cave (Photo made on 13th January 2007) /Photo: D. Tome/.

Foto 5: Merjenje in risanje načrta jame Velika Pasica (na fotografiji: Matej Dular in Petra Gostinčar) (fotografirano 13. januarja 2007) /Foto: D. Tome/.
Photo 5: The measuring and drawing of the cave plan of the Velika Pasica cave (On the photo: Matej Dular in Petra Gostinčar) (Photo made on 13th January 2007) /Photo: D. Tome/.

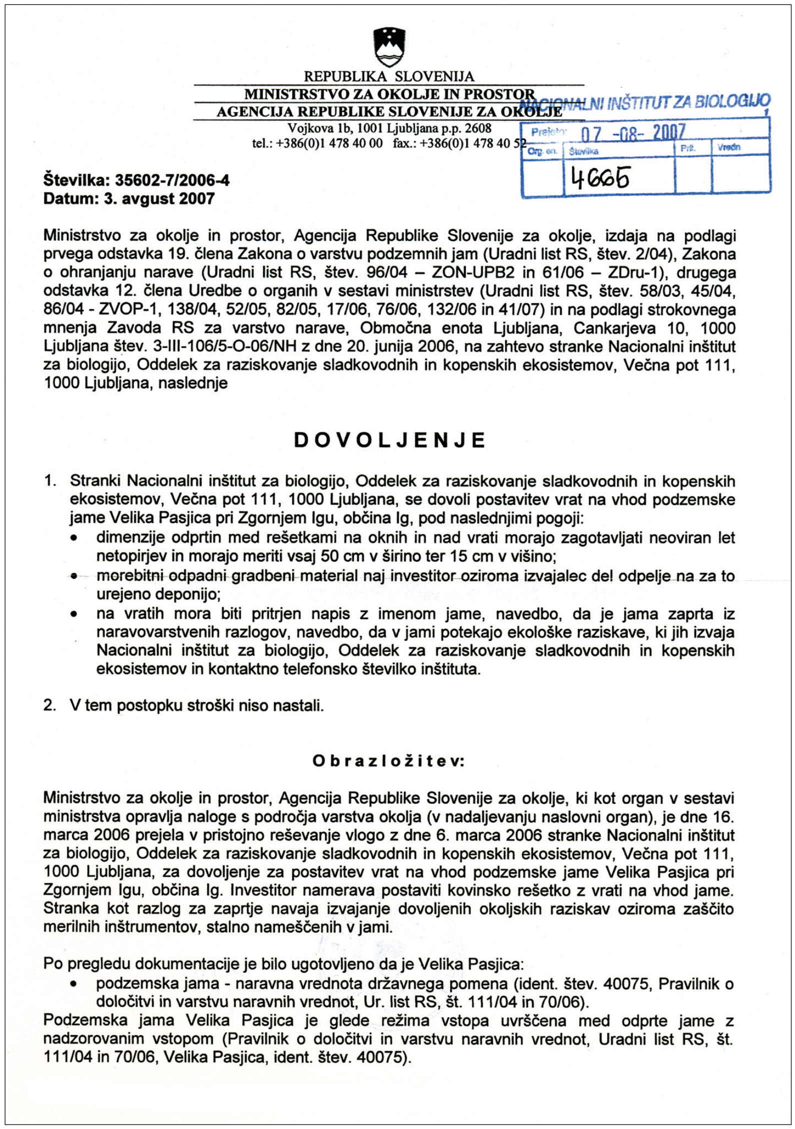
jamski rovi (Slika 4). Zanimala nas je zlasti debelina jamskega stropa, ki je življenjsko okolje zelo specializiranega vodnega življenja, ki smo ga proučevali.

Da bi jamo bolj približali obiskovalcem oziroma pohodnikom na Krim, je bila 26. maja 2009 pred vhodom odkrita informacijska tabla (http 1). Odkrila sta jo župan Janez Cimperman in avtor te knjige. Na tabli je poleg tlorisa jame predstavljena še kratek opis raziskav v preteklosti, potekajoče raziskave ter živali v sliki in besedi, ki jih obiskovalci ob spremstvu vodnika lahko vidijo v lužah ali na stenah jame (Foto 6).

location of corridors (Figure 4). The thickness of the ceiling was of particular interest, which is an environment, where the studied animals live.

On 26th May 2009, an information sign was put up next to the entrance, where visitors and hikers to Mt. Krim can get some information about the cave (http 1). It was officially presented by Mayor Janez Cimperman and the author of this book. The sign contained besides the presentation of the cave plan, the following information: the short history of the research, the ongoing research project, and a short description and the photos of the most common animals in the cave which can be seen during an organised visit of the cave (Photo 6).

Slika 3: Kopija dovoljenja za postavitev rešetke na vhod jame Velika Pasica (Slovenija).
Figure 3: The facsimile of the permission for construction of the gates at the entrance of the Velika Pasica cave (Slovenia).



REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR
AGENCIJA REPUBLIKE SLOVENIJE ZA OKOLJE
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NACIONALNI INŠTITUT ZA BIOLOGIJO
Prejeto: 07 -08- 2007
Org. en. | Številka 4665 | Pril. | Vredn.

Številka: 35602-7/2006-4
Datum: 3. avgust 2007

Ministrstvo za okolje in prostor, Agencija Republike Slovenije za okolje, izdaja na podlagi prvega odstavka 19. člena Zakona o varstvu podzemnih jam (Uradni list RS, štev. 2/04), Zakona o ohranjanju narave (Uradni list RS, štev. 96/04 – ZON-UPB2 in 61/06 – ZDru-1), drugega odstavka 12. člena Uredbe o organih v sestavi ministrstev (Uradni list RS, štev. 58/03, 45/04, 86/04 - ZVOP-1, 138/04, 52/05, 82/05, 17/06, 76/06, 132/06 in 41/07) in na podlagi strokovnega mnenja Zavoda RS za varstvo narave, Območna enota Ljubljana, Cankarjeva 10, 1000 Ljubljana štev. 3-III-106/5-O-06/NH z dne 20. junija 2006, na zahtevo stranke Nacionalni inštitut za biologijo, Oddelek za raziskovanje sladkovodnih in kopenskih ekosistemov, Večna pot 111, 1000 Ljubljana, naslednje

D O V O L J E N J E

1. Stranki Nacionalni inštitut za biologijo, Oddelek za raziskovanje sladkovodnih in kopenskih ekosistemov, Večna pot 111, 1000 Ljubljana, se dovoli postavitev vrat na vhod podzemske jame Velika Pasjica pri Zgornjem Igu, občina Ig, pod naslednjimi pogoji:
   - dimenzije odprtin med rešetkami na oknih in nad vrati morajo zagotavljati neoviran let netopirjev in morajo meriti vsaj 50 cm v širino ter 15 cm v višino;
   - morebitni odpadni gradbeni material naj investitor oziroma izvajalec del odpelje na za to urejeno deponijo;
   - na vratih mora biti pritrjen napis z imenom jame, navedbo, da je jama zaprta iz naravovarstvenih razlogov, navedbo, da v jami potekajo ekološke raziskave, ki jih izvaja Nacionalni inštitut za biologijo, Oddelek za raziskovanje sladkovodnih in kopenskih ekosistemov in kontaktno telefonsko številko inštituta.
2. V tem postopku stroški niso nastali.

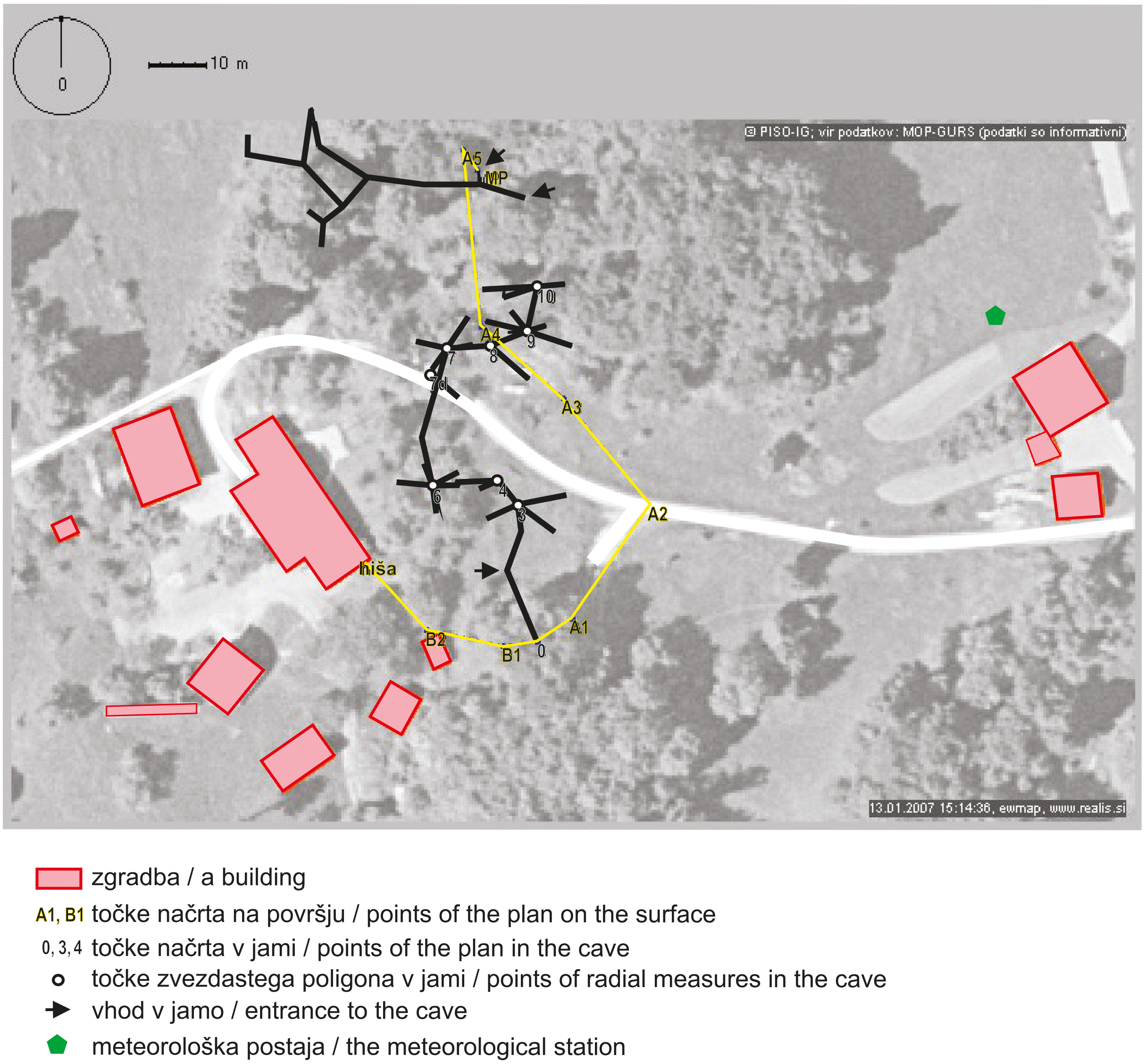
O b r a z l o ž i t e v:

Ministrstvo za okolje in prostor, Agencija Republike Slovenije za okolje, ki kot organ v sestavi ministrstva opravlja naloge s področja varstva okolja (v nadaljevanju naslovni organ), je dne 16. marca 2006 prejela v pristojno reševanje vlogo z dne 6. marca 2006 stranke Nacionalni inštitut za biologijo, Oddelek za raziskovanje sladkovodnih in kopenskih ekosistemov, Večna pot 111, 1000 Ljubljana, za dovoljenje za postavitev vrat na vhod podzemske jame Velika Pasjica pri Zgornjem Igu, občina Ig. Investitor namerava postaviti kovinsko rešetko z vrati na vhod jame. Stranka kot razlog za zaprtje navaja izvajanje dovoljenih okoljskih raziskav oziroma zaščito merilnih inštrumentov, stalno nameščenih v jami.

Po pregledu dokumentacije je bilo ugotovljeno da je Velika Pasjica:
- podzemska jama - naravna vrednota državnega pomena (ident. štev. 40075, Pravilnik o določitvi in varstvu naravnih vrednot, Ur. list RS, št. 111/04 in 70/06).

Podzemska jama Velika Pasjica je glede režima vstopa uvrščena med odprte jame z nadzorovanim vstopom (Pravilnik o določitvi in varstvu naravnih vrednot, Uradni list RS, št. 111/04 in 70/06, Velika Pasjica, ident. štev. 40075).

Foto 6: Odkritje informacijske table pred vhodom v jamo Velika Pasica (na fotografiji: Anton Brancelj (levo) in župan Iga, Janez Cimperman (desno) (fotografirano: 26 maja 2009) /Foto: H. Končar/.
Photo 6: The setting of the information sign in front of the Velika Pasica cave on 26th May 2009 (On the photo: Anton Brancelj (left) and mayor of the Ig county, Janez Cimperman (right) (Photo made on 26th May 2009) / Photo: H. Končar/.



Slika 4: Lega jam Velike in Male Pasice (Slovenija) preslikana na orto foto terena nad jamo (črne črte), poligon do jame Mala Pasica (MP; rumena črta) ter mesto meteorološke postaje (zeleni peterokotnik).
Figure 4: The location of the Velika and Mala Pasica caves (Slovenia), copied onto the orthophoto of the terrain above the cave (black solid lines), the track to the Mala Pasica cave (MP; yellow line) and the location of the meteorological station (green pentagram).

DOSTOP DO JAME, OKOLJE NAD NJO IN NJEN OPIS

LEGA IN DOSTOP DO JAME

Jama Velika Pasica leži na Rakitniško-krimski planoti, južno od Ljubljanskega barja, 15 km jugo-jugo-zahodno od Ljubljane. Vhod v jamo se nahaja na skrajnem južnem robu naselja Gornji Ig na nadmorski višini 670 m (Slika 5).

Iz Ljubljane se usmerimo po cesti, ki pelje na jug in vodi skozi naselja Ig, Staje, Iška vas in Iška. Tik pred tablo za naselje Iška prečkamo potok Iška. Nadaljujemo še okoli 600 m do križišča, kjer je oznaka za odcep Gornji Ig/Krim.

Če nadaljujemo pot z avtomobilom, sledimo asfaltirani cesti do naselja Gornji Ig, kjer takoj za tablo z oznako naselja zavijemo levo v vas. Sledimo asfaltirani cesti, ki vodi strmo v hrib. Čez 300 m se nahaja križišče takoj za osamljeno hišo na desni strani. Zavijemo desno in sledimo asfaltirani cesti še 100 m. Dvajset metrov nad cesto na levi stoji informacijska tabla o jami, in to tik nad vhodom v jamo (Foto 3, 6).

Pohodniška različica dostopa do jame se začne tik pred odcepom za Gornji Ig/Krim na parkirišču, kjer pustimo avtomobil. Sledimo oznakam pešpoti na Krim. Pot vodi od parkirišča še okoli 100 m v smeri Iški Vintgar, kjer se tik pred kmetijo Janežič (Iška 8) na desno v hrib odcepi pešpot. Po okoli 45-minutnem vzponu prispemo do zadnjih hiš v naselju Gornji Ig. Zavijemo desno in po kratkem sprehodu po asfaltirani cesti, okoli 200 m, pridemo ponovno na odcep za gozdno vlako proti vrhu Krima. Na desni strani gozdne

THE ACCESS TO THE CAVE, THE ENVIRONMENT ABOVE IT AND THE DESCRIPTION OF THE CAVE

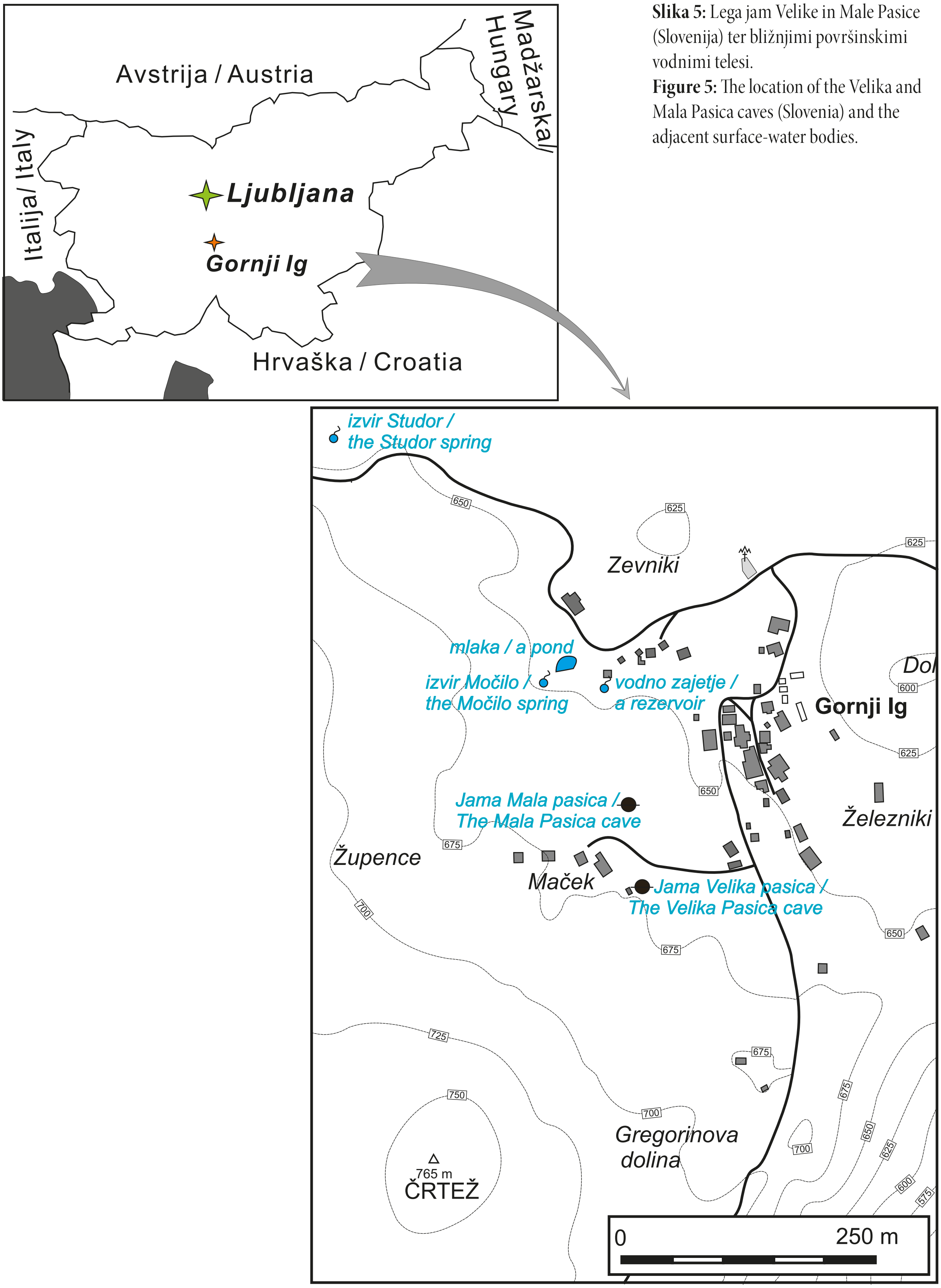
THE LOCATION AND ACCESS TO THE CAVE

The Velika Pasica cave is located on the Rakitniško-Krimska Planota plateau, south of the Ljubljansko Barje marshes and 15 km south-south-west of Ljubljana. The entrance into the cave is next to the outermost outskirts of the Gornji Ig village, at the altitude of 670 m (Figure 5).

If driving from Ljubljana, follow the road towards the south and go through the villages of Ig, Staje, Iška Vas and Iška. Just before sign for the Iška village, cross the Iška river. Go straight on for about 600 m, where is a crossroads with a sign marked Gornji Ig/Krim.

Go straight on, along the asphalt road to the Gornji Ig village, where immediately after the sign, turn left into the village. Follow the steep asphalt road up the hill. After 300 m is a crossroad, next to a small house on your right. Turn right and go straigt on for 100 m. About 20 m above the road is an information sign about the cave, right above the entrance into the cave (Photos 3, 6).

If hiking, drive to the sign to Gornji Ig/Krim and leave your car at a parking place there. Then, follow the footpath to Mt. Krim. Walk 100 m in the direction of Iški Vintgar, then turn right just before the Janežič farm (Iška 8), along the footpath. After 45 minutes' ascent, you should reach the outskirts of the Gornji Ig village. Turn right, and after about a 200-meter-walk along an asphalt road, there is another sign to Mt.



Slika 5: Lega jam Velike in Male Pasice (Slovenija) ter bližnjimi površinskimi vodnimi telesi.
Figure 5: The location of the Velika and Mala Pasica caves (Slovenia) and the adjacent surface-water bodies.

vlake, 20 m nad asfaltirano cesto, stoji tik nad vhodom v jamo informacijska tabla o jami.

POVRŠJE NAD JAMO

Teren nad jamo in neposredna okolica sta geološko razmeroma enotna, a je raba prostora toliko bolj raznovrstna, čeprav obsega površino, ki je velika le nekaj več kot 1 ha. Območje se geološko nahaja na močno dolomitiziranem apnencu (Pleničar, 1970), ki je sicer podvržen močnemu zakrasevanju, vendar zaradi svojih mehanskih lastnosti ne omogoča obstoja večjim jamskim objektom. Jama se nahaja na obrobju vasi, kjer se prepletajo vaška gmajna, sadovnjak, vrt, kmetija s hlevom in lokalna cesta (Sliki 4, 5).

Vhod v jamo je na meji med bukovim gozdom in sadovnjakom. Večji del jame leži pod sadovnjakom, vendar se na zahodnem delu močno približa hlevu in pripadajočemu gnojišču. Približno na polovici jame rove prečka lokalna cesta. Del jame se nahaja še pod začasnim odlagališčem lesa, v preteklosti tudi odpadnega gradbenega materiala in se konča v bukovem gozdu. Prav na koncu jame so v preteklosti v vrtačo stresali različne gradbene odpadke. Vodozbirno območje jame obsega teren nad jamo, le manjši del vode priteka s hriba, ki je južno od vhoda.

Z Veliko Pasico so geografsko in hidrološko neposredno povezani še jama Mala Pasica, občasni izvir Močilo ter vodno zajetje, ki je v preteklosti služilo za oskrbo vasi Gornji Ig z vodo. Najbližji vhod v Malo Pasico leži le okoli 10 m severno od skrajne točke v Veliki Pasici. Na površju loči obe jami razmeroma plitva in široka vrtača, ki je posledica udora jamskega stropa. Vhod v Malo Pasico je na robu vrtače in okoli 2 m nad njenim dnom. Rovi Male Pasice potekajo od vhoda 50 m proti zahodu, kjer se zaključijo. So vodoravni, v povprečju visoki 0,7 m in le mestoma visoki več kot 1,5 m (DZRJL-9, 1976). Na nekaj mestih so na tleh manjše plitve luže, napolnjene s preniklo vodo s stropa. V jami je nekaj kapnikov, ki pa so jih obiskovalci v preteklosti močno poškodovali.

Sto petdeset metrov od skrajne zahodne točke Male Pasice se v smeri proti severu nahaja občasni izvir Močilo, ki je dejaven le po izdatnem in dolgotrajnem deževju ali ob spomladanskem taljenju snega (Foto 7).

Krim. On its right side, about 20 m above the asphalt road, is an information sign above the cave entrance.

THE SURFACE ABOVE THE CAVE

The terrain above the cave and the immediate vicinity of the cave are geologically rather uniform, while the land use is much more diverse, although it covers a surface of only about 1 hectar (100 x 100 m). Geologically, the area is characterised with intensively dolomitised limestone (Pleničar, 1970), which was subjected to intensive karstification processes, but due to its mechanical characteristics does not enable the formation of larger cave objects. The cave is located on the outskirts of the village, where is a small area of intermixed hedges, orchards, garden, farm with stable and a local road (Figures 4, 5).

The cave entrance is on the border between a beech forest and an orchard. The majority of the cave is located below the orchard, next to a farm and a dunghill, facing west. At approximately half lengths of the corridors on the surface is an access road crossing the cave. The smaller part of the cave is located under a temporary deposition of wood, where used to be a dumpsite for demolition waste, ending in the beech forest. The catchment area of the cave consists mainly of the terrain above the cave, with only a small amount of water flowing into the cave from a hill located at the south of the entrance.

The Velika Pasica cave is geographically and hydrologically connected with the Mala Pasica cave, the Močilo temporary spring and a reservoir, which in the past was used for supplying the Gornji Ig village. The nearest entrance to the Mala Pasica cave is located only 10 m north from the most distant point of the Velika Pasica cave. On the surface, both caves are separated by a shallow and wide doline, formed by the collapse of the cave ceiling. The entrance into the Mala Pasica cave is on the edge of doline, about 2 m above the bottom. The corridors of the Mala Pasica cave run about 50 m westward from the entrance, where they end. They are horizontal, with an average height of 0.7 m and higher than 1.5 m only on a few sites (DZRJL-9, 1976). On certain sites in the corridors are shallow pools filled with drip water. There are also some damaged stalactites as a result of visits in the past.

About 150 m from the westernmost point of the Mala Pasica cave is the Močilo temporary spring, active only after a heavy and long-lasting rain or a snowmelt in the spring

Foto 7: Občasni izvir Močilo in mlaka pred njenim očiščenjem aprila 2014 (fotografirano 9. februarja 2014) /Foto: A. Brancelj/.
Photo 7: The Močilo temporary spring and pond just before its cleaning in April 2014 (Photo made on 9th February 2014) / Photo: A. Brancelj/.

Izvir je pod strmim, 10-metrskim pobočjem in je 10 m pod najnižjo točko v Mali Pasici. Ustje izvira ima obliko enakostraničnega trikotnika, čigar osnovnica meri 20 cm. Izteka se v strugo, katere dno je pokrito z ostrorobimi skalami in odpadlimi vejami ter listjem. Po 20 m se izlije v kotanjo, ki je bila v preteklosti povsem zapolnjena z odpadlim listjem ter vejami (Foto 7). Spomladi leta 2014 jo je bližnji sosed dal na pobudo avtorja knjižice očistiti. Mlako so očistili do skalnega dna, tako da je globoka okoli 2 m in ima ovalno obliko, ki po daljši

(Photo 7). It is located below a 10-meter-slope and 10 m below the lowest point in the Mala Pasica cave. The spring mouth has a form of equilateral triangle with a baseline of 20 cm. It flows into a channel, with a bottom covered with sharp-pointed stones, fallen twigs and leaves. After 20 m, it enters a pond, which used to be completely filled with fallen twigs and leaves (Photo 7). In spring 2014, the neighbour cleaned it on the author's initiative. The oval 2-meter-deep and 7-meter-long pond was cleaned completely to the solid rock. In 2014, the water depth never exceeded 50 cm after

Foto 8: Vodni zbiralnik za pitno vodo v vasi Gornji Ig (fotografirano: 8. marca 2015) /Foto: A. Brancelj/.
Photo 8: The drinking water reservoir in the Gornji Ig village (Photo made on 8th March 2015) /Photo: A. Brancelj/.

stranici meri 7 m. V letu 2014 ni gladina vode po daljšem obdobju brez dežja nikoli presegala globine 50 cm, kar nakazuje, da obstajajo razpoke, skozi katere voda odteka naprej proti veliki vrtači, ki jo domačini imenujejo Zevniki (Slika 5).

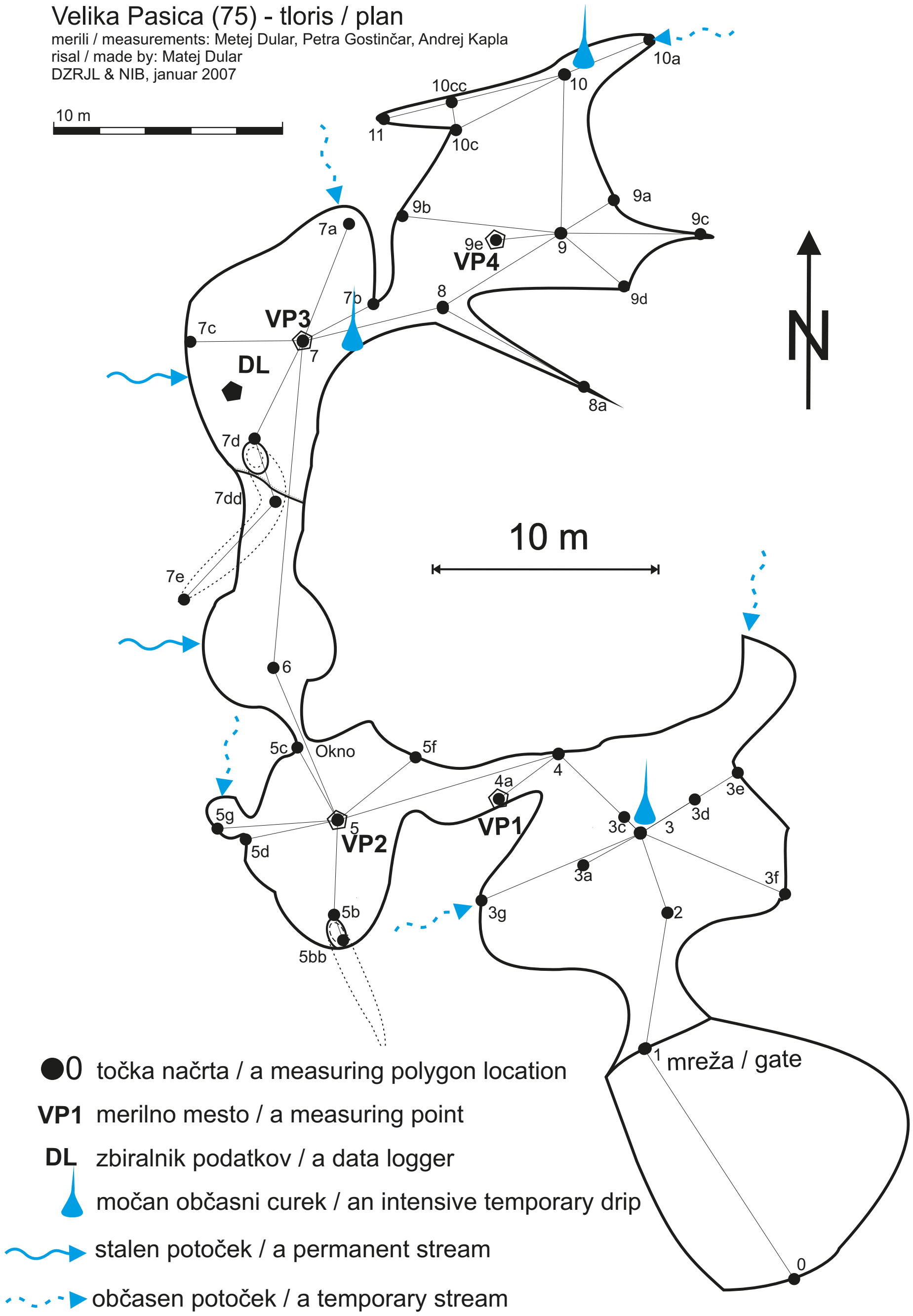
Trideset metrov zahodno-severo-zahodno od izvira Močilo je nad lokalno cesto Iška-Rakitna vodni zbiralnik, iz katerega so se domačini dolga leta oskrbovali z vodo in ob njem napajali živino (Foto 8). Zbiralnik ima prostornino 400 m^3 (10 x 10 x 4 m) in je bil dokončan leta 1918. Od leta 1989 ni več v uporabi, potem ko so izvrtali 350 m globoko vrtino, iz katere se vas oskrbuje z vodo. Zbiralnik je sedaj namenjen kot vir vode za protipožarno varnost (Franc Brancelj, ustni vir). Tako izvir Močilo kot vodni zbiralnik sta povezana z jamskim sistemom Velike in Male Pasice, od koder dobivata del vode.

V bližini je še majhen izvir Studor, in sicer 300 m severo-zahodno od izvira Močilo (Slika 5). Vendar pa zaradi lege in izdatnosti (verjetno) nima povezave z jamskim sistemom, ampak je rezultat lokalnega odvodnjavanja. Tretji manjši izvir Mrzlica, ki je bil v preteklosti urejen kot zajetje, a hidrološko ni povezan z Močilom,

a prolonged dry period, which is an indication of the existence of cracks through which the water flows toward the deep doline, named by the villagers as "Zevniki" (Figure 5).

30 m from the Močilo spring in west-north-west direction and just above the local Iška-Rakitna road, is a reservoir which served the villagers and their cattle as a water supply for a long time (Photo 8). The reservoir has a volume of 400 m^3 (10 x 10 x 4 m) and was finished in 1918. It has not been used for water supply since 1989, as a 350 m deep borehole was made as an alternative water supply source. Nowadays, it functions as a reservoir for water supply in the case of fire (Franc Brancelj, personal communication). Both, the Močilo spring and the reservoir are connected with hydrological systems of the Velika and Mala Pasica caves from where a part of their water supply originates.

Nearby is the location of the Studor spring. It is 300 m north-west from the Močilo spring (Figure 5). Due to its location and the amount of discharge, the water is not likely a part of the cave system, but has its own catchment area. The third small spring named Mrzlica (Slov. *cold spring*) was in the past built also as a small reservoir, but has no connection with spring Močilo. It is located 1.1 km west-south-west from



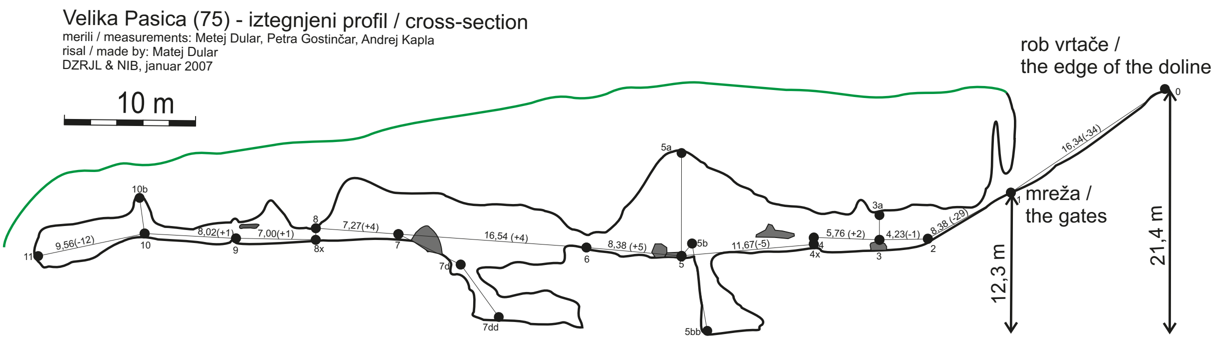
Slika 6: Tloris jame Velika Pasica (Slovenija) z vrisanimi merilnimi točkami (VP 1–VP 4), mestom data-loggerja, točkami poligona, močnejšimi občasnimi curki ter občasnimi in stalnimi potočki.
Figure 6: The plan of the Velika Pasica cave (Slovenia) with marked measuring sites (VP 1–VP 4), position of data-logger, measuring polygon locations, locations of stronger temporary water jets as well as permanent and temporary streams.

je 1,1 km zahodno-jugo-zahodno od vasi Gornji Ig, na nadmorski višini 750 m. Nahaja se v globoki vrtači pod cesto, kjer cesta iz smeri Gornji Ig-Rakitna drugič prečka traso visokonapetostnega daljnovoda. Zajetje je sicer porušeno, a so betonski ostanki zidov še vedno vidni.

Drugih vodnih virov v neposredni okolici jame ni. Najbližji stalni izvir je izvir Krvavice, ki se nahaja 2 km jugo-zahodno od jame. Voda iz izvira odteka neposredno v potok Iška, ki je okoli 300 m nižje.

the Gornji Ig village, at the altitude of 750 m. It is located in a deep doline, below the Gornji Ig-Rakitna local road, where the road is for the second time crossed by high-voltage landline. The reservoir was demolished although the concrete walls can be still recognised.

There are no other sources of water nearby. The nearest spring Krvavice is located 2 km south-west from the cave. The water from spring flows directly into the Iška river, about 300 m bellow the spring.



Slika 7: Profil jame Velika Pasica (Slovenija) z vrisanimi točkami poligona ter razdaljami in nakloni med točkami (v oklepajih).
Figure 7: The cross-section of the Velika Pasica cave (Slovenia), with marked measuring sites, polygon locations and the distances and inclines between the polygon points (in brackets).

OPIS IN NAČRT JAME

Tloris jame ima obliko nekoliko nepravilne črke S in ima glavno os v smeri sever-jug, pri čemer je vhod na jugu in najbolj oddaljeni del jame na severu (Sliki 4, 6; Tabela 1). Vhod v jamo je na dnu 10 m globoke udorne vrtače in ima koordinate: 45° 55' 07.72'' S, 14° 29' 35.19'' V, 670 m nadmorske višine. Južno pobočje vrtače je strm podor pokrit s prstjo, listjem in odpadlimi vejami, medtem ko je na severni strani previsna stena, ki se nadaljuje v manjši spodmol. Pod previsno steno je od pomladi leta 2006 vgrajena kovinska mreža z vrati, ki nepooblaščenim preprečuje vstop v jamo (Foto 3).

Takoj za kovinsko mrežo je manjši 4 m širok spodmol in sega 3,6 m v notranjost. Na notranji steni je kamin, ki sega pod površje (Slika 7). Del spodmola ima po steni sigaste prevleke delno pokrite z mahovi oziroma algami. Dno spodmola je strmo nagnjeno proti vzhodu, kjer je 2 x 1 m velik prehod v jamo oziroma v vhodno dvorano. Za vhodom je na desni strani zgoraj gruščnato pobočje iz zdrobljenega dolomita pomešanega z ilovico; ostanek podora. Jama se nadaljuje pod kotom 20° navzdol proti jugu. Dno vhodne dvorane je rahlo ovalne oblike z daljšo osjo (15 m) v smeri vzhod-zahod. Na skrajnem severo-vzhodnem delu dvorane je na dnu 2 x 2 m velika kotanja z ilovnatim dnom, ki je ob močnem deževju zapolnjena z 10 cm globoko lužo. Večji del časa pa so manjše luže le v stopinjah prejšnjih obiskovalcev. Preostali del dna dvorane je prekrit z ostrorobimi skalami, 15–20 cm v premeru. Sredi dvorane je večja skala, odpadla iz stropa in obilno prekrita s sigo. Strop dvorane je visok do 3 m. Nad večjo skalo

THE DESCRIPTION OF THE CAVE AND THE CAVE PLAN

The ground plan of the cave is roughly S-shaped and faces north-south. The entrance is on the south and the most distant part of the cave is on the north (Figures 4, 6; Table 1). The entrance into the cave is at the bottom of 10-meter-deep collapsed doline. The coordinates of the entrance are: 45° 55' 07.72'' N, 14° 29' 35.19'' E, 670 m above the sea level. The southern slope of doline is steep, covered with humus and litter while on the north is a vertical cliff, continuing into a small chamber. In 2006, right below the vertical cliff, iron gates were constructed, preventing access to unauthorised personnel (Photo 3).

In the immediate vicinity of the iron gates there is a small chamber, 4 m wide and 3.6 m long. In inner wall there is a chimney extending close to the surface (Figure 7). A part of the chamber is made from flowstone and covered by mosses and algae. The floor of the chamber is steep and slants to east, where is a 2 x 1 meter passage into the cave, *i.e.* entrance hall. Behind the entrance on the right is a steep slope composed from dolomite debris and clay, which is actually a collapsed dome. The cave continues with a twenty-degree decline towards south. The floor of the entrance hall is roughly oval, with a longer axis (15 m) in the east-west direction. At the most distant north-east part of the hall there is a depression (2 x 2 m) with a clay bottom, which turns into a 10-centimeter-deep pool during heavy rain. Most of the time water remains only in foot-depressions made by visitors. Most of the floor is covered with sharp-edged stones, measuring 15–20 cm in diameter. In the middle of the hall is a big rock, having fallen from the ceiling and partly covered by flowstone. The

Tabela 1: Osnovni podatki o jami Velika Pasica (Slovenija) (povzeto po slikah 6 in 7).
Table 1: The basic data on the Velika Pasica cave (Slovenia) (according to Figures 6 and 7).

Koordinate vhoda: / *The coordinates of the entrance:* X: 45° 55' 07,95'' S / *N* Y: 14° 29' 35,09'' V / *E* Z: 670 m (rob vrtače / *the edge of doline*); 660 m (kovinska vrata / *iron gate*)	
Dolžina vodoravnih rovov (brez obeh brezen) / *The length of the horizontal corridors (both pits excluded)*	104,7 m
Največja razdalja med vhodom (jug; Tč. 1) in skrajno notranjo točko (sever; Tč. 10a) / *The maximum distance between the entrance (South; Tč. 1) and the distal-most inner point (North; Tč. 10a)*	44,4 m
Največja višinska razlika med vhodom (mreža; Tč. 1) in skrajno notranjo točko (Tč. 11) / *The maximum difference in altitude between the entrance (iron gate; Tč. 1) and the distal-most inner point (Tč. 11)*	4,5 m
Največja višinska razlika med vhodom (mreža; Tč. 1) in dnom brezna (Tč. 6bb) / *The maximum difference in altitude between the entrance (iron gate; Tč. 1) and the bottom of the pit (Tč. 6bb)*	12,3 m
Največja višinska razlika med robom vrtače (Tč. 0) in dnom brezna (Tč. 6bb) / *The maximum difference in altitude between the edge of doline (Tč. 0) and the bottom of the pit (Tč. 6bb)*	21,4 m

Foto 9: Sedimentna zapolnitev jamskega rova v vhodni dvorani Velike Pasice (na fotografiji: Andrej Mihevc) (fotografirano: 6. marca 2015) /Foto: A. Brancelj/.
Photo 9: The sediment fill of the cave corridor in the entrance part of the Velika Pasica cave (On the photo: Andrej Mihevc) (Photo made on 6th March 2015) /Photo: A. Brancelj/.

je sigast balkon, s katerega ob močnejšem deževju ali tajanju snega teče obilnejši curek vode, kar pa traja le po nekaj ur. Na zahodni steni od velike skale je 1,2 m nad tlemi plast konglomerata, ki je debela 30 cm in je ostanek sedimentne zapolnitve jamskega rova, verjetno starega 3,5–4 milijonov let (Andrej Mihevc, ustni vir) in ki ga zasledimo še na nekaj mestih v jami (Foto 9).

Jama se nadaljuje na najnižji točki v severo-zahodnem delu dvorane, kjer je 1 m širok in 3 m visok prehod v naslednjo dvorano. Od te točke je dno jame bolj ali manj vodoravno z nekaj manjšimi vzponi oziroma spusti. Za vogalom je mesto močnejšega stalnega

maximum height of the hall is 3 m. Above the big rock is a formation of flowstone, resembling a balcony, from which flows a strong jet of water lasting only a few hours, after a heavy rain or a snowmelt. On the western wall, there is 1.2 m above the floor a layer of conglomerate, which is a remnant of sediment fill of corridor, probably 3.5–4 million years old (Andrej Mihevc, personal communication) which can be seen on several sites along the main corridor (Photo 9).

The cave continues at the lowest point of the hall, at the north-western corner, where it is a 1 m wide and 3 m high passage into the next hall. From this point on, the floor is more or less flat with a few uneven patches. Just next to the

Foto 10: Odlomljeni oziroma poškodovani kapniki v jami Velika Pasica (fotografirano: 6. marca 2015) / Foto: A. Brancelj/.
Photo 10: The broken and/or damaged stalactites in the Velika Pasica cave (Photo made on 6th March 2015) /Photo: A. Brancelj/.

Foto 11: Zaradi bakel poškodovana niša na koncu vhodne dvorane v Veliki Pasici /Foto: A. Brancelj/.
Photo 11: The niche at the end of entrance hall in the Velika Pasica cave, which had been damaged with torches / Photo: A. Brancelj/.

Foto 12: "Okno" – prehod med zunanjim in notranjim delom jame Velika Pasica /Foto: A. Brancelj/.
Photo 12: "The window" - a passage between the outer and inner part of the Velika Pasica cave /Photo: A. Brancelj/.

Foto 13: »Špagetki«, tanki, hitro rastoči stalaktiti v jami Velika Pasica /Foto: A. Brancelj/.
Photo 13: »The spaghetti«, thin and fast-growing stalactites in the Velika Pasica cave /Photo: A. Brancelj/.

kapljanja oziroma curka prenikle vode (v nadaljevanju označen kot VP 1). Rov je z 1 m debelim sigastim obokom, na katerem je večji stalagmit premera 1 m in višine 1 m, razdeljen v vodoravni smeri na dva dela. Spodnji, po katerem obiskovalci normalno nadaljujejo pot, je širok 2,5 m in visok 1,5 m, ter zgornji, ki je visok 5 m. Domačini ta prehod imenujejo "prižnica", ker spominja na povzdignjeno mesto v cerkvah, od koder so duhovniki podajali pridige. Na sredini je lužica vode, ki presahne le ob dolgotrajnih sušah. Na stalagmit na prižnici priteka voda iz drugega stalnega curka (v nadaljevanju označen kot VP 2). Že nad prižnico se strop dvorane strmo dvigne na višino 7 m in se zelo približa površini. Stene so bogato pokrite s sigo, medtem ko so večje kapnike obiskovalci v preteklosti odlomili oziroma poškodovali (Foto 10). Prav tako je močno poškodovana majhna niša na desni strani, 1,5 m nad tlemi, kamor so v preteklosti obiskovalci postavljali bakle, ki so jim služile za orientacijo pri obiskih jame (Foto 11). Na levi strani dvorane je pod steno 2 x 1 m velik vhod v 7 m globoko brezno, ki se konča v gruščnatem podoru. Malo naprej je vhod v majhno dvorano, premera 3 m in višine 1,5 m z ilovico na dnu, vmes je več večjih kamnov. Ob močnejšem deževju se v njej oblikuje začasna luža, ki občasno rahlo smrdi po gnojevki. Na levi steni oziroma na skrajnem severo-zahodnem delu dvorane je ozek prehod v notranji del jame. Domačini so ga poimenovali "okno" (Foto 12). Prehod je

corner there is a permanent jet of water (hereafter named as VP 1). The corridor is separated with a 1 m thick sintered vault, topped with a stalagmite measuring 1 m in diameter and 1 m in height. The lower part of the corridor, used by visitors, is 2.5 m wide and 1.5 m high; the upper part of the corridor is 5 m high. The locals call the sinter vault "'pulpit" because it resembles an elevated place in a church where the priest preaches. Right below the vault is a pool which dries out only after a long-lasting draught. On pulpit stands a stalagmite on which falls the water from another permanent water jet (hereafter named as VP 2). Immediately after pulpit the ceiling of the hall rises 7 m in height and comes close to surface. Walls there are richly laden with sinter, while the stalagmites had been demolished by visitors in the past (Photo 10). Also, there is a small niche on the right side of the hall, 1.5 m above the floor, damaged as a result of torches, put there by visitors for orientation during the visits (Photo 11). On the left side of the hall, under the wall is an entrance (2 x 1 m) into a 7 m deep shaft, ending in a rubble slope. Next to it, is an entrance to a small chamber, measuring 3 m in diameter and 1.5 m in height, its floor covered with clay and several boulders in between. During heavy rain a temporary pool is formed in the chamber, smelling slightly of manure. In the left wall, *i.e.* on the most north-western part of the hall is a narrow passage into the inner part of the cave. The locals call it a "window" (Photo 12). The dimensions of the passage are 0.7 x 1 m.

In the immediate vicinity of the passage is a small round

Foto 14: Kapniški steber v notranjem delu jame Velika Pasica (na fotografiji: Anton Brancelj) (fotografirano: 3. marca 2006) /Foto: D. Tome/.
Photo 14: A column in the inner part of the Velika Pasica cave (On the photo: Anton Brancelj) (Photo made on 3rd March 2006) /Photo: D. Tome/.

velik 0,7 x 1 m. Takoj za prehodom je manjša okrogla dvoranica, okoli 8 m v premeru in do 1,8 m visoka, ki se nadaljuje v kratek rov. V njej je več debelejših kapnikov oziroma stebrov; nekateri med njimi so nagnjeni ali zlomljeni, kar je poledica izpodjedanja podlage v preteklosti. Z leve strani tik za prehodom je za kapniki manjša niša z blatnim dnom, tlorisa 2 x 1 m in 1 m visoka. Izpod stene priteka manjši potok (do nekaj dL min^{-1}), katerega voda ima vonj po gnojevki. Potoček že po 2 m ponikne v špranjo v tleh. Del te vode se ob povečanih pretokih občasno pojavi tudi v prej omenjeni dvoranici, ki se nahaja med breznom in "oknom".

chamber with floor, measuring 8 m in diameter and up to 1.8 m in height, continuing into the short corridor. There are several thick stalactites and columns; some of them are tilted or broken as a result of erosion of substrate in the past. On the left side, immediately after the "window" there is an additional side chamber (2 x 1 m) and 1 m high; the floor is covered with clay. A small stream (a few dL min^{-1}) flows into the chamber from the side, giving off sligh odour of manure. A part of this water can be located for a short period in small chamber after a heavy rain, between the shaft and the "window". The ceiling of the main chamber is rather smooth and densely covered with short "spaghetti," quite fragile and

Strop glavne dvoranice je razmeroma raven in na gosto prekrit s kratkimi "špageti". To so pravzaprav krhki in hitrorastoči stalaktiti – bele cevčice s tankimi stenami, ki rastejo s stropa (Foto 13). Zaradi krhkosti jih je veliko polomljenih, saj so jih prejšnji obiskovalci polomili bodisi zaradi zadevanja s čelado ali hrbtom ob strop ali pa so jih polomili z roko zgolj iz radovednosti. Strop je na tem mestu črn, kar je posledica saj bakel, ki so jih obiskovalci v preteklosti uporabljali za osvetljevanje, medtem ko so "špageti" zaradi hitre rasti svetle oziroma bele barve. Dvorana se nadaljuje še 5 m po rahlo dvignjenem rovu s presekom 2 x 1,5 m in se konča z 1,7 m globoko stopnjo, ki diagonalno preseka rov in je posledica dobro vidnega preloma. Na zgornjem robu stopnje je še ena majhna niša, močno poškodovana zaradi ognja bakel obiskovalcev jame. Na dnu stopnje je največji kapniški steber v jami, ki ima na dnu premer 30 cm in je visok 4 m (Foto 14). Na višini enega metra ima podolgovato špranjo v izmeri 60 x 5 cm, kar nakazuje, da je nastal kot posledica zlitja dveh bližnjih stalaktitov in stalagmitov. Takoj za kapnikom je še manjša, meter globoka stopnja, ki je posledica še enega preloma in poteka glede na prejšnjega pod kotom 30°. Stopnja se nadaljuje v drugo brezno v jami, ki je globoko 7,8 m. Dno brezna je 1,5 do 2 m široka in 8 m dolga špranja, ki poteka v smeri proti jugo-zahodu. Dno je ravno in pokrito z ilovico. V kotanjicah je voda, z vonjem po gnojevki.

Na nasproti strani stopnje pod kapniškim stebrom se dno jame strmo dvigne za okoli 2 m in vodi na dno največje dvorane v jami. Jamsko dno se od stopnje dviga pod kotom 30° v smeri severo-severo-vzhod, kjer se po 15 m konča. Strop dvorane je do 8 m visok in se po načrtu približa površini na 4 m. Ta točka je na površini v neposredni bližini asfaltirane poti, ki vodi do domačije Maček (Gornji Ig 7). Dno dvorane je iz podornega grušča, ki je delno pokrit s sigo. Na nekaterih mestih so vidne sledi kopanja, ki so ga izvedli nabiralci jamskih hroščev, ko so tja postavljali lovilne lončke z vabami.

Pet metrov nad vhodom v brezno je na levi strani dvorane na višini 2 m lepo viden profil fosilnega jamskega rova, ki je popolnoma zapolnjen s konglomeratom; ta je enak tistemu v vhodni dvorani. Pod njim, v nivoju dna dvorane, priteka s strani manjši potok, ki tvori nekaj lužic; iz njih se voda pretaka v smeri brezna,

fast-growing stalactites, white tubes with thin walls, growing from the ceiling (Photo 13). Due to their fragility, most of them are broken as a result of visitors who accidentally had bumped into them with their helmets or had intentionally broke them out of curiosity. The ceiling is black as a result of soot from the torches used in the past for lighting, while the "spaghetti" are, due to their fast growth, bright white. The chamber continues into the 5 m long slightly ascending corridor with a 2 x 1.5 m profile and ends with a 1.7 m deep step, cutting the oblique and is a result of a well seen fault. On the upper edge of the step is another small chamber, heavily damaged by fire from torches. At the bottom of the step there is the largest column in the cave, measuring 30 cm in diameter at the base and 4 m in height (Photo 14). At the height of 1 m there is an elongated opening in dimension 60 x 5 cm, which is an indication that the column is actually a result of the fusion of two nearby stalactites and stalagmites. Next to the column is one metre deep step as a result of another fault, at the angle of 30° in relation to the previous fault. The step continues into the second shaft in the cave and is 7.8 m deep. The bottom of the shaft is 1.5–2 m wide and 8 m long cranny, facing south-west. The floor is flat and covered by clay. In some small pools, the water gives off slight odour of manure.

On the opposite site of the step below the column, the floor of the cave inclines in around 2 m, leading to the biggest hall in the cave. The floor inclines for a distance of 15 m at the angle of 30°, facing north-north-east, where it ends. The height of the hall is up to 8 m and according to the cave plan, it approaches to surface to a distance of 4 m. This point is close to an asphalt road leading to the Maček farm (Gornji Ig 7). The floor of the hall is from collapsed dome partly covered by flowstone. On some spots are visible traces of digging made by beetle collectors who put there the traps with baits.

Five metres above the entrance into the shaft on the left side of the hall is at 2-meter-height a cross-section of a fossil corridor, completely filled with conglomerate which is identical to that in the entrance hall. Right below the corridor, at the same height as the bottom of the hall, flows a small stream of water from the side, forming a few pools. The water flows from the pools into a pit where it disappears in the cracks. This water also gives off the odour of manure. A few metres from the highest point of the hall flows the third permanent jet of drip water from the ceiling (hereafter named as VP 3). At the bottom of

Foto 15: "Slonja glava z odlomljenim oklom" na prehodu v zadnjo dvorano jame Velika Pasica (fotografirano: 8. maja 2006) /Foto: A. Brancelj/.
Photo 15: "The elephant's head with a straight trunk and a broken tusk" at the passage to the rear hall of the Velika Pasica cave (Photo made on 8th May 2006) / Photo: A. Brancelj/.

Foto 16: Kapniški stebri v zadnji dvorani v jami Velika Pasica (fotografirano: 24. decembra 2013).
Photo 16: The dripstone columns in the back hall of the Velika Pasica cave (Photo made on 24th December 2013) /Photo: A. Brancelj/.

kjer se porazgubi v špranjah. Tudi ta voda občasno vonja po gnojevki. Nekoliko vstran od najvišje točke dvorane s stropa priteka v jamo tretji stalni curek prenikle vode (v nadaljevanju označen kot VP 3). Na dnu dvorane sta levo in desno tik nad vhodom v brezno dve večji skali (2 x 1 x 1 m ter 2 x 2 x 1,5 m), ki sta se v daljni preteklosti odlomili od jamskega stropa. O tem pričajo debele plasti sige, s katerimi sta delno prekrita oba kamna.

Na levi strani dvorane se na vzhodni strani pod kapnikom, ki ima obliko slonje glave z ravnim rilcem

the hall, on the left and right side of the entrance into the shaft, are two big boulders (2 x 1 x 1 m and 2 x 2 x 1.5 m, respectively), having fallen from the roof long time ago. Thick deposits of flowstone which partly covers both boulders is prove this.

On the left side of the hall, facing east, below the stalagmite resembling an elephant's head with a straight trunk and a broken tusk (Photo 15) is an entrance to the last, fourth hall, the floor plan measuring 15 x 15 m. Right after the passage is a narrow vertical crack, 3 m high and with a floor plain in a shape of an elongated triangle. The in odlomljenim oklom (Foto 15), odpira prehod v zadnjo, četrto dvorano. Njen tloris je približno 15 x 15 m. Takoj za prehodom je ozka navpična špranja, visoka 3 m in s trikotnim tlorisom dna. Dno je iz grobih in ostrorobih skal s premerom do 30 cm. Špranja se končuje v ozkem neprehodnem zasiganem odtoku, ki ob intenzivnih padavinah odvaja vodo.

Pet metrov naprej je sigasta kopa, ki zapolnjuje jugo-vzhodni del dvorane. Iz stropa priteka četrti stalni curek prenikle vode (v nadaljevanju označen kot VP 4). Takoj poleg njega je stena s podpisi obiskovalcev. Strop je visok v povprečju 1,7 m z nekaj manjšimi kamini. Levo od sigaste kope, proti vzhodu, so štirje kapniški stebri visoki do 1 m in kijaste oblike (Foto 16). Njihova osnova izrašča iz luže v sigasti ponvici, ki je globoka nekaj centimetrov in s površino 5 m^2. Dno ponvice je pokrito s koščki oglja, ki so ostanki bakel, s katerimi so si obiskovalci osvetljevali pot. Kapniški stebri imajo na vrhu ozke vodoravne reže, ki jasno nakazujejo posedanja jamskega dna, ki se zaradi potresov ali spodjedanja občasno zniža, nastalo špranjo pa zapolni nova siga.

Severno od sigaste kope dno dvorane preide v podorni stožec. Ta je sestavljen iz grušča, ki je mestoma prekrit s sklenjenimi površinami sige. Pobočje podornega stožca se vzpenja pod kotom 20^o. Na skrajnem severo-vzhodnem delu dvorane, ki je najvišji, so jasne sledi podora pomešanega s prstjo, ki je v preteklosti zaprl jamske rove. Ta del je po meritvah le nekaj metrov oddaljen od površja; končuje se v plitvi vrtači, ki loči Veliko in Malo Pasico. Na skrajnem severo-zahodnem delu dvorane se jama zaključuje v ozki špranji, ki poteka v zahodni smeri; njeno dno je pokrito s sigo.

floor is covered by robust and sharp stones up to 30 cm in diameter. The crack ends in a narrow impassable channel, covered with flowstone, which carries the water away during heavy rain.

Five metres further is a dome of flowstone, filling the south-eastern part of the hall. There is the fourth permanent jet of water in the cave (hereafter named VP 4) falling from the ceiling, measuring about 1.7 m in height and surrounded by several smaller chimneys. Next to it is a wall with the signatures of the visitors. On the left side of the dome, facing east, are four columns, up to 1 m high and in shape of a baseball bat (Photo 16). Their bases are in a sinter pool which is a few centimetres deep and covers an area of 5 m^2. The bottom of the pool is covered with particles of charcoal, originating from the torch leftovers, used by visitors to light their way. On the top of each column is a narrow horizontal slit, clearly indicating of lowering of the cave bottom, as a result of the earthquakes and erosion; and the newlymade gap is filled with new flowstone.

North from the flowstone dome the floor of the cave continues in form of a collapsed dome. It is composed from gravel, partly covered with big chunks of flowstone. The slopes of the dome are inclined at 20^o angle. At the most distant north-eastern part of the hall, which is also the highest point, are visible remnants of the collapse, mixed with soil, which had filled the corridor. This site is, according to the measurements, only a few meters below the surface, ending in a shallow and wide doline, dividing the Velika Pasica cave from the Mala Pasica cave. At the most distant north-western part of the hall, the cave ends in narrow crack, facing west; its bottom covered by flowstone.

MATERIAL IN METODE

Podatki o zgodovini in obsegu raziskav v jami, zlasti s področja biologije, so bili zbrani s pomočjo podatkov iz literature, iz muzejskih zbirk, jamarskih zapisnikov in tudi ustnih virov.

Redne meritve ekoloških parametrov v jami so se pričele 8. maja 2006 in so obsegale meritve pretoka v štirih stalnih curkih (VP 1–VP 4) ter temperaturo prenikle vode in okoliškega zraka. Neprekinjeno so potekale do avgusta 2014, ko so bile začasno prekinjene zaradi okvare shranjevalnika podatkov (Foto 17a, b). Vsi merilni inštrumenti so bili od proizvajalca Delta-T Device Company (Velika Britanija). Vsako uro so merilci (senzorji) poslali v zapisovalec podatke o količini vode, ki je pritekla iz curka ter podatke o temperaturi

Foto 17a: Nameščanje shranjevalnika podatkov (data-logger) v jami Velika Pasica (na fotografiji: Davorin Tome) (fotografirano: 8. maja 2006) /Foto: A. Brancelj/.
Photo 17a: The installation of the data-logger in the Velika Pasica cave (On the photo: Davorin Tome) (Photo made on 8th May 2006) /Photo: A. Brancelj/.

MATERIAL AND METHODS

The information on the history and extent of the research in the cave, especially from the biological point of view, was collected from literature, from museum collections, the caving logs and signatures of visitors on the cave's walls.

The regular measurements of ecological parameters in the cave started on 8th May 2006 and included the measurements of the discharge in four permanent water jets (VP 1–VP 4) and the temperature of drip water as well as the surrounding air temperature. They ran continuously until August 2014, when they were stopped as a result of the damage on the data-logger (Photo 17a, b). All instruments were obtained from the Delta-T Device Company (Great Britain). Every hour the probes (*i.e.* sensors) would send information into the data-logger on the discharge of water and

Foto 17b: Prenašanje podatkov iz shranjevalnika podatkov (data-logger) (v ozadju) na prenosni računalnik (na fotografiji: Anton Brancelj) (fotografirano: 6. februarja 2013) /Foto D. Tome/.
Photo 17b: The data transmission from the data-logger (in the back) to the laptop (On the photo: Anton Brancelj) (Photo made on 6th February 2013) /Photo D. Tome/.

Foto 18: Merilec pretoka s filtrirnimi plastenkami na VP 2 v jami Velika Pasica /Foto: A. Brancelj/.
Photo 18: The discharge meter with filtering bottles at the measuring location VP 2 in the Velika Pasica cave /Photo: A. Brancelj/.

Foto 19: Jemanje vzorcev živalstva iz filtrirnih plastenk na VP 3 v jami Velika Pasica (na fotografiji: Anton Brancelj) (fotografirano: 6. februarja 2013) /Foto: D. Tome/.
Photo 19: Taking sample of the fauna from the filtering bottle at the measuring location VP 3 in the Velika Pasica cave (On the photo: Anton Brancelj) (Photo made on 6th February 2013) /Photo: D. Tome/.

vode in zraka. Pod vsak curek je bila pod kotom 45° nameščena plastična ponjava v izmeri 1,5 x 1,5 m z namenom, da se razpršene kapljice iz curkov ob večjih pretokih usmerijo natančno na ustje merilca pretoka.

Na izliv vsakega merilca pretoka (prirejen merilec padavin) (Foto 18) sta bili nameščeni po dve filtrirni plastenki z gosto mrežico (velikost okenc = 60 µm = 0.06 mm) (Brancelj, 2004), ki je v plastenki zadržala vse delce večje od 60 µm (Foto 19). Voda je s seboj iz epikrasa prinašala blato, pesek, drobne koščke lesa in listja, pa tudi kopenske in vodne živali, kar se je vse zadržalo v filtrirni plastenki. Ob vsakem obisku jame so bili ob nadzoru aparatur preneseni podatki iz zapisovalca podatkov na prenosni računalnik ter pobrani vzorci živali iz filtrirnih plastenk. Vsebina vsake filtrirne plastenke je bila že v jami prenesena v 150 mL plastenke, kjer so bili vzorci do nadaljnjega shranjeni v 60 % alkoholu.

the temperature of air and water. Beneath each permanent water jet was put a plastic screen, measuring 1.5 x 1.5 m in dimension, positioned under the 45° angle. The screen collected the dispersed drops from the water jets during a heavy rain and directed them into the opening of discharge meter (actually a rain gauge).

On the outlet of each discharge meter (Photo 18) were fixed two filtering bottles with fine mesh (mesh size = 60 µm = 0.06 mm) (Brancelj, 2004), retaining all particles larger than 60 µm in the bottle (Photo 19). The water had brough from the epikarst mud, sand, particles of wood and leaves, as well as some terrestrial and aquatic animals which were retained in the bottles. During every visit of the cave, the data from the data-logger was transferred to the computer and fauna was collected from the bottles as well. The contens of filtering bottle had been transferred into 150 mL plastic bottles with 60 % concentration of alcohol, already in the cave.

After three years of filtering the drip water, the plastic

Foto 20: S sigo in organskimi delci zamašene odprtine filtrirne mrežice po treh letih filtriranja prenikle vode v jami Velika Pasica (fotografirano: 8. januarja 2011) /Foto: A. Brancelj/.
Photo 20: The mesh nets clogged with speleothem and organic particles after three years of filtering drip water in the Velika Pasica cave (Photo made on 8th January 2011) / Photo: A. Brancelj/.

Foto 21: Vzorčevalnik za jemanje vzorcev prenikle vode v enournih razmikih za kemijske analize v jami Velika Pasica (fotografirano: 7. avgusta 2011) /Foto: A. Brancelj/.
Photo 21: The sampler for collecting water samples in one-hour intervals for chemical analyses in the Velika Pasica cave (Photo made on 7th August 2011) / Photo: A. Brancelj/.

Po približno treh letih filtriranja prenikle vode so bile plastične mrežice na filtrih že močno obložene s sigo (Foto 20). Zato je bilo potrebno plastenke odnesti v laboratorij, kjer se je sigo raztopilo s solno kislino (HCl) in se jih nato ponovno preneslo v jamo.

V laboratoriju so bili do višjih taksonomskih skupin določeni vsi organizmi iz filtrirnih plastenk, do vrst pa so bili določeni le predstavniki rakov iz skupin ceponožci (Copepoda) in dvoklopniki (Ostracoda). Pri skupini ceponožcev so bili za vsako vrsto določeni še: število osebkov, razvojni stadij, spol, razmnoževalni

mesh on each filtering bottle was coated with thick layer of flowstone (Photo 20). Therefore, the filtering bottles were transported to the laboratory, put in the hydrochloric acid (HCl) and then brought back to the cave.

In the laboratory most of organisms collected in the filtering bottles had been determined to higher taxonomic groups, except for the representatives of copepods (Copepoda) and ostracods (Ostracoda) which were determined to the species level. Each representative in the group of copepods was also determined by: the number of specimens, their development stage, sex, reproductive status (male and female

Foto 22: Meteorološka postaja blizu vhoda v jamo Velika Pasica (Na potografiji: Davorin Tome)/Foto: A. Brancelj/.
Photo 22: The meteorological station near the entrance into the Velika Pasica cave (On the photo: Davorin Tome)/Photo: A. Brancelj/.

stadij (samec in samica v paru, samice s pritrjenim paketom spermijev oziroma spermatoforjem, samice z jajci).

V obdobju od 8. maja 2006 do 24. oktobra 2013 je bilo pobranih 88 nizov podatkov o živalstvu ter 65.410 zapisov o urnih pretokih ter temperaturi prenikle vode in okoliškega zraka za vsakega od štirih curkov.

Občasno so bili odvzeti tudi vzorci prenikle vode za kemijske analize. Ti so bili naključno pobirani v različnih sezonah v vseh curkih naenkrat, da bi se ugotovilo morebitne razlike v kemijski sestavi vode. Na dveh curkih (VP 1 in VP2) so bili nekajkrat opravljeni tudi intenzivnejši odvzemi vode in sicer vsako uro. Prvi vzorec je bil odvzet tik pred začetkom močnejših neviht (z upanjem, da je vremenska napoved pravilna!). Jemanje vzorcev je trajalo navadno 48 ur, tako da je dež že ponehal. Za tako odvzemanje je bil narejen poseben vzorčevalnik (Foto 21), ki je omogočal zajem vode vsako uro, saj bi bilo delo z ljudmi v jami drago, nepotrebno in mučno opravilo. Namen teh vzorčenj je bil, da se ugotovi, ali se kemijska sestava vodnega curka spreminja glede na padavine oziroma intenzivnost pretoka.

V laboratoriju je bil za vsak vzorec izmerjen pH in električna prevodnost. V vzorcih, kjer so bili ugotovljeni večji preskoki električne prevodnosti, je bila s

in couple, females with attached spermatophores, ovigerous females = females with attached eggs).

From 8th May 2006 to 24th October 2013, 88 sets of fauna samples were collected and 65,410 records were made on hourly discharge, the temperature of the drip water and the temperature of the surrounding air for each of the four permanent water jets.

Occasional samples of drip water were taken for chemical analyses. The samples were collected randomly in different seasons, though simultaneously in all four permanent water jets to detect potential differences in chemical composition of water. The samples on the water jets VP 1 and VP 2 were taken on several occasions with higher intensity, *i.e.* on every hour. The first sample was taken just before a strong storm (in hope of the weather forecast had been correct). The intensive sampling period usually lasted up to 48 hours, therefore the rain had already stopped. A special sampler was constructed for this kind of sampling (Photo 21), which enabled the sampling of water in one-hour intervals, as man-work in the cave would have been an expensive, unnecessary and a troublesome task. The aim of this kind of sampling was to find, if chemical composition of the drip water changes according to the precipitation and intensity of discharge.

Each sample was measured in the laboratory for pH and electric conductivity. In the samples where significant pomočjo ionskega kromatografa (Methrom 761 Compact IC) podrobneje analizirana kemijska sestava raztopljenih snovi, in sicer: natrij (Na^+), kalij (K^+), kalcij (Ca^{2+}), magnezij (Mg^{2+}), amonij (NH_4^+), klor (Cl^-), nitrat (NO_3^-) in sulfat (SO_4^{2-}). Na podlagi teh podatkov je bila kasneje izračunana tudi koncentracija hidrogen-karbonata (HCO_3^-).

Poleg štirih merilnih mest v jami je bila v bližini vhoda postavljena še zunanja meteorološka postaja enakega tipa kot tista v jami (Foto 22). Ta postaja je bila nameščena 90 m vzhodno-severo-vzhodno (smer 61º) od vhoda v jamo, okoli 20 m severo-severo-zahodno od hiše Pavle Janežič (Gornji Ig, 12). Na posnetkih "Google Earth" z dne 30. marca 2014 je meteorološka postaja videti kot malo svetlejša pika s koordinatami 45º 55' 09,42'' S in 14º 29' 38,8'' V, 655 m nadmorske višine. V meteorološki postaji so bili nameščeni instrumenti za meritve padavin, temperature zraka, relativne vlažnosti ter vlažnosti prsti na dveh globinah (-10 in -20 cm). Zunanja meteorološka postaja je bila postavljena leto dni kasneje kot instrumenti v jami in je bila vmes približno eno leto tudi izključena. Med delovanjem so bile ure med obema shranjevalnikoma podatkov usklajene, tako da so se istočasno zapisovale vrednosti merjenih parametrov tako v jami kot tudi na površini. Namen meritev je bil, da se poveže količino padavin s pretokom curkov v jami in sicer tako v količini padavin in pretoku kot tudi v zamiku med začetkom padavin in povečanim pretokom curkov v jami.

changes in electric conductivity were detected, detailed additional analyses were made with the ion chromatograph (Methrom 761 Compact IC) which enabled a detailed analysis of a chemical composition of dissolved content of: sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), ammonium (NH_4^+), chloride (Cl^-), nitrate (NO_3^-) and sulphate (SO_4^{2-}). Based on these results, the concentration of hydrogen-carbonate (HCO_3^-) was calculated afterwards.

Besides measuring locations in the cave, a meteorological station was set on the surface, close to the entrance to the cave, and of the same label (Photo 22). The station was set 90 m east-north-east (direction 61º) from the entrance to the cave and about 20 m north-north-west from the Mrs. Pavla Janežič's house (Gornji Ig, 12). The meteorological station on the images from "Google Earth," which were taken on 30th March 2014, resembles a light spot with coordinates 45º 55' 09.42'' N, 14º 29' 38.8'' E, 655 m above the sea level. The sensors for measuring precipitation (rain gauge), air temperature, relative humidity and soil moisture on two depths (-10 in -20 cm) were put up in the meteorological station. However, the outside meteorological station was put up one year later. It must be noted that during the measuring, it was one year turned off. During the whole operational period, both the clocks in the stations were synchronised, thus recording the values of the measured parametres in the cave as well as on the surface simultaneously. The aim of the measurements was to link the amount of precipitation with the discharge of the water jets, both in terms of the quantity of precipitation and discharge as well as in the length of the lag phase between the start of the precipitation and the increase of the discharge in the cave.

REZULTATI IN RAZPRAVA

ZGODOVINSKI PREGLED RAZISKAV

Jama Velika Pasica je bila domačinom verjetno poznana že od vsega začetka osnovanja naselja Gornji Ig, saj se je nahajala v neposredni bližini vasi. Osnovanje vasi lahko datiramo v obdobje nekoliko pred gradnjo vaške cerkve, ki je bila tam najverjetneje postavljena, ko je imela vas dovolj prebivalcev. V kroniki župnije Ig je navedeno, da je bila cerkvica sv. Lenarta na Gornjem Igu prvič omenjena leta 1498, v obdobju drugih intenzivnih turških vpadov na slovenskem ozemlju (med letoma 1498 in 1500) (http 2). Iz tega lahko sklepamo, da je naselje Gornji Ig staro več kot 520 let. Po nekaterih nepreverjenih podatkih pa naj bi bilo naselje prvič omenjeno v zapiskih že okoli leta 1300 (http 2) in je morda tako tudi vedenje o jami v neposredni bližini vasi še starejše.

Večina lokalnih pisnih virov, med njimi najbrž tudi tisti o jami, ki so jih hranili lokalni prebivalci, nato pa bližnje šole in cerkve, so pogoreli med 2. svetovno vojno, ko je bilo v času italijanskih ofenziv celotno območje požgano. Pisnih virov o jami in o raziskavah v njej je danes malo, delijo pa se na štiri skupine: članki v znanstveni in strokovni literaturi, zapisi v zbirkah živali nabranih v jami, zapisniki jamskih ogledov ter podpisi obiskovalcev na stenah v jami.

V prvo skupino podatkov o obiskih jame spadajo **znanstveni opisi živali**, ki so jih našli v jami (podrobnosti o vrstah so v naslednjem poglavju). Na podlagi teh opisov je gotovo, da je Veliko Pasico okoli leta 1850 obiskal Ferdinand Schmidt, ki je znan po tem, da je po primerkih iz Postojnske jame opisal prvega jamskega hrošča (Coleoptera) na svetu, ki nosi ime *Leptodirus hochenwartii* Schmidt 1832 (drobnovratnik). Iz Velike

RESULTS AND DISCUSSION

THE HYSTORICAL OVERVIEW OF THE RESEARCH

The Velika Pasica cave has probably been known to the villagers of Gornji Ig since the foundation of the settlement as it is located next to the village. The establishment of the village dates sometime before the construction of the local church, which was probably constructed when the population was big enough. In the chronicle of the Ig parish is indicated, that the St. Lenart at Gornji Ig church was mentioned in 1498 for the first time, during the second period of the intensive Ottoman invasion in the area of the contemporary Slovenia, between the years 1498 and 1500 (http 2). Therefore, it can be concluded that the village is more than 520 years old. Based on some unverified information, the village was actually mentioned for the first time in the records around 1300 (http2) and consequently, the knowledge of the cave in the immediate vicinity of the village is actually older.

Most of the records, including those of the cave, were either kept by the locals or stored in the nearby churches or schools, had been lost in fires during the World War II, as a result of the Italian attack to the entire area. The records on the cave and research conducted in it are scarce, though, but could be grouped into four sources: articles in scientific and professional literature, records in museum collections from the cave, caving logs and signatures of the visitors on the cave's walls.

As mentioned before, in the first group are **scientific descriptions of the animals** found in the cave (the details on the species are in the next chapter). Based on this source it can be ascertained that around 1850, the Velika Pasica cave was visited by Ferdinand Schmidt, a man renowned for describing the first cave dwelling beetle (Coleoptera) named *Leptodirus hochenwartii* Schmidt 1832 whose specimens were collected in the Postojnska Jama cave in Slovenia. He brought

Pasice je ob obisku prinesel nepoznane jamske hrošče, ki so bili kasneje opisani kot nova vrsta. Tja se je vrnil vsaj še leta 1854, ko je jamo obiskal skupaj z Georgom Frauenfeldom in je potem leta 1855 ter 1860 iz jame opisal še eno vrsto in eno podvrsto hroščev (Tabela 2; Pretner, 1974; Vrezec in Kapla, v tisku).

Jamo je 20. aprila 1854 obiskal tajnik botanično--zoološkega društva iz Trsta Georg Frauenfeld, ki je bil tudi priznan strokovnjak za polže (Gastropoda). Za nekaj dni se je na poti v Dalmacijo ustavil v Ljubljani pri prijatelju Ferdinandu Schmidtu in v njegovi družbi obiskal tri jame v okolici: Matjaževo jamo pod Šmarno goro, Veliko Pasico na Gornjem Igu ter Skednenco na Mokrcu (Aljančič, 1994). Približno v istem obdobju (1854 in 1856) je iz Velike Pasice opisal dve vrsti jamskih polžev iz rodu *Zospeum* (takrat rod *Carychium*), ki mu jih je (verjetno) že prej poslal F. Schmidt.

Šele okoli 70 let kasneje je bila iz jame opisana naslednja kopenska žival in sicer paščipalec (Pseudoscorpiones) (Gardini, 2014). Edini primerek iz jame je verjetno vzel A. Hadži ob obisku in registraciji jame leta 1927 (DZRJL-1, 1927a).

Niz opisov novih vrst iz jame v prvi polovici 20. stoletja zaključuje opis nove vrste dvojnonoge (Diplopoda), katere osebke je v jami nabral Egon Pretner in jih poslal v določanje specialistu Karlu Strasserju v Trst (DZRJL-2, 1934a).

Sledi daljše obdobje, ko so raziskovalci, zlasti biologi, jamo sicer obiskovali, vendar o njihovih obiskih lahko sklepamo le na podlagi **nabranih vzorcev, ki se hranijo v muzejski zbirki** Prirodoslovnega muzeja Slovenije, Inštituta za raziskovanje krasa v Postojni ali v zasebnih zbirkah. Po navedbah Vrezca in Kaple (v tisku) so bile "najbolj intenzivne raziskave v začetku 20. stoletja, ko je zlasti Veliko Pasico obiskala vrsta takrat uglednih raziskovalcev hroščev in speleobiologov, denimo Alfonz Gspan, Roman Kenk, Ljudevit Kuščer, Giuseppe Müller, Egon Pretner, Albin Seliškar in Jožef Staudacher".

Edini znani eksponat v Prirodoslovnem muzeju Slovenije o sesalcih iz te jame je lobanja malega podkovnjaka (kat. št. 710), ki jo je okoli l. 1976 (datum ni zapisan) prinesel avtor te knjige (Boris Kryštufek, ustni vir).

Jama se je ponovno pojavila v znanstveni literaturi šele po letu 2000, ko so se začele raziskave vodnega

a few specimens of unknown species of cave-dwelling beetle from the Velika Pasica cave, and were later described as a new species. He visited the cave again in 1854 in the company of Georg Frauenfeld, describing one more cave-dwelling species and one sub-species of the beetles in 1855 and 1860 (Table 2; Pretner, 1974; Vrezec and Kapla, in print).

Georg Frauenfeld, a secretary of botanical-zoological association from Trieste, a well known specialist for snails (Gastropoda) visited the cave on 20th April 1854. He made a short stop in Ljubljana during his journey to Dalmatia, visiting his friend Ferdinand Schmidt. They visited three caves near Ljubljana: Matjaževa Jama near the Mt. Šmarna Gora, Velika Pasica at the Gornji Ig village and Skednenca on the Mt. Mokrc (Aljančič, 1994). In about the same period, from 1854 to 1856, he described two new species of snails from the genus *Zospeum* (at that time known as *Carychium*) from the Velika Pasica cave, which had probably been sent to him by F. Schmidt.

Only seventy years later, another terrestrial species was described from the cave, belonging to the pseudoscorpions (Pseudoscorpiones) (Gardini, 2014). The only specimen from the cave was probably collected by A. Hadži during his visit and registration of the cave in 1927 (DZRJL-1, 1927a).

The list of the description of a new species from the cave in the first half of 20th century concludes the description of a new species of millipedes (Diplopoda). The specimens were collected in the cave by Egon Pretner who sent them to the specialist Karl Strasser in Trieste (DZRJL-2, 1934a), in order for a species to be determined.

In the following period, the researchers, especially biologists, had been visiting the cave, however the information on their visits could only be obtained from **samples, deposited in the museums' collections** of the Slovenian Natural History Museum, the Karst Research Institute in Postojna or private collections. According to Vrezec and Kapla (in print), it was "the most intensive research done at the beginning of 20th century, when the Velika Pasica cave in particular, was visited by a number of respected beetle researchers and speleobiologists, such as Alfonz Gspan, Roman Kenk, Ljudevit Kuščer, Giuseppe Müller, Egon Pretner, Albin Seliškar in Jožef Staudacher".

The only known exhibit in the Slovenian Museum of Natural History on the mammals from the cave is a skull of lesser horseshoe bat (Cat. No. 710). It was collected by the author of this book around 1976 (exact date is not known) (Boris Kryštufek, personal communication).

živalstva, natančneje ceponožnih rakov (Copepoda), in je bilo o tem objavljenih več **strokovnih in znanstvenih člankov**. Raziskave so obsegale opise novih vrst, njihovo razširjenost ter ekološke in hidrološke značilnosti jame (Brancelj, 2000, 2002, 2009, 2011, Wei Liu in Brancelj, 2011, 2013, 2014; Wei Liu in sod., 2014). Med najbolj poglobljenimi študijami hidrologije in ekologije jame vsekakor spada doktorat, ki ga je opravil kitajski študent Allen Liu Wei pod mentorstvom avtorja knjižice (Wei Liu, 2014). Poleg znanstvenih člankov je bilo objavljenih nekaj poljudnih člankov o raziskavah v jami in tudi predavanja za širšo javnost (Brancelj in Vrezec, 2006; Brancelj, 2012; svetovni splet: http 1,3–5: – geslo Velika Pasica).

Naslednji vir podatkov o raziskavah so **jamarski zapisniki** o obiskih jame. V katastru Društva za raziskovanje jam Ljubljana (DZRJL), ki je najstarejše jamarsko društvo v Sloveniji, je shranjena večina starejših zapisnikov o obisku Velike Pasice. Zapisnik, s katerim so uradno dokumentirali jamo, nosi zaporedno številko 95, medtem ko je jama dobila zaporedno številko 75. Zapisnik je bil narejen 15. maja 1927 (DZRJL-1, 1927a) (Slika 8). Jama je bila zavedena ob registraciji kot "VELIKA PASICA pri Zgornjem Igu" in ne kot Velika Pasjica kot se kasneje nekajkrat pojavi v jamarskih zapisnikih ali literaturi. Udeleženci ekskurzije so bili člani "Društva za raziskavanje podzemnih jam v Ljubljani", kot se je današnje Društvo za raziskovanje jam Ljubljana imenovalo od ustanovitve do konca 2. svetovne vojne (Primož Presetnik, osebni podatek). Udeleženci ekskurzije so bili E. (Evgenija) Gorskij, Vs. (Vsevolod) Gorskij, A. Hadži, R. (Roman) Kenk, M. Klemenčič, R. Klemenčič in A. Nučič. Načrt jame je naredil inženir Vs. Gorskij, medtem ko je bil zapisnikar R. Kenk.

Istega dne so registrirali tudi jamo Mala Pasica (št. zapisnika 96 in zaporedna številka jame 76). Kot udeleženci ekskurzije v Malo Pasico so navedeni Č. Gorskij (*ne E. Gorskij – op. avtorja*), Vs. Gorskij, A. Hadži, Roman Kenk in A. Nučič. Načrt jame je tudi v tem primeru naredil Vs. Gorskij, medtem ko je bil zapisnikar ponovno Roman Kenk (DZRJL-1, 1927b).

Poleg opisa dostopa, opisa in načrta obeh jam so v rubrikah "Hidrologija" in "Meteorologija" za Veliko Pasico navedli temperaturo vode (7,4 oziroma 7,7 °C) in zraka (7,8 °C), v rubriki "Biologija" pa so navedli

The cave was mentioned again in scientific literature after 2000, when research on aquatic fauna, particularly copepods (Copepoda), had started and several **scientific and professional papers** were published. The research included the description of new species, their distribution and ecological and hydrological characteristics of the cave (Brancelj, 2000, 2002, 2009, 2011; Wei Liu and Brancelj, 2011, 2013, 2014; Wei Liu et al., 2014). Among one of the most in-depth studies in the field of hydrology and ecology of the cave, is a PhD thesis written by the Chinese student Allen Liu Wei, under the mentorship of the author of this book (Wei Liu, 2014). Besides the scientific papers, several popular scientific ones were published on the on-going research activities in the cave, as well as open lectures (Brancelj and Vrezec, 2006; Brancelj, 2012; World Wide Web: http 1, 3–5: – entry: Velika Pasica).

The next kind of records on the research activities and the visits of the cave are **caving logs**. In the cadastre of the Society for Cave Exploration Ljubljana (Slov. *DZRJL*), which is the oldest caving society in Slovenia, are kept records of most of old caving logs on the visits to the Velika Pasica cave. The caving log of the official documentation of the cave was registered under number 95, while the cave got a cadastrial registration number (Cad. No.) 75. The log was written on 15th May 1927 (DZRJL-1, 1927a) (Figure 8). The cave was officially registered as "VELIKA PASICA pri Zgornjem Igu"' and not as "Velika Pasjica" as it had been reported later in several caving logs or papers. The participants of the first official excursion were the members of the former Ljubljana Underground Cave Exploration Society (Slov. *Društvo za raziskavanje podzemnih jam v Ljubljani)*, which was later renamed into the Society for Cave Exploration Ljubljana (Slov. *Društvo za raziskovanje jam Ljubljana*) at the end of the World War II (Primož Presetnik, personal communication). The members of the excursion were E. (Evgenija) Gorskij, Vs. (Vsevolod) Gorskij, A. Hadži, R. (Roman) Kenk, M. Klemenčič, R. Klemenčič and A. Nučič. The plan of the cave was made by an engineer, Vs. Gorskij, and the caving log was written by R. Kenk.

On the same day, the Mala Pasica cave was also registered (caving log No. 96 and Cad. No. 76). As members of the expedition to the Mala Pasica cave were reported Č. Gorskij (not *E. Gorskij – author's comment*), Vs. Gorskij, A. Hadži, R. Kenk and A. Nučič. The plan of the cave was made by Vs. Gorskij and the caving log was written by R. Kenk (DZRJL-1, 1927b).

Št. eksk.: 95.

Št. jame: 75.

V E L I K A   P A S I C A pri Zgornjem Igu

Datum obiska: 15. V. 1927.

I. Ime jame: " Velika pasica"

II. Topografija:

1.) Politična lega: politični okraj:

politična občina:

katastralna občina:

katast. parcel. štev.:

sedanji posestnik:

2.) Oro-hidrografska lega: Jama leži n SE pobočju grima

3.) Pristop do jame: Dostop z želez. postaje Škofljica slabe 3 ure preko vasi Studenec. Iška vas in Zgornji Ig. Jama se nahaja kake 3 minute nad vodnim rezerovarjem Zgornjega Iga in je v vasi dobro znana. Dostopna je brez posebne opreme.

4.) Višina vhoda:

III. Geologija:

1.) geološka formacija, značaj hribin:

2.) destrukcija:

Slika 8: Kopija zapisnika in načrta jame ob registraciji Velike Pasice 15. maja 1927.

Figure 8: The facsimile of the caving log and the cave plan at the registration of the Velika Pasica cave on 15th May 1927.

IV. Morfologija:

1.) **Tloris in profili:**

Tloris v prilogi.

2.) **Morfološki opis jame in bližnje okolice:** Vhod je na dnu strmega lijaka, je ozek in nizek in vodi strmo (nogromadenem gruščü) navzdol. jama sestoji iz štirih glavnih oddelkov (A,B,C in D) in dveh manjših rovov, ki izhajata iz odd. B (rov E) in C (rov F) (glej Tloris!) Tudi ima več ožjih kaminov. Stene so večinoma zasigane, tudi so v jami številne kapniške tvorbe, posebno stebri. V začetnem delu oddelka B je lep most izs sige, na katerem stoji širok stalagmit (glej fotogr. sliko). Dno tvorijo v oddelku "A" nagromadene skale in prst (ob desni strani tudi ilovica), v ostalih oddelkih mestom siga, ilovica, le tu pa tam manjše skale in kamenje.

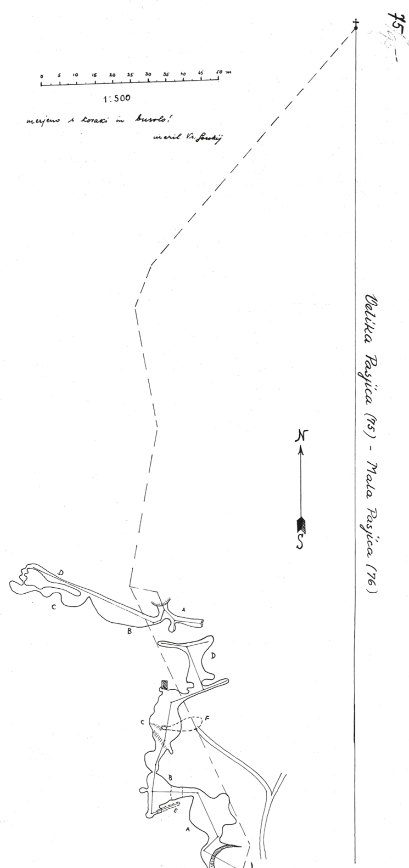
V. Hidrografija:

1.) Na več mestih se nahajajo plitvi tolmuni, ponekod s stenami iz sige. Temperatura vode v oddelku "B" $7.4^{o}C$, v nekem tolmunu v oddelku "C" ali "D" $7.7^{o}C$.
2.) Stene so večinoma mokre, ponekod kaka s stropa.

VI. Meteorologija:

1.) Temperatura zraka v odd. B $7.8^{o}C$
2.) Vlažnost " " " " 100% (lasni higrometer)
5.) Svetloba prodira v odd. "A"

VII. Paleobiologija (fosilni ostanki):



IX. Biologija:

V oddelku "A" leži mnogo strohnelega lesa.
Nabraliismo sledeči materijal: Titanethes, Niphargus (v tolmunu v odd. C ali D), Diplopoda (tudi pred jamo), Areneida na stenah), Lipura (posebno na gladini tolmunov), Collembola, Troglophilus (tudi pred jamo), Trichoptera (na steni v odd.A), Coleoptera (pod kamni v A in B), Diptera (na steni), Zospeum (na vlažni steni).
Iz ilovice izprano : Lipura, Opbismum, Gastropoda.

X. Jama in človek:

Udeleženci ekskurzije: E.Gorskij, Vs. Gorskij, A.Hadži, R.Kenk, M.Klemenčič, R.Klemenčič, A.Nučič.

Skice risal: Tloris (meril in ris. Ing.Vs.Gorskij)

Fotografije: Most iz sige v odd. "B" (10 x 15 cm fot. R.Kenk)

Biološki materijal: Isopoda, Amphipoda, Araneida, Pseudoscorpionidea, Myirapoda, Apterygogenea, Orthoptera, Trichoptera, Diptera, Coleoptera, Gastropoda.

Podpis zapisnikarja:

R. Kenk

vrsto kopenskih in vodnih živali (podrobneje o tem v poglavju o biodiverziteti kopenskega in vodnega živalstva).

Naslednja zapisnika je naredil svetovno priznani raziskovalec jamskih hroščev Egon Pretner, ki je jamo obiskal 25. februarja in 11. marca 1934. V rubriki "Biologija" je navedel več vrst hroščev in omenil, da je nekaj materiala poslal še strokovnjaku za dvojnonoge (Karlu Strasserju v Trst) ter drugemu za polže (Ljudevitu Kuščerju v Ljubljano) (DZRJL-2, 1934a). Istočasno je obiskal tudi Malo Pasico (DZRJL-2, 1934b). Le malo kasneje, 26. avgusta 1934, je jamo obiskal Fran Slokan in napisal zelo čustven opis jame (DZRJL-3, 1934). Jamo je Egon Pretner ponovno obiskal 10. julija in 26. julija 1935 in navedel podobne vrste živali kot ob prvem obisku (DZRJL-4, 1935). Jamo je kmalu po 2. svetovni vojni (6. januarja in 17. februarja 1946) obiskal še tretjič in navedel podobne vrste živali kot pri predhodnih obiskih. Omenil je tudi, da je bila vas ob obeh obiskih popolnoma prazna, hiše pa povsem porušene (DZRJL-6, 1946).

Primernost jame za vojaške namene so tik pred začetkom 2. svetovne vojne preverjali (Franci ml.) Bar, (?) Hafner in (Alfred) Šerko, ki so jamo obiskali 25. junija 1939 (DZRJL-5, 1939a). Pri tem so naredili še nekaj črno-belih posnetkov in sicer skupino vaških otrok pri vodnem zbiralniku (med njimi je tudi avtorjev oče), vhod v Veliko Pasico ter tri posnetke notranjosti; na slednjih je kapniški steber, ob katerem so na eni sliki tudi otroci. Istega dne so obiskali tudi Malo Pasico (DZRJL-5, 1939b).

V začetku leta 1972 (30. januarja in 20. februarja 1972) so jamo obiskali Nace Sivec, Rado Smerdu in še štirje neimenovani biologi, ki so nabirali hrošče in druge živali (DZRJL-7, 1972).

Novi načrti jame Velika Pasica so bili narejeni 12. julija 1975, pri čemer so sodelovali Marko Jurečič, Alenka Terlep in Staško Otorepec (DZRJL-8, 1975). Nekaj kasneje, 8. februarja 1976, pa sta naredila nov načrt Male Pasice Jure Jakofčič in Anton Brancelj, kjer je zapis, da je pri vhodu v notranje brezno "zanimiva breča iz grušča in kosti, pomešanega z ilovico" (DZRJL-9, 1976).

Zanimiv vir podatkov o obiskovalcih jame so **podpisi**, ki se nahajajo na steni manjše niše v končni dvorani, to je blizu VP 4. Del stene je razmeroma suh in

Besides describing of the access to the cave, its interior and the plan of both caves, the notes mention measuring the water temperature (7.4 and 7.7 °C) and air temperature (7.8 °C) in the "Hydrology and Meteorology" section. In the "Biology" section, several terrestrial and aquatic animals were recorded (more on this topic is in the chapter on biodiversity of the terrestrial and aquatic fauna).

The next caving logs were made by world-renowned specialist for cave-dwelling beetles, Egon Pretner, who visited the cave on 25th February and 11th March 1934. In the "Biology" section, he listed several beetle species, and he mentioned that some additional material was sent to a millipede specialist, Karl Strasser from Trieste, and to a snail specialist, Ljudevit Kuščer, from Ljubljana (DZRJL-2, 1934a). He also made a visit to the Mala Pasica cave (DZRJL-2, 1934b). A few months later, on 26th August 1934, the cave was visited by Fran Slokan who wrote quite an emotional record of the cave (DZRJL-3, 1934). Egon Pretner revisited the cave on 10th and 26th July 1935 and listed similar beetle fauna as had been recorded during his first visit (DZRJL-4, 1935). He visited the cave for the third time soon after the end of World War II (6th January and 17th February 1946) and again recorded similar beetle species. He also mentioned in his records that there were no people in the village as the houses had been completely destroyed (DZRJL-6, 1946).

The potential use of the cave for military purposes had been observed just before World War II by (Franci jun.) Bar, (?) Hafner and (Alfred) Šerko, who visited the cave on 25th June 1939 (DZRJL-5, 1939a). During their visit they made several black and white photos, including of a group of children at the water reservoir, one of them was the author's father, of the entrance into the cave Velika Pasica and three more of its interior; the latter included a big column besides which were also the children. The Mala Pasica cave was visited on the same day, as well (DZRJL-5, 1939b).

At the beginning of 1972, on 30th January and 20th February 1972, to be exact, the cave was visited by Nace Sivec, Rado Smerdu and four additional biologists, who had collected beetles and other animals (DZRJL-7, 1972).

A new plan of the Velika Pasica cave was made on 12th July 1975 by Marko Jurečič, Alenka Terlep and Staško Otorepec (DZRJL-8, 1975). A few months later, on 8th February 1976, the new plan for the Mala Pasica cave was made by Jure Jakofčič and Anton Brancelj. In the caving log they recorded, that there is "an interesting breccia from stones raven. Na tem mestu se je podpisalo veliko obiskovalcev, tako da je vseh podpisov več kot 60. Nekateri so zaradi vlage že močno poškodovani ali celo nečitljivi. Med njimi jih je osem dobro ohranjenih iz 19. stoletja. Najstarejši je napis "I. Virant 1841", pri čemer je številka 4 nekoliko poškodovana in bi lahko bila tudi 6. Sledijo podpisi "N. Hoffman 1861", "F. Slana 10/6 1862" ter "Zd. Zupančič 1862". Naslednji napis po starosti je "Šemi Jože 6/8 84" (mišljeno je 1884), sledijo pa mu še "Josip Zelnik 6/8 1888", "Julij Čuk 1890" ter "naducitelj Trošt 1890" (ali 1896) (Foto 23). Podpis "N. Hoffman" se pojavi tudi v vhodni dvorani tik nad rovom zapolnjenim s konglomeratom, in sicer ima letnico 1886 (lahko tudi 1880). Poleg tega je levo spodaj zapisano še "96" (1896), kar nakazuje, da je bil morda N. Hoffman v jami vsaj trikrat.

Ostali podpisi so iz 20. stoletja. Zadnji in edini znani napis iz 21. stoletja je bil zapisan leta 2004.

V jami je bilo okoli leta 1976 narejenih tudi nekaj filmskih posnetkov o delu jamarjev in jamskih biologov (speleobiologov), ki jih je naredil biolog Rado Smerdu in njegovi poklicni in jamarski prijatelji, a zaradi njegove prezgodnje smrti leta 1984 film ni bil dokončan (Mojmir Štangelj, ustni vir; Anton Brancelj, osebno).

JAMA KOT TIPSKO NAHAJALIŠČE (*LOCUS TYPICUS*)

Jama je z vidika biologije postala svetovno znana večkrat, saj so v jami našli več vrst jamskih živali, ki so bile opisane prav po primerkih iz te jame (Tabela 2). Pravzaprav je le malo jam, iz katerih bi bilo opisanih toliko novih vrst za znanost. Podatek je še toliko bolj osupljiv, če ga pogledamo z vidika velikosti jame. V tej kategoriji sega v sam svetovni vrh, saj je bila na vsakih nekaj metrov jamskih rovov opisana nova vrsta. V biologiji oziroma ožje v taksonomiji (veda, ki se ukvarja z razvrščanjem organizmov v urejene preglednice) imajo taka mesta naziv "tipsko nahajališče - *locus typicus*". Osebki s teh nahajališč so nekakšni "prototipi" oziroma "patenti" svoje vrste, s katerimi se primerjajo drugi podobni osebki, kadar se bodisi opisuje nova vrsta ali le ugotavlja razširjenost določene vrste. Eden od osebkov s tipskega nahajališča dobi ob opisu nove vrste oznako

and bones mixed with clay" near the entrance to the inner shaft (DZRJL-9, 1976).

Another interesting source of information on the visitors of the cave are the **signatures** on the wall in a small niche in the last hall, next to the VP 4. This part of the wall is relatively dry and smooth, bearing many signatures by visitors, in total more than 60. However, some of them have been damaged or have become illegible due to humidity, some, however, are well preserved, eight of them dating back to the 19th century. The oldest one is by "I. Virant 1841," where number 4 had been slightly damaged and could be read as 6. It is followed by "N. Hoffman 1861," "F. Slana 10/6 1862" and "Zd. Zupančič 1862". The next is "Šemi Jože 6/8 84" (meant as 1884) followed by "Josip Zelnik 6/8 1888," "Julij Čuk 1890" and "naducitelj Trošt 1890" (or 1896) (Photo 23). The signature "N. Hoffman" could be seen also in the entrance hall, right above the corridor filled with conglomerate and is dated with 1886 (could be, however, also read as 1880). Next to the signature is another number, "96" (could be read as 1896), indicating that N. Hoffman might have visited the cave at least three times.

Other signatures are from 20th century. The last one and the only one recorded from 21st century is dating back into 2004.

Around 1976, a few short movie clips were made on work of cavers and speleobiologists in the cave, filmed by a biologist, Rado Smerdu, and his fellow-biologists and cavers. Unfortunately, his work was not finished due to the authors unexpected death in 1984 (Mojmir Štangelj, personal communication; author, personally).

THE CAVE AS TYPE LOCALITY (*LOCUS TYPICUS*)

From the biological point of view, the cave has become world renowned quite a few times, as several new species were found there, which were described after the specimens had been collected from it (Table 2). There are not many caves with as many records of the new species for science as in the Velika Pasica. In reference to the size of the cave, the information is even more astonishing. In this category it probably holds the world record as a new species had been described on every few metres. In biology, precisely in taxonomy (the science which groups organisms into categories) such places have a name "type locality - *locus typicus*". The specimens

Foto 23: Podpisi obiskovalcev na steni v zadnji dvorani v jami Velika Pasica (fotografirano: 28. decembra 2013) /Foto: A. Brancelj/.
Photo 23: The signatures of the visitors on the wall in the back hall of the Velika Pasica cave (Photo made on 28th December 2013) /Photo: A. Brancelj/.

"*holotip*"; to je osebek, po katerem je nova vrsta praviloma opisana. Drugi osebki iste vrste z iste ali bližnje lokacije, ki so vključeni v prvi opis vrste, dobijo oznako "*paratip(i)*".

Prvič je bila jama vpisana na seznam tipskih nahajališč med letoma 1853 in 1860, ko so v njej našli pet vrst in podvrst jamskih hroščev (Coleoptera) ter dve

collected from such places are a "prototype" or "patent" of their kind and are compared to other similar specimens, when a new species is described or a population of species is ascertained. A selected specimen from the type locality is during description of the new species named "*holotype*;" after which the new species is described. Other specimens of the same kind, collected from the same or nearby location, vrsti jamskih polžev (Gastropoda) iz skupine pljučarjev, ki so bili novi za znanost in jih tudi znanstveno opisali.

Prvi na seznamu novih vrst je *Anophthalmus hirtus* Sturm 1853 (dlakavi brezokec) (Foto 24a, b, c), sledijo pa mu *Typhlotrechus bilimeki hacqueti* Sturm 1853, *Aphaobius milleri* Schmidt 1855, *Bythoxenus subterraneus* Motschulsky 1859 in *Anophthalmus schmidti motschulskyi* Schmidt 1860 (Pretner, 1974; Tabela 2).

V istem obdobju so v jami odkrili tudi jamske polže pljučarje (Pulmonata) iz rodu *Zospeum* Bourguignat 1856, ki se zadržujejo na vlažnih oziroma z vodo prepojenih predelih in so značilni za severo-zahodni del Dinarskega krasa. Iz jame sta bili opisani vrsti *Zospeum spelaeum schmidti* (Frauenfeld 1854) (Foto 25a, b) ter *Zospeum amoenum* (Frauenfeld 1856) (Bole, 1974; Rajko Slapnik, osebni podatek). Obe vrsti sta bili v originalu opisani pod rodovnim imenom *Carychium* (Frauenfeld, 1854, 1856).

Naslednja kopenska žival, opisana po treh primerkih iz jam, je predstavnik paščipalcev (Pseudoscorpiones) in sicer vrsta *Chthonius raridentatus* Hadži 1930 (Hadži, 1930; Gardini, 2014). En primerek iz jame, v

and are included into description of the new species, are named "*paratype(s)*".

The cave was first put on the list of type localities between 1853 and 1860, when five species and sub-species of cave-dwelling beetles (Coleoptera) and two species of cave-dwelling snails (Gastropoda) were found, all of them new to science and were later scientifically described.

The first one on the list of new species was *Anophthalmus hirtus* Sturm 1853 (hairy eyeless) (Photo 24a, b, c), followed by *Typhlotrechus bilimeki hacqueti* Sturm 1853, *Aphaobius milleri* Schmidt 1855, *Bythoxenus subterraneus* Motschulsky 1859 and *Anophthalmus schmidti motschulskyi* Schmidt 1860 (Pretner, 1974; Table 2).

Foto 24a, b, c: Endemična vrsta hrošča (Coleoptera) vrste *Anophthalmus hirtus* Sturm 1853, prvič opisana po osebkih iz jame Velika Pasica /Foto: A. Kapla/.
Photo 24a, b, c: The endemic beetle species (Coleoptera) *Anophthalmus hirtus* Sturm 1853, described upon the specimens collected in the Velika Pasica cave /Photo: A. Kapla/.

In the same period, the cave-dwelling air-breathing snails (Pulmonata) from the genus *Zospeum* Bourguignat 1856 were also found there. They are common on wet or water-saturated places and are typical for the north-western part of the Dinaric Karst. From the cave were described *Zospeum spelaeum schmidti* (Frauenfeld 1854) (Photo 25a, b) and *Zospeum amoenum* (Frauenfeld 1856) (Bole, 1974; Rajko Slapnik, personal communication). Both species had been originally described under the generic name *Carychium* (Frauenfeld, 1854, 1856).

Foto 25a: Polž (Gastropoda) vrste *Zospeum spelaeum schmidti* (Frauenfeld 1854), prvič opisan iz jame Velika Pasica (z zanj značilnimi jasno vidnimi grebeni) /Foto: A. Kapla/.
Photo 25a: The shell of the snail (Gastropoda) *Zospeum spelaeum schmidti* (Frauenfeld 1854), described upon the specimens collected in the Velika Pasica cave (note distinct ridges on its shell) /Photo: A. Kapla/.

Foto 25b: Živ osebek polža (Gastropoda) vrste *Zospeum spelaeum schmidti* (Frauenfeld 1854), prvič opisana po osebkih iz jame Velika Pasica /Foto: R. Slapnik/.
Photo 25b: A live specimen of snail (Gastropoda) *Zospeum spelaeum schmidti* (Frauenfeld 1854), described upon the specimens collected in the Velika Pasica cave /Photo: R. Slapnik/.

originalnem opisu naveden kot "*paratype*", je avtorju vrste iz Velike Pasice verjetno prinesel A. Hadži, ki je leta 1927 sodeloval pri registraciji jame Velika Pasica. Tako ta vrsta samo pogojno spada med vrste opisane iz te jame, saj originalni osebek (*holotype*), po katerem je vrsta dejansko opisana, izvira iz jame Frauenloch pri vasi Borovec blizu Kočevja. Danes je ta jama uradno zavedena kot Babja luknja pri Borovcu (kat. št.: 93) in je bila registrirana le dobre tri mesece (28. avgusta 1927) za Veliko Pasico (DZRJL, 2014).

Zadnja kopenska žival na spisku iz Velike Pasice je dvojnonoga oziroma železna kačica (Diplopoda) vrste *Acherosoma largescutatum* Strasser 1935. Primerke je nabral Egon Pretner 11. marca 1934, skupaj z nekaj zgoraj navedenimi hrošči in jih poslal poznavalcu skupine Karlu Strasserju v Trst (kot je sam zapisal v jamarskem zapisniku). Le-ta jih je naslednje leto opisal kot novo vrsto in je kot podvrsta *A. largescutatum largescutatum* znana le iz te jame (Strasser, 1935).

Drugo obdobje jamske slave se začne z letom 2000, ko so bili v lužicah na dnu jamskih rovov odkriti številni predstavniki drobnih ceponožnih rakov (Copepoda) (Brancelj, 2000; 2002). Iz lužic na dnu jamskih rovov ter curkov prenikle vode so bile opisane tri nove vrste, ki so zaenkrat znane samo iz te jame oziroma njene bližnje okolice: *Morariopsis dumonti* Brancelj

The next terrestrial species, described after the three specimens from the caves, is a representative of pseudoscorpions (Pseudoscorpiones), namely *Chthonius raridentatus* Hadži 1930 (Hadži, 1930; Gardini, 2014). One specimen from the cave, named in the original description as "*paratype*," was brought from the Velika Pasica cave probably by A. Hadži, who was also involved in the registration of the cave in 1927. This species is only conditionally a member of species described from the Velika Pasica cave, as the holotype, after which the species had been described, was collected in the Frauenloch cave, near the Borovec village at Kočevje in Slovenia. Today, the official name of the cave is Babja Luknja pri Borovcu (Cad. No. 93) and was registered only three months after the Velika Pasica cave (on 28th August 1927) (DZRJL, 2014).

The last terrestrial species described from the Velika Pasica cave was a millipede (Diplopoda) named *Acherosoma largescutatum* Strasser 1935. The specimens were collected by Egon Pretner on 11th March 1934, along with some above mentioned cave-dwelling beetles. Upon having seen the log records, he sent the specimens to the specialist, Karl Strasser, in Trieste. Based on the specimens Strasser described the following year, a new species which is as sub-species *A. largescutatum largescutatum* known only from this cave (Strasser, 1935).

The next era of the cave's renown started in 2000, when

Tabela 2: Seznam vseh novih vrst in podvrst za znanost, opisanih po primerkih iz jame Velika Pasica (Slovenija); vrste so podane po letnici opisa. * - razlaga pojma je v poglavju "Ekološka oznaka živalstva v jami".
Table 2: The list of all species and subspecies new for science, described upon the specimens from the Velika Pasica cave (Slovenia); the species are listed according to the year of their description. * - for the explanation of the category, see the section "The ecological characterisation of the cave fauna".

VRSTA/PODVRSTA (višja taksonomska skupina) *SPECIES/SUBSPECIES (higher taxonomic group)*	AVTOR LETNICA *AUTHOR YEAR*	EKOLOŠKA OZNAKA* *ECOLOGICAL AFFINITY**
Anophthalmus hirtus (Coleoptera)	Sturm 1853	troglobite / *troglobite*
Typhlotrechus bilimeki hacqueti (Coleoptera)	Sturm 1853	troglofil / *troglophile*
Zospeum spelaeum schmidti (Gastropoda)	(Frauenfeld 1854)	troglobite / *troglobite*
Aphaobius milleri (Coleoptera)	Schmidt 1855	troglofil / *troglophile*
Zospeum amoenum (Gastropoda)	(Frauenfeld 1856)	troglobite / *troglobite*
Bythoxenus subterraneus (Coleoptera)	Motschulsky 1859	troglobite / *troglobite*
Anophthalmus schmidti motschulskyi (Coleoptera)	Schmidt 1860	troglobite / *troglobite*
Chthonius raridentatus (paratype) (Pseudoscorpiones)	Hadži 1930	troglobite / *troglobite*
Acherosoma largescutatum largescutatum (Diplopoda)	Strasser 1935	troglobite / *troglobite*
Morariopsis dumonti (Copepoda)	Brancelj 2000	stigobiont / *stygobite*
Elaphoidella millennii (Copepoda)	Brancelj 2009	stigobiont / *stygobite*
Elaphoidella tarmani (Copepoda)	Brancelj 2009	stigobiont / *stygobite*
Maraenobiotus slovenicus (Copepoda)	Brancelj & Karanovic 2015	stigobiont / *stygobite*

2000 (Foto 26), *Elaphoidella millennii* Brancelj 2009 (Slika 9) in *Elaphoidella tarmani* Brancelj 2009. Kasneje je bila v bližjem občasnem izviru Močilo, ki dobiva del vode tudi iz jame, opisana še četrta vrsta, *Maraenobiotus slovenicus* Brancelj & Karanovic 2015 (Foto 27).

S tem pa seznam novih vrst še ni povsem izčrpan, saj sta znani vsaj še dve vrsti iz jame oziroma njene okolice, ki spadata v kategorijo "nove vrste za znanost". Obe spadata v skupino epibiontskih praživali; to so živali, ki živijo na drugih živalih. Ena med

many representatives of tiny copepods (Copepoda) were found in small pools on the floor of the cave (Brancelj, 2000; 2002). Three new species were described upon the specimens found in the pools on the floor of the corridors and drip water and so far found only in the cave and its immediate vicinity: *Morariopsis dumonti* Brancelj 2000 (Photo 26), *Elaphoidella millennii* Brancelj 2009 (Figure 9) and *Elaphoidella tarmani* Brancelj 2009. Later, the fourth species, *Maraenobiotus slovenicus* Brancelj & Karanovic 2015 (Photo 27) was found in the nearby temporary spring Močilo, which is hydrologically connected with the cave.

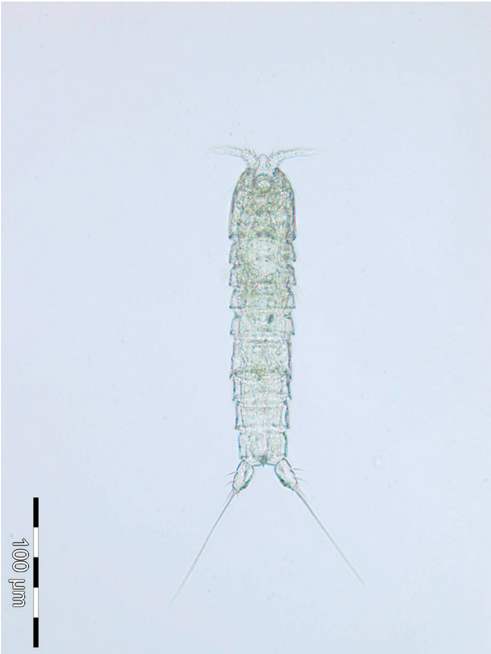


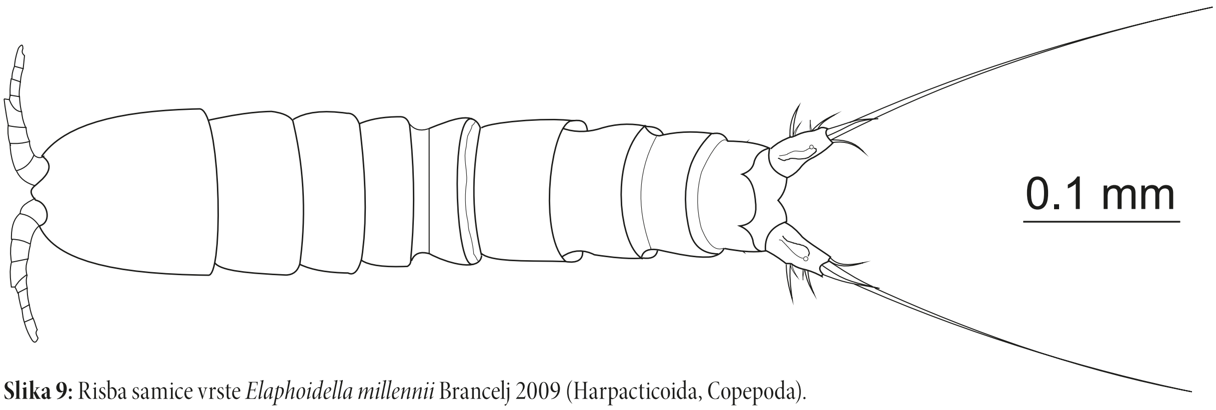
Foto 26: Samica vrste *Morariopsis dumonti* Brancelj 2000 (Copepoda), prvič opisana po osebkih iz jame Velika Pasica /Foto: A. Brancelj/.
Photo 26: The female of the *Morariopsis dumonti* Brancelj 2000 (Copepoda), described upon the specimens collected in the Velika Pasica cave /Photo: A. Brancelj/.

Foto 27: Samec vrste *Maraenobiotus slovenicus* Brancelj & Karanovic 2015 (Copepoda), prvič opisana po osebkih iz občasnega izvira Močilo. Naseljen s številnimi enoceličnimi epibionti / Foto: A. Brancelj/.
Photo 27: The male of *Maraenobiotus slovenicus* Brancelj & Karanovic 2015 (Copepoda), described upon the specimens collected from the Močilo temporary spring. The male is populated with numerous unicellular epibionts /Photo: A. Brancelj/.

Foto 28: Z epibionti iz skupine Suctoria (Ciliata) bogato poseljena samica vrste *Morariopsis dumonti* Brancelj 2000 /Foto: A. Brancelj/.
Photo 28: With epibionts from the group Suctoria (Ciliata), densely populated female of the *Morariopsis dumonti* Brancelj 2000 /Photo: A. Brancelj/.

njimi, iz skupine Suctoria, živi na vrsti *M. dumonti* (Brancelj, 2000; 2002) (Foto 28). Druga, iz skupine Ciliata, živi na vrsti *M. slovenicus* (Brancelj in Karanovic, 2015) (Foto 27).

With the above mentioned list, the number of new species has not yet come to its end. There are at least two new species from the cave and near-by location which could be put in a category "new species for science". Both are epibiotic protozoans; animals living off other animals. These belong to the group Suctoria, living off the *M. dumonti* (Brancelj, 2000; 2002) (Photo 28). Another species, the member of Ciliata, live off specimens of *M. slovenicus* (Brancelj and Karanovic, 2015) (Photo 27).



Slika 9: Risba samice vrste *Elaphoidella millennii* Brancelj 2009 (Harpacticoida, Copepoda).
Figure 9: The line drawing of a female of *Elaphoidella millennii* Brancelj 2009 (Harpacticoida, Copepoda).

SODOBNE RAZISKAVE

METEOROLOGIJA V JAMI

Za globoke jame oziroma večje izvire velja, da je temperatura zraka ali vode v globljih oziroma bolj oddaljenih predelih jame ali v izviru blizu povprečne letne temperature kraja, kjer se jama ali izvir nahaja. Za Veliko Pasico to pravilo ne velja povsem, saj je jama razmeroma majhna in plitvo pod površjem. Zato so tako temperature zraka kot prenikle vode podvržene nihanjem zunanje temperature, ki se spreminjajo dnevno in sezonsko. Najbolj se spreminjajo v bližini vhoda, kamor se pozimi spušča mrzel zrak. Vrtača tik pred vhodom deluje kot mesto temperaturne inverzije, to je mesto, kjer se temperatura zraka z nižjo nadmorsko višino znižuje in ne zvišuje. Pojav je sicer zelo lokalen in omejen le na območje vrtače. V vrtačo se steka hladen zrak s pobočij. Del ga steče tudi v jamo, vendar se že ob vhodu zaradi majhne propustnosti vhoda in mešanja s toplejšim zrakom iz jame segreje (Slika 10). Tako se ob mrzlih zimskih obdobjih ledene sveče tvorijo le tik do vhoda, medtem ko je zrak takoj za vhodom že toliko segret, da voda ostane v tekočem stanju. Kljub temu so vplivi mrzlega zraka zaznavni v celotni vhodni dvorani.

Zaradi pojava inverzije so bile najnižje temperature zraka in vode izmerjene v vhodni dvorani na točki VP 1. V obdobju 2006–2013 je bila najnižja temperatura zraka meter nad tlemi 5,08 °C, medtem ko je bila najnižja temperatura vode 5,91 °C. Najvišje temperature so bile izmerjene v največji notranji dvorani na

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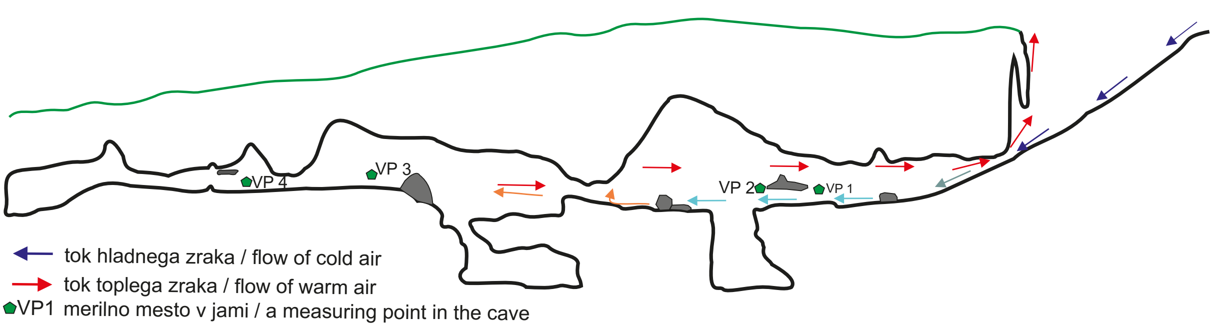
THE METEOROLOGY IN THE CAVE

The temperature of water or air in deeper or more distant parts of the caves reflects the average year temperature of the location in the deep caves and big karstic springs, where the cave or spring is located. The Velika Pasica cave is an exception to the rule, as the cave is relatively small and positioned right below the shallow surface. For that reason, the temperatures of air or drip water depend on the oscillations of the surface temperature, which changes daily and seasonally. The changes are most obvious near the entrance, where cold air descends during the winter. The doline just in front of the entrance is actually a place of temperature inversion, *i.e.* the place where the air temperature decreases with a lower altitude, instead of increasing. This phenomenon is very localised and limited only to the area of doline. The cold air descends from the surrounding slopes in the doline. A part of it enters the cave, but its temperature right at the entrance increases as the entrance is small and it mixes with warm air from the inner parts of the cave (Figure 10). For that reason, icicles are formed during the winter periods only in front of the entrance, while the air temperature behind the entrance is high enough to keep the water inside in a liquid stage. However, the effects of cold air are felt in the entire entrance hall.

As a result of the inversion, the lowest air and water temperatures were recorded in the entrance hall at VP 1. In the period between 2006 and 2013, the lowest air temperature one metre above the floor was 5.08 °C, while the lowest temperature of drip water was 5.91 °C. The highest temperatures

Tabela 3: Podatki o najnižjih, najvišjih ter povprečnih vrednostih temperature zraka in prenikle vode na štirih merilnih mestih v jami Velika Pasica (Slovenija) v obdobju med 8. majem 2006 in 16. junijem.2013. (* - najnižja merilna točka v jami; '' - najvišja merilna točka v jami).
Table 3: The data on the minimum, maximum and average air and drip-water temperatures at the four permanent water jets in the Velika Pasica cave (Slovenia) in the period between 8th May 2006 and 16th June 2013. (* - the lowest measuring point in the cave; '' – the highest measuring point in the cave).

	VP 1-zrak* / *air**	VP 2-zrak / *air*	VP 3-zrak'' / *air''*	VP 4-zrak / *air*	VP 1-voda /*water*	VP 2-voda / *water*	VP 3-voda / *water*	VP 4-voda / *water*
Temperatura: / *Temperature:*	°C	°C	°C	°C	°C	°C	°C	°C
najnižja (min.) / *minimum (min.)*	5,08	6,01	8,10	7,45	5,98	5,91	7,45	7,52
najvišja (max.) / *maximum (max.)*	11,87	9,95	12,16	10,92	11,59	10,71	11,52	11,27
povprečna / *average*	8,10	8,23	9,77	9,34	8,27	8,23	9,20	9,57
razlika med min. in max. / *the difference between min. and max.*	6,79	3,94	4,06	3,47	5,61	4,80	4,07	3,75



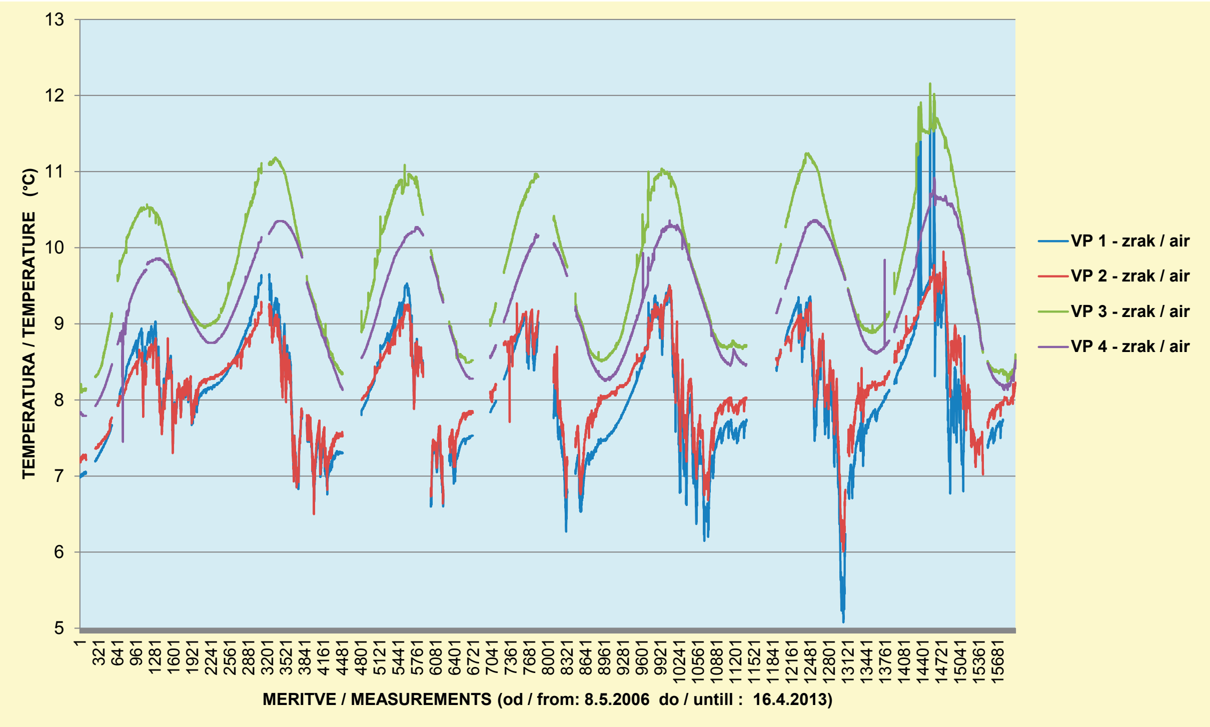
Slika 10: Kroženje zraka v jami Velika Pasica (Slovenija) pozimi.
Figure 10: The air circulation in the Velika Pasica cave (Slovenia) in winter time.

točki VP 3, in sicer je bila temperatura zraka 12,16 °C in temperatura vode 11,52 °C (Sliki 11, 12; Tabela 3). Povprečne letne temperature zraka so bile med 8,10 °C na VP 1 ter 9,77 °C na VP 3, medtem ko so bile temperature vode na istih mestih med 8,27 °C in 9,57 °C. Razlike med najnižjimi in najvišjimi izmerjenimi vrednostmi med posameznimi sezonami so bile tako pri temperaturi zraka med 6,79 °C na VP 1 ter 3,47 °C na VP 4. Pri vodi so bile te razlike med sezonami med 5,61 °C na VP 1 ter 3,75 °C na VP 4.

V zaporedju več letnih meritev so se vrednosti najvišjih, najnižjih in povprečnih temperatur v jami spreminjale glede na vremenske razmere. Te so vplivale tudi na časovni zamik med najvišjo in najnižjo temperaturo v jami in na površini. Ker se površje nad jamo hitreje in intenzivneje ohlaja oziroma segreva, najvišje in najnižje vrednosti sezonskih temperatur v jami sledijo tistim na površini s časovnim zamikom in so bile v času meritev v mejah 50 do 60 dni. V Tabeli

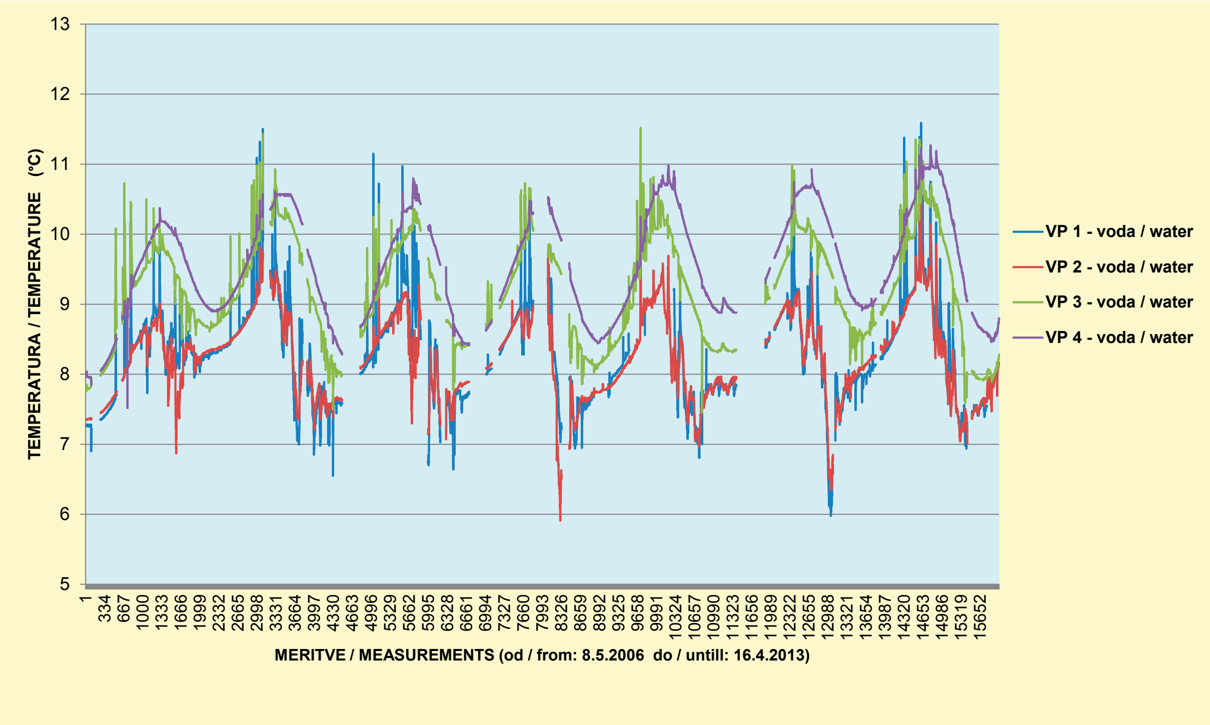
were recorded in the biggest inner hall at VP 3, where the air temperature was up to 12.16 °C and the water temperature was 11.52 °C (Figures 11, 12; Table 3). The average annual air temperatures were 8.10 °C at VP 1 and 9.77 °C at VP 3, while the water temperatures at the same locations were 8.27 °C and 9.57 °C, respectively. The difference between the lowest and the highest recorded temperatures during different seasons were of the air temperatures 6.79 °C at VP 1 and 3.47 °C at VP 4, respectively. The differences in water temperature between seasons were 5.61 °C at VP 1 and 3.75 °C at VP 4, respectively.

During several consecutive measurements over the years, the values of the highest, the lowest and average temperature changed according to weather conditions. The meteorological conditions on the surface influenced the time-lag between the highest and the lowest temperature in the cave and on the surface. As the surface cools or warms quicker and more intensively, the highest and lowest seasonal temperature values in the cave follow that on the surface with a



Slika 11: Temperature zraka v jami Velika Pasica (Slovenija) na štirih merilnih mestih od maja 2006 do aprila 2013. Meritve so bile narejene v 4-urnih intervalih.

Figure 11: The air temperatures in the Velika Pasica cave (Slovenija) on the four measuring locations in the period from May 2006 to April 2013. The measurements were made in 4-hours intervals.



Slika 12: Temperature prenikle vode v jami Velika Pasica (Slovenija) na štirih merilnih mestih od maja 2006 do aprila 2013. Meritve so bile narejene v 4-urnih intervalih.

Figure 12: The water temperatures in the Velika Pasica cave (Slovenia) on the four measuring locations in the period from May 2006 to April 2013. The measurements were made in 4-hours intervals.

Tabela 4: Časovna obdobja, med katerimi so bili dosežene najnižje in najvišje temperature zraka in vode na posameznih merilnih točkah v jami Velika Pasica (Slovenia) od jeseni 2006 do pomladi 2013.
Table 4: The periods during which the minimum and maximum water and air temperatures on selected measuring locations were recorded between autumn 2006 to spring 2013, in the Velika Pasica cave (Slovenia).

Curek / *Water jet*	Obdobje najnižjih temperatur zraka/vode / *The period of minimum temperatures of air / water*	Obdobje najvišjih temperatur zraka/vode / *The period of maximum temperatures of air / water*
VP 1	4. jan. – 12. feb. / *4th Jan. – 12th Feb.*	29. sep. – 25. nov. / *29th Sep. – 25th Nov.*
VP 2	19. jan. – 24. feb. / *19th Jan. – 24th Feb.*	29. sep. – 25. nov. / *29th Sep. – 25th Nov.*
VP 3	14. feb. – 9. maj / *14th Feb. – 9th May.*	13. sep. – 25. okt. / *13th Sep. – 25th Oct.*
VP 4	16. feb – 9. maj / *16th Feb. – 9th May*	19. okt. – 16. nov. / *19th Oct. – 16th Nov.*

4 so navedeni datumi, kdaj so bile dosežene najnižje oziroma najvišje temperature na posameznih merilnih mestih od jeseni 2006 do pomladi 2013. Merilni točki VP 1 in VP 2 sta zaradi oblike vhoda dosegli najnižje temperature precej hitreje kot merilni mesti v notranjosti (VP 3 in VP 4). Mrzel in s tem težji zrak se je hitro spustil skozi vhod. Tudi najvišje temperature so bile v vhodni dvorani razmeroma hitro dosežene. Najpočasneje se je odzivalo merilno mesto VP 3, ki je bilo postavljeno na najvišji točki v jami in jo je kroženje zraka znotraj jame najmanj prizadelo.

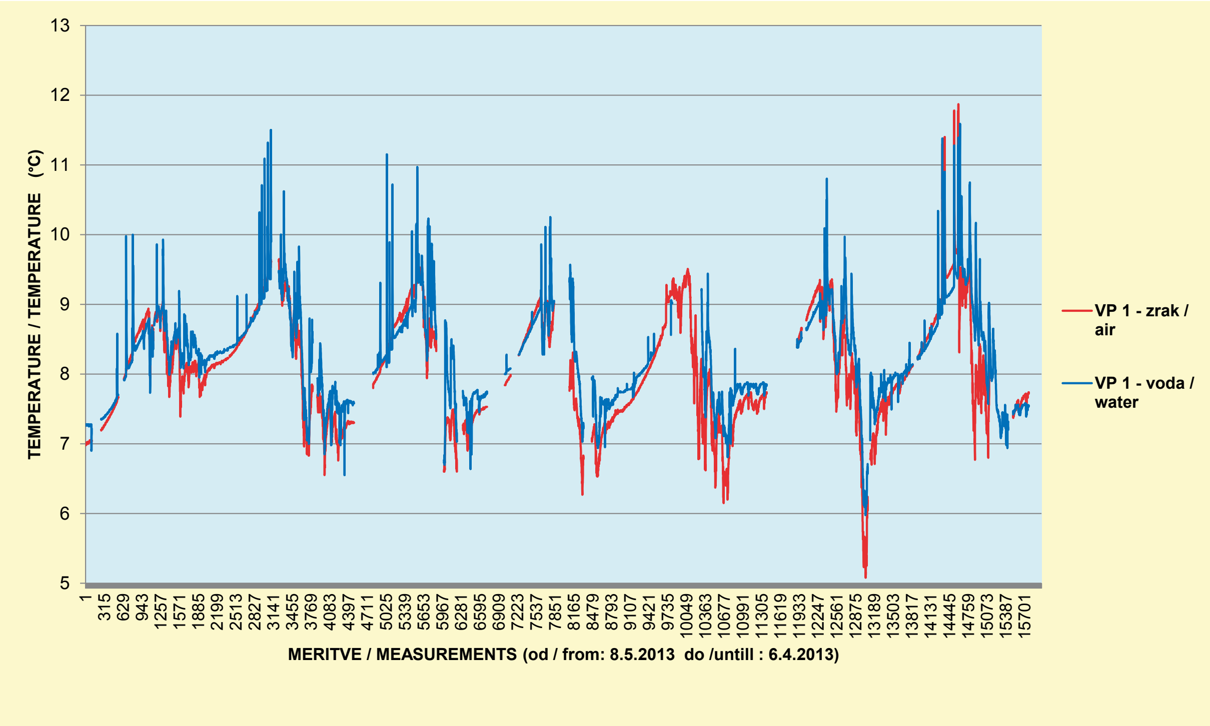
Temperaturne krivulje zraka na štirih merilnih mestih se niso razlikovale samo po temperaturnih razlikah in obdobjih najvišjih in najnižjih vrednosti, temveč tudi po obliki (Slika 11). Krivulji na notranjih merilnih mestih (VP 3 in VP 4) sta bili gladki in le z manjšimi konicami v spomladanskem obdobju (v razponu ±0,1–0,3 °C). V primerjavi z notranjimi merilnimi mesti sta kazali temperaturni krivulji na zunanjih mestih (VP 1 in VP 2) izrazita nihanja pod vplivom zunanjih vremenskih razmer. Te so bile povezane z vetrom v poletnem času in še dodatno z nizkimi zunanjimi temperaturami pozimi, kar je povzročilo spremembe temperature tudi do 2 °C v obdobju nekaj ur. Večina sprememb v temperaturi je bila v smeri zniževanja temperature v primerjavi s povprečjem v trenutno opazovanim obdobju (Slika 11).

Temperature prenikle vode so sledile že prej opisanim sezonskim pa tudi vremenski nihanjem temperature zraka (Slika 12). Vendar so bile med njimi razlike v izmerjenih temperaturah. Največje so bile pri curku

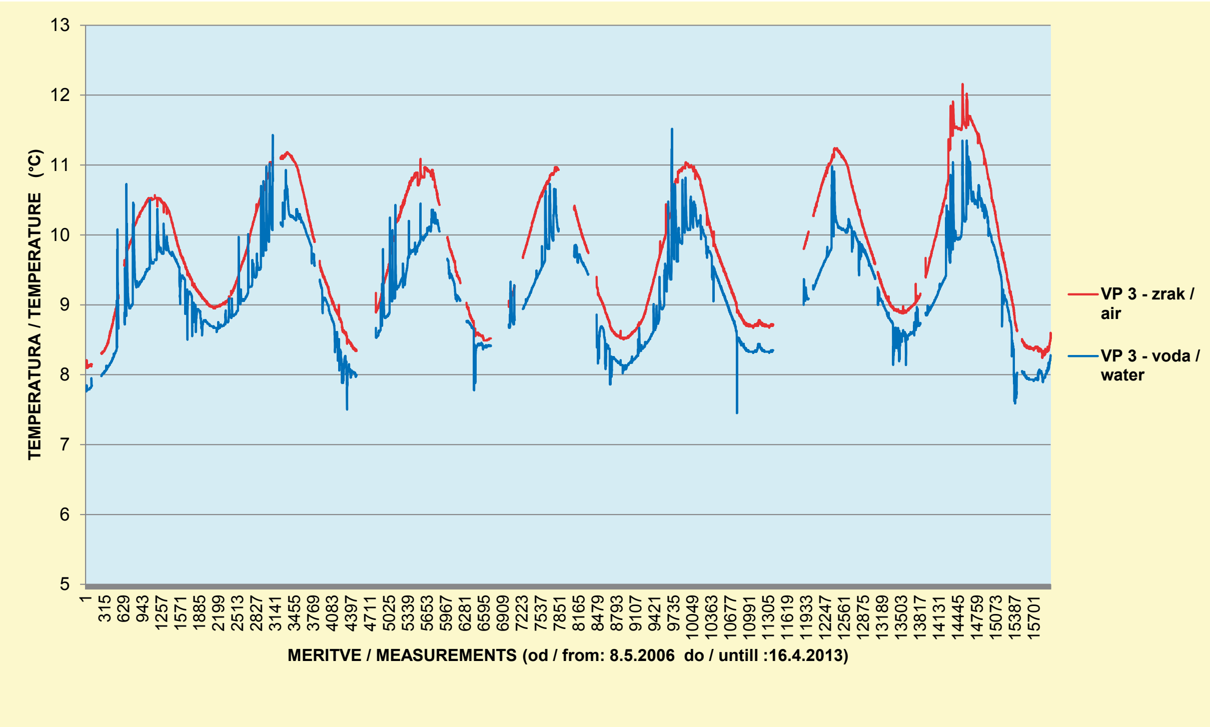
50- to 60-day delay. Table 4 indicates dates when the lowest or highest temperatures were achieved on four measuring points in a period from autumn 2006 to spring 2013. The measuring points at VP 1 and VP 2 achieved the lowest temperatures due to the shape of the entrance sooner than the inner measuring points (VP 3 and VP 4). The cold and thus heavier air quickly descended through the entrance. Also, the highest temperatures were relatively quickly achieved in the entrance hall. The slowest changes were observed at VP 3, which had been located at the highest point of the cave and was least effected by air circulation.

The air temperature curves on four measuring sites did not differ only in absolute values and periods of the highest and lowest values, but also in their shape (Figure 11). The curves at the inner measuring sites (VP 3 and VP 4) were smooth and with only few minute spikes during spring periods (in a range of ±0.1–0.3 °C). Compared with the inner measuring sites, the temperature curves on outer section of the cave (VP 1 and VP 2) showed evident oscillations effected by the weather conditions on the surface. They were induced by the wind in the summer time, and additional low outside temperatures during the winter which resulted in temperature differences up to 2 °C in just a few hours. The majority of changes in temperature were observed in the direction of the lowering of air temperature compared to the average values in the actual observed period (Figure 11).

The temperature of drip water depended on the above described oscillation in seasonal as well as weather-induced oscillations of air temperature (Figure 12). However, there were differences in the recorded temperatures. The biggest were at VP 3, where the water enters the cave high on the



Slika 13: Razlike med temperaturo vode (modro) in temperaturo zraka (rdeče) v jami Velika Pasica (Slovenija) na merilnem mestu VP 3 od maja 2006 do aprila 2013. Meritve so bile narejene v 4-urnih intervalih.
Figure 13: The differences between the water (blue) and the air (red) temperatures in the Velika Pasica cave (Slovenia) at the measuring location VP 3. The measurements were made in 4-hours intervals.



Slika 14: Razlike med temperaturo vode (modro) in temperaturo zraka (rdeče) v jami Velika Pasica (Slovenija) na merilnem mestu VP 1 od maja 2006 do aprila 2013. Meritve so bile narejene v 4-urnih intervalih.
Figure 14: The differences between the water (blue) and air (red) temperatures in the cave Velika Pasica (Slovenia) at measuring location VP 1. Measurements were made in 4-hours intervals.

VP 3, kjer je voda prenikala visoko na stropu, okoli osem metrov nad merilcem temperature, ki je bil sicer meter nad tlemi. Temperatura prenikle vode na ustju merilca pretoka je bila zato vedno nižja od temperature zraka, v povprečju za 0,58 °C (Slika 13). To je bila posledica sedem metrov dolge poti vodnih kapljic s stropa do merilca. Zaradi padanja so se vodne kapljice ohladile in niso odražale prave temperature, ki so jo imele, ko so zapustile epikraško cono (Cigna, 2004). Bolj realno sliko temperature prenikle vode so kazale meritve na VP 4. Pot vodnih kapljic je bila dolga le 0,5 m po zraku in je prenikla voda neposredno tekla v ustje merilca pretoka, kjer je bil nameščen tudi temperaturni senzor. Tam so bile temperature vode v povprečju za 0,23 °C višje od temperature okoliškega zraka. Povprečna odstopanja temperature prenikle vode od temperature zraka so bile na merilnem mestu VP 1 za 0,2 °C višje od okoliškega zraka (Slika 14), medtem ko so bile na VP 2 višje le za 0,01 °C. Na VP 1 je voda zelo hitro odtekala po kratki poti po plastični ponjavi do merilca, medtem ko je na VP 2 zaradi majhnega pretoka polzela le počasi, zato se je temperatura vode izenačila s temperaturo okoliškega zraka.

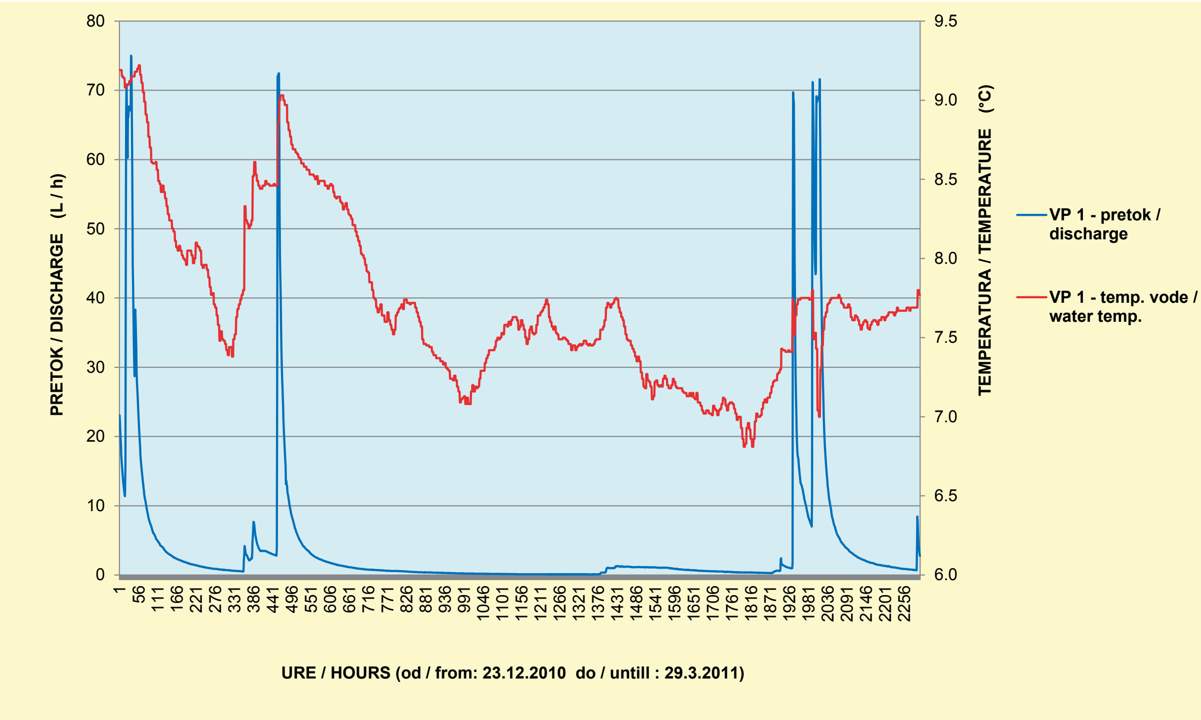
Objektivno je del teh razlik tudi posledica razlik v merilnem območju merilcev/napaka instrumenta, ki niso bili dodatno umerjeni in je po podatkih proizvajalca lahko v merilnem območju ± 0,1 °C. Ne glede na omenjeno sistemsko napako pa je vzorec sprememb temperature odsev resničnih sprememb v realnem času.

Na razlike v trenutnih temperaturah med zrakom in vodo je poleg dolžine poti vodnih kapljic skozi zrak vplival tudi pretok curka (količina vode v enoti časa). To se je odražalo v nenadnih spremembah temperature vode v jesenskem (najvišje temperature) oziroma v spomladanskem obdobju (najnižje temperature) v primerjavi s predhodno temperaturo. Pojav je bil še zlasti izrazit pri curkih VP 1 in VP 3, kjer so se pretoki hitro spreminjali in so bili izdatni (Slike 15 a,b; 16 a,b). V toplem obdobju leta, ko sta se strop nad jamo in zrak v jami ogrevala, se je ob močnejših padavinah oziroma nalivih temperatura prenikle vode za kratek čas povišala celo za več kot 2 °C (Sliki 15b, 16 b), medtem ko je v času ohlajanja stropa in zraka v jami po taljenju snega za kratek padla za več kot 0,7 °C (Sliki 15 a, 16 a).

ceiling, about eight metres above the temperature sensor, which was actually located one metre above the floor. The temperature of the drip water at the mouth of discharge meter was thus always lower than that of air temperature, 0.58 °C on average (Figure 13). The difference was a result of the 7-meter-long path of the water drops, from the ceiling to the instrument. During the fall, the drops cooled (Cigna, 2004) and they did not reflect the actual temperature they had had when leaving the epikarst zone. A more realistic temperature of drip water was recorded at VP 4. The air distance of the drop fall was 0.5 m, the water running directly into the mouth of the discharge meter where temperature sensor was located. The water temperature there was on average 0.23 °C higher than the surrounding air temperature. The average difference between the temperature of the drip water and the surrounding air were at VP 1 for 0.2 °C higher from the air temperature (Figure 14); while at VP 2 were higher only for 0.01 °C. At VP 1 the water flowed fast along the plastic screen to the temperature sensor, while at VP 2, due to low discharge, it flowed slowly, and water and air temperatures could be considered the same.

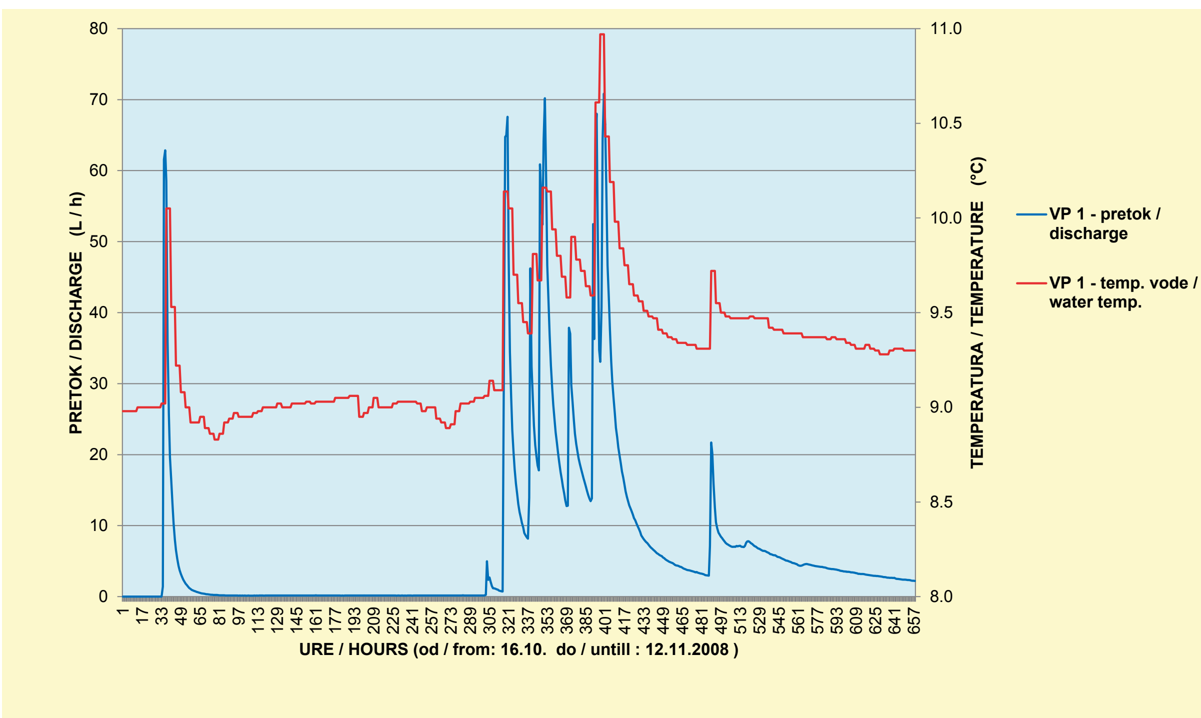
Objectivelly, the part of the differences between the measured temperatures are also the result of the accuracy of the measuring instruments or possible errors made by the instruments, which were not additionally calibrated and can differ, according to the manufacturer, up to of ± 0.1 °C. Regardless of the possible systematic error, the pattern of temperature changes reflectes the temperature situation in a real time.

The actual differences between the water and air temperatures, besides the length of the fall made by a drop, were also effected by discharge, which is volume of water per unit of time. This was clearly reflected in the abrupt changes in the water temperature in the autumn period, having the higher temperature, or in spring period, having the lower temperature, compared to previously recorded temperatures. This phenomenon was particularly evident at VP 1 and VP 3, where changes in discharge were fast and abundant (Figures 15a, b; 16a, b). In the warmer period, when the temperatures of the ceiling above the cave and air within the cave were high, the temperature of the drip water after a heavy rain or a storm increased in a short time for more than 2 °C (Figures 15b, 16b). During the cold period, when the temperature of the ceiling and of the air within the cave was low, the temperature of the drip water after the snowmelt decreased in a short period of time for about 0.7 °C (Figures 15a, 16a). In



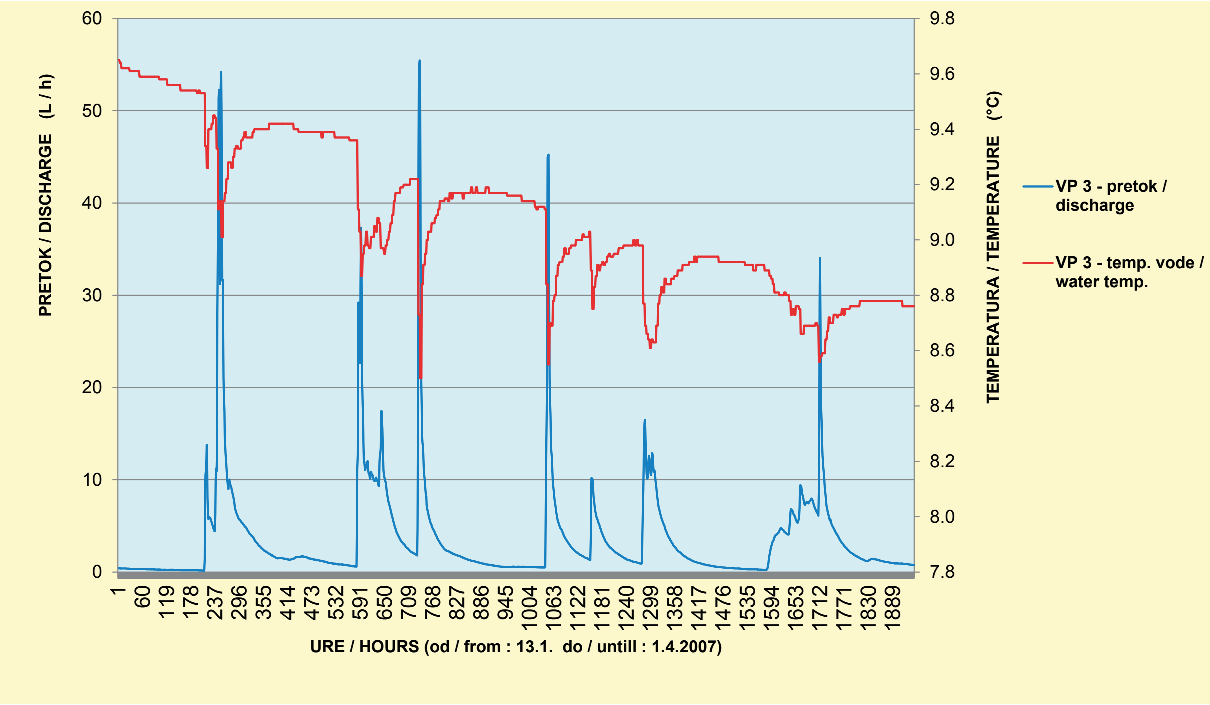
Slika 15a: Povezava med temperaturo vode (rdeče) in pretokom prenikle vode (modro) v jami Velika Pasica (Slovenija) na merilnem mestu VP 1 od 23. decembra 2010 do 29. marca 2011. Meritve so bile narejene v enournih intervalih.

Figure 15a: The relations between the water temperature (red) and the discharge (blue) of drip water in the Velika Pasica cave at measuring location VP 1 in a period from 23rd December 2010 to 29th March 2011. The measurements were made in one-hour intervals.



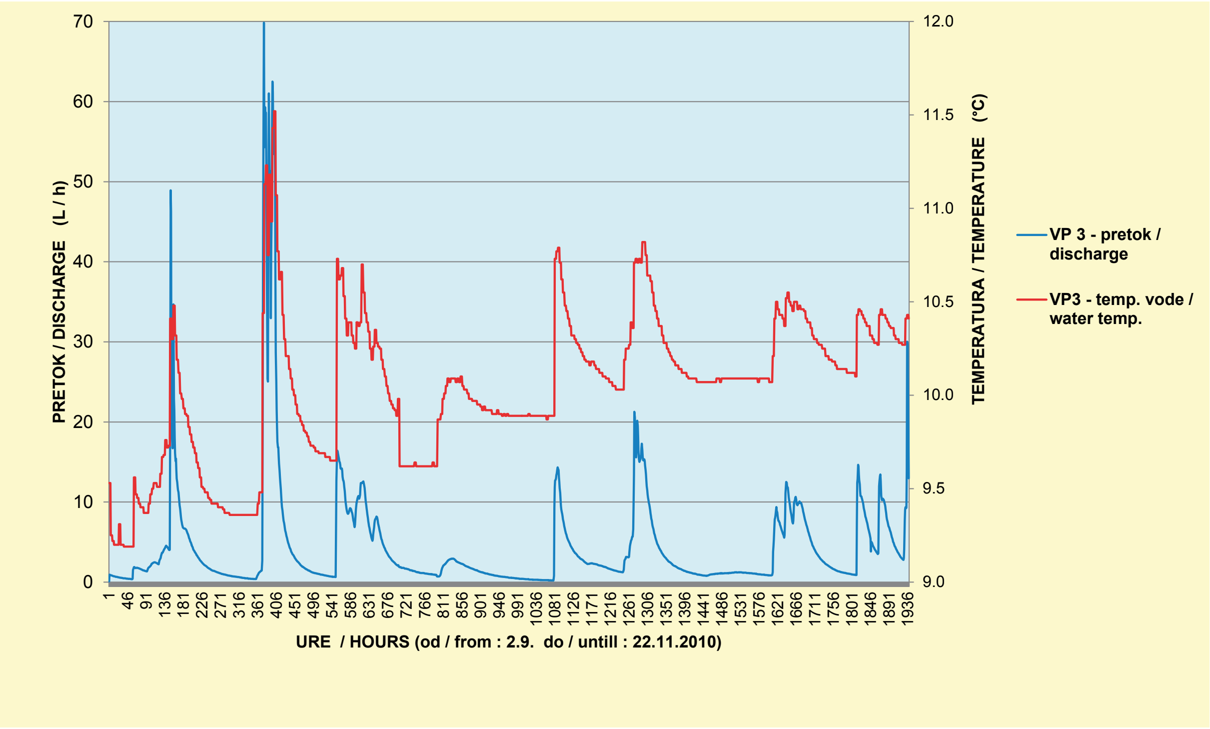
Slika 15b: Povezava med temperaturo vode (rdeče) in pretokom prenikle vode (modro) v jami Velika Pasica (Slovenija) na merilnem mestu VP 1 od 16. oktobra do 12. novembra 2008. Meritve so bile narejene v enournih intervalih.

Figure 15b: The relations between the water temperature (red) and the discharge (blue) of the drip water in the Velika Pasica cave at measuring locationt VP 1 in a period from 16th October to 12th November 2008. The measurements were made in one-hour intervals.



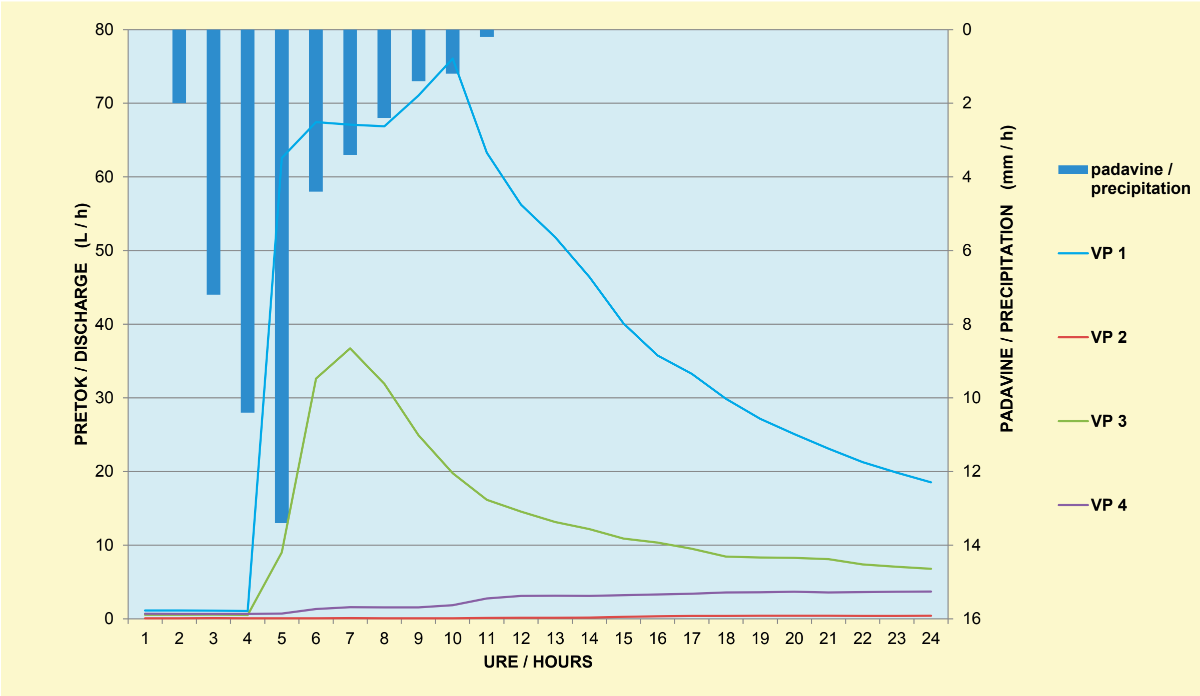
Slika 16a: Povezava med temperaturo vode (rdeče) in pretokom prenikle vode (modro) v jami Velika Pasica (Slovenija) na merilnem mestu VP 3 od 13. januarja do 1. aprila 2007. Meritve so bile narejene v enournih intervalih.

Figure 16a: The relations between the water temperature (red) and the discharge (blue) in the Velika Pasica cave at the measuring location VP 3 in a period from 13th January to 1st April 2007. The measurements were made in one-hour intervals.



Slika 16b: Povezava med temperaturo vode (rdeče) in pretokom prenikle vode (modro) v jami Velika Pasica (Slovenija) na merilnem mestu VP 3 od 2. septembra do 22. novembra 2010. Meritve so bile narejene v enournih intervalih.

Figure 16b: The relations between the water temperature (red) and the discharge (blue) in the Velika Pasica cave at the measuring location VP 3 in a period from 2nd September to 22nd November 2010. The measurements were made in one-hour intervals.



Slika 17: Sprememba pretoka posameznega curka v jami Velika Pasica (Slovenija) glede na poletno nevihto po daljšem sušnem obdobju.
Figure 17: The discharge curves of the four permanent water jets in the Velika Pasica cave (Slovenia) during a summer storm after long dry period.

Na curkih VP 2 in VP 4, kjer so pretoki manjši, so bile tudi spremembe temperature prenikle vode še manjše.

HIDROLOGIJA

Jama se nahaja plitvo pod površjem, zato so vodni kanali med površjem in jamskim stropom pričakovano kratki. Kljub temu curki niso odreagirali na padavine s povečevanjem pretoka takoj in istočasno, ampak so bili med curki časovni zamiki med začetkom deževanja in povečevanjem pretoka v njih. To je bilo še posebej očitno, kadar je deževalo po daljšem sušnem obdobju. V takih primerih so se morale z deževnico najprej napolniti prej suhe ali delno izsušene špranje med površjem in jamskim stropom in šele nato je voda pritekla skozi razpoke v obliki intenzivnejšega kapljanja ali curkov na stropu v jamo. Curki so reagirali že po treh urah od začetka padavin (VP 1) ali pa le neznatno po 16 urah (VP 2) (Slika 17).

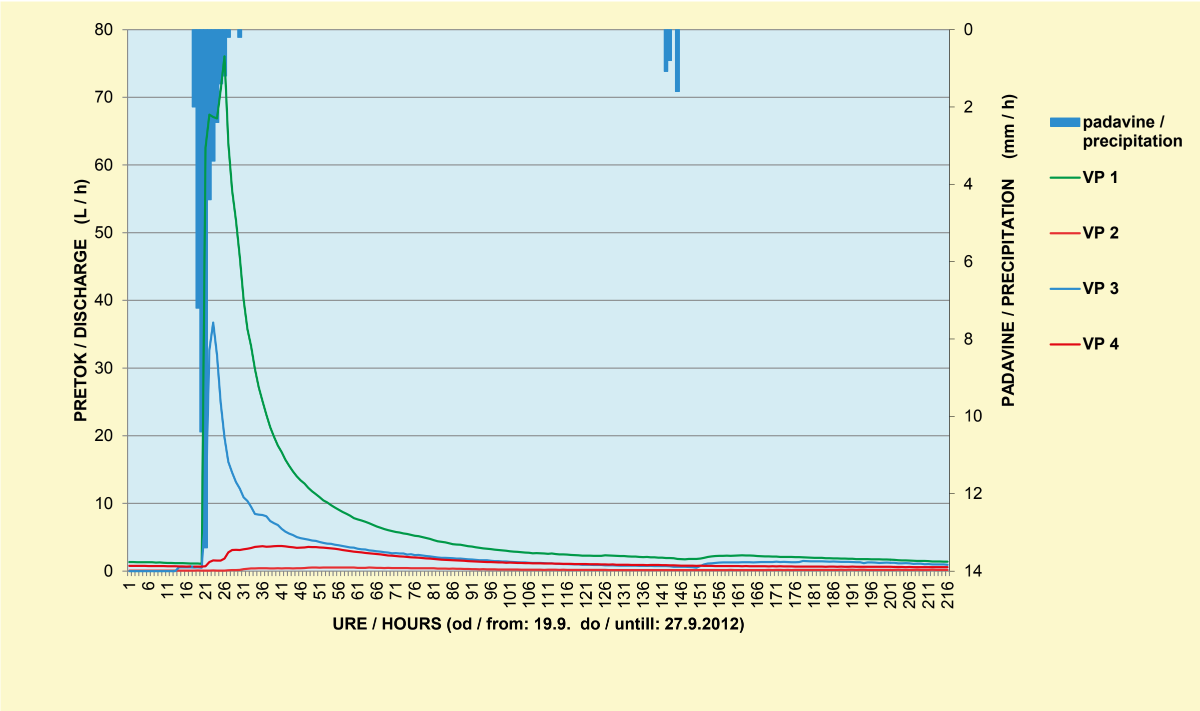
Posamezni curki niso reagirali na dež enako glede na volumen prenikle vode. Njihova hidravlična prepustnost, in s tem volumen prenikle vode, je bila odvisna od velikosti kanalov v njihovem zaledju. Največji izmerjeni pretoki v opazovanem obdobju so prikazani

the water jets VP 2 and VP 4, where discharges were lower, the oscillation in temperature was also less intensive.

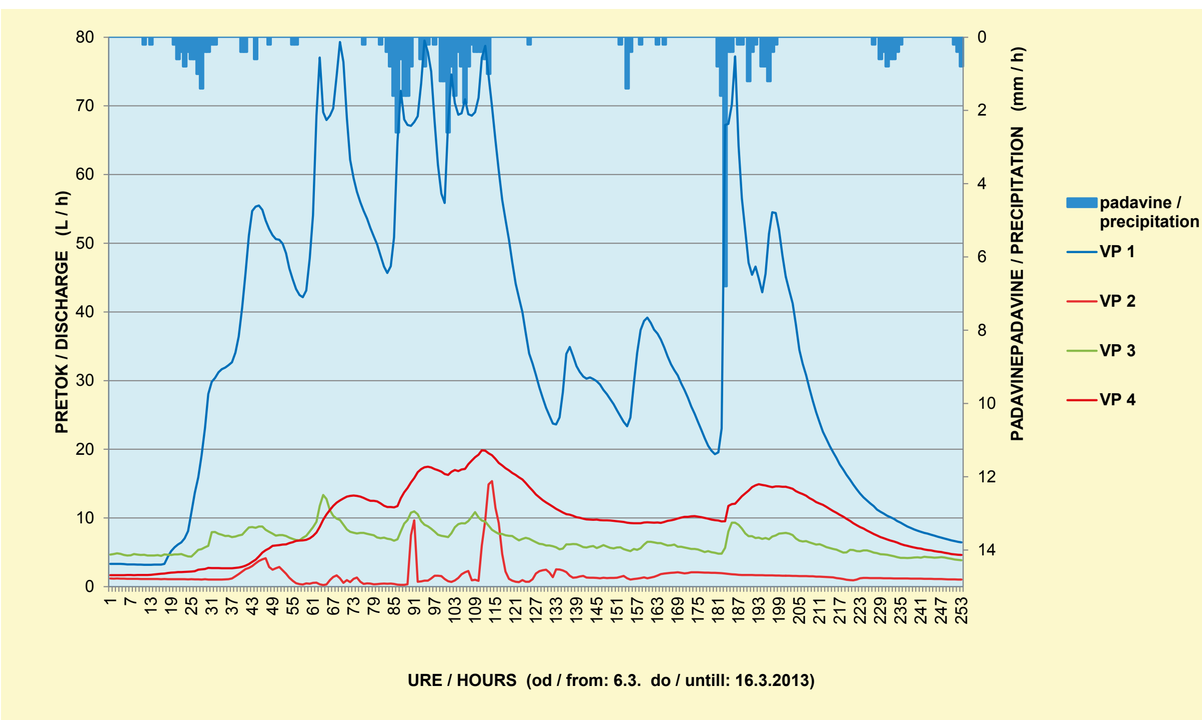
THE HIDROLOGY

The cave is located just few metres below the surface, thus the water channels connecting the surface and the cave ceilings are short, as expected. Although the water jets did not react to the precipitation with the increased discharge instantly and simultaneously, there were, however, differences among them in time delay between the beginning of the precipitation and the increase of discharge. This was particularly obvious after a prolonged dry period, followed by a rainfall. Thus, partly or completely dry cracks between surface and ceiling had to be filled with rain water first and only then could the water enter the cave in a form of either more intensive dripping or water jets falling from the ceiling. The water jet had reacted intensively three hours after the beginning of an intensive precipitation (VP 1) or just moderately after 16 hours (VP 2) (Figure 17).

The individual water jets did not react to the rain in the same way regarding the volume of the drip water. Their hydraulic conductivity and consequently the volume of drip water was determined by the size of the channels in their



Slika 18: Krivulje pretokov štirih curkov v jami Velika Pasica (Slovenija) po poletni nevihti 19. septembra 2012, ki je sledila dolgemu sušnemu obdobju.
Figure 18: The discharge curves of the four permanent water jets in the Velika Pasica cave (Slovenia) after summer storm on 19th September 2012 after a long dry period.



Slika 19: Krivulje pretokov štirih curkov v jami Velika Pasica (Slovenija) v rahlem večdnevnem dežju v mesecu marcu 2013.
Figure 19: The discharge curves of the four permanent water jets in the Velika Pasica cave (Slovenia) after several days of low intensity rainfall in March 2013.

Tabela 5: Največji izmerjeni pretoki na posameznih curkih v Veliki Pasici (Slovenija) od maja 2006 do oktobra 2013. Glavni curek = prenikla voda le z enega mesta; vsi curki = več začasnih curkov po močnih padavinah okoli glavnega curka na površini 1,5 x 1,5 m.
Table 5: The maximum discharge of four permanent water jets in the Velika Pasica cave (Slovenia) from May 2006 to October 2013. The main water jet = discharge form one point; all water jets = several temporal water jets after a heavy rainfall around the main water jet on the surface of 1.5 x 1.5 m.

Curek / *Water jet*	VP 1	VP 2	VP 3	VP 4
Največji pretok glavnega curka (L h^{-1}) / *The maximum discharge of the main water jet (L h^{-1})*	80,6	15,3	66,8	37,8
Največji pretok vseh curkov (L h^{-1}) / *The maximum discharge of all water jets (L h^{-1})*	95,4	51,1	69,8	69,1

v Tabeli 5. Dolžina največjega pretoka po instrumentalnih zapisih ni nikoli trajala dve uri. Opazovanja neposredno po močnejših padavinah so pokazala, da so se okoli glavnih curkov pojavili še začasni, skozi katere se je odvedel del prenikle vode s površja. Ti so tako prevzeli višek vode, ki se ni mogel pretočiti skozi glavni curek (princip preliva).

Pri kanalih z največjo hidravlično prepustnostjo (VP 1) in ob intenzivnih padavinah (ob nevihti) se je pretok lahko povečal od najmanjšega (> 1,13 L h^{-1}) do največjega (80,6 L h^{-1}) v treh do štirih urah, nato je razmeroma hitro upadel na 20 % najvišjega (v 24 do 30 urah), nato se je šibko kapljanje (1,34–1,41 L h^{-1}) nadaljevalo vsaj še teden dni. Nobeden od štirih curkov ni nikoli popolnoma presahnil, čeprav so bili časovni intervali med posameznimi kapljicami po dolgem sušnem obdobju lahko dolgi tudi po nekaj minut.

Tako se je ob pozno-poletni nevihti (19. septembra 2012) (Slika 18), ko je padlo 50 mm v 10 urah, skozi VP 1 v devetih dneh pretočilo 1.594 litrov vode, skozi VP 2 51,6 litrov, skozi VP 3 607 litrov in skozi VP 4 308 litrov vode. Skupaj se je skozi vse štiri curke pretočilo 2.560 litrov vode, kar je enako količini dežja, ki je padel na površini 51,2 m^2 v zaledju vseh štirih curkov.

V zimskem času pa je ob le nekoliko večji količini padavin (59,6 mm v 12,4 dneh) (Slika 19) skozi VP 1 steklo 9.237 litrov vode, skozi VP 2 477 litrov, skozi VP 3 2.514 litrov in skozi VP 4 1.888 litrov. Skupaj se je tako skozi vse štiri curke pretočilo 14.117 litrov vode, kar je enako količini dežja, ki je padel na površini 237 m^2 v zaledju štirih curkov. Ker so izračunane zlivne površine zaledja majhne v primerjavi z realnim zaledjem (vsaj 10.000 m^2), sklepamo, da večina vode steče po kanalih, ki vodijo mimo omenjenih štirih curkov.

catchment area. The maximum discharge values in the observed period are presented in Table 5. The duration of the maximum discharge according to the instrumental records had never lasted more than two hours. Following a heavy rain, numerous temporary water jets were formed around the main water jets, venting a part of the drip water. They accepted the surplus of water, which had not been able to be conducted through the main channel: this also known as "the principle of derivation".

In the channels with the highest hydraulic conductivity (VP 1) and after an intensive precipitation, such as a storm, the discharge could be increased from minimal (> 1.13 L h^{-1}) to the maximal (80.6 L h^{-1}) in three to four hours, followed by a relatively fast decrease to 20 % of the highest discharge (in 24 to 30 hours), followed by weak dripping (1.34–1.41 L h^{-1}) continuing at least one week. None of the four water jets had completely dried out, although the time intervals between the successive drops after long dry periods can last several minutes.

During the late summer storm on 19th September 2012 (Figure 18), when 50 mm of rainfall was measured in 10 hours, through VP 1 1,594 litres of water were discharged in nine days, through VP 2, 51.6 litres, through VP 3, 607 litres and through VP 4, 308 litres. Altogether, the four water jets had discharged 2,560 litres of water, an equivalent to the precipitation on surface of 51.2 m^2 in their catchment area.

During the winter period, a slightly higher precipitation was recorded (59.6 mm in 12.4 days) (Figure 19), through VP 1, 9,237 litres of water were discharged, through VP 2, 477 litres, through VP 3, 2,514 litres and through VP 4, 1,888 litres. In total, all four water jets had discharged 14,117 litres of water, an equivalent to the precipitation on surface of 237 m^2. This area is small compared to the real catchment area of at least 10,000 m^2, therefore, it can be concluded that the majority of water flows through channels, running in parallel with the aforementioned of four permanent drips.

KEMIJSKA SESTAVA PRENIKLE VODE

S spreminjanjem pretoka in temperature vode v posameznih curkih se spreminja tudi kemijska sestava prenikle vode v njih. Natančneje, spreminjale so se količine različnih raztopljenih snovi na poti od tam, kjer sta dež ali snežnica vstopala na površju v špranje in razpoke v stropu, do mesta, kjer sta kot prenikla voda pritekla v jamo. Poenostavljeno to pomeni, da ima voda "spomin", kje in koliko časa je tekla po špranjah in rovih. Velja, da višje ko so temperature in daljši ko je zadrževalni čas, več snovi se v vodi raztopi. Omejitev je le stopnja zasičenja (Lazarini in Brenčič, 1989).

Medtem ko vsebujeta dež in snežnica le malo raztopljenih snovi, se njihova količina potem, ko pade dež ali se sneg stopi na zemeljski površini, le na nekaj metrih navpične poti skozi podzemne špranje spremeni v pitno vodo, ki priteče iz pip v večini Slovenije, kjer vodo zajemajo iz izvirov ali globokih vodnjakov na prodiščih (Tabela 6). V primeru Velike Pasice velja, da so bile povprečne vrednosti raztopljenih snovi posameznih curkov razmeroma različne med seboj. V večini parametrov je izstopal curek VP 4, katerega neposredno zaledje je v preteklosti služilo kot odlagališče različnih odpadkov (gradbeni odpadki, vreče za kmetijska gnojila).

THE CHEMICAL COMPOSITION OF DRIP WATER

Along with the changes in discharge and water temperature of each individual water jet, changed also the chemical compositions of drip water. More precisely, the quantity of various dissolved chemicals changed from the site where the rain or snowmelt water entered the cracks on the surface, to the site where it entered the cave as drip water. To put it simply, it could be said that the water has "a memory," where and how long it persists in the cracks and fissures. As a rule, the higher the temperatures and the longer the retention time, the more matter can be dissolved. The only limitation is the degree of saturation (Lazarini and Brenčič, 1989).

As the rain and snow-melt water have a low amount of dissolved chemicals, their amount increases when the rain or snowmelt water is transformed on only a few metres of vertical distance through the cracks and fissures in limestone. That water also runs from the taps in most of Slovenia, where drinking water is pumped from the springs or deep boreholes on alluvium (Table 6). In the case of the Velika Pasica cave, the average values of dissolved chemicals were quite different among the permanent water jets. In most of the parameters, the water jet VP 4 stands out, whose catchment area used to be a dumping

Tabela 6: Povprečne vrednosti fizikalnih in kemijskih parametrov padavin, prenikle vode ter pitne vode iz vodarne Brest (Slovenija). (Brest: P – vir vode so padavine in reka Iška; Brest: G – vir vode so zaledne vode iz Krima; P: plitvi vodonosnik; G: globoki vodonosnik). Standardna odstopanja niso prikazana. PMD = pod mejo detekcije.

Table 6: The average values for physical and chemical parameters of precipitation, drip water and drinking water from the Brest water plant (Slovenia). (Brest: P - the source of water are the precipitation and the Iška river; Brest: G – the source of water is from the Krim water cathment area; P: shallow aquifer; G: deep aquifer). Standard deviations are not presented here. PMD = under limit of detection.

	El. prev. / El. cond.	pH	Cl^- klorid / *chloride*	NO_3^- nitrat / *nitrate*	SO_4^{2-} sulfat / *sulphate*	Na^+ natrij / *sodium*	K^+ kalij / *potassium*	Ca^{2+} kalcij / *calcium*	Mg^{2+} magnezij / *magnesium*
Enota / *Unit* Vzorec / *Sample*	µS cm^{-1}		mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
Dež / *Rain* – Gornji Ig	24,75	6,31	0,11	0,35	2,73	0,12	PMD	0,31	0,22
VP 1	395,13	8,22	0,54	0,91	1,39	0,48	0,57	62,58	30,79
VP 2	418,57	8,21	2,28	2,38	2,23	0,93	0,25	57,43	36,82
VP 3	474,83	8,17	2,75	2,08	1,43	1,91	0,32	70,95	34,00
VP 4	619,17	8,18	0,72	28,84	5,59	0,91	0,83	51,90	95,92
Pitna voda / *Drinking water* – Brest: P	690,63	7,17	4,16	4,33	5,71	1,22	0,58	86,93	43,76
Pitna voda / *Drinking water* – Brest: G	481,63	7,58	3,17	5,42	4,18	0,74	0,44	57,46	29,03

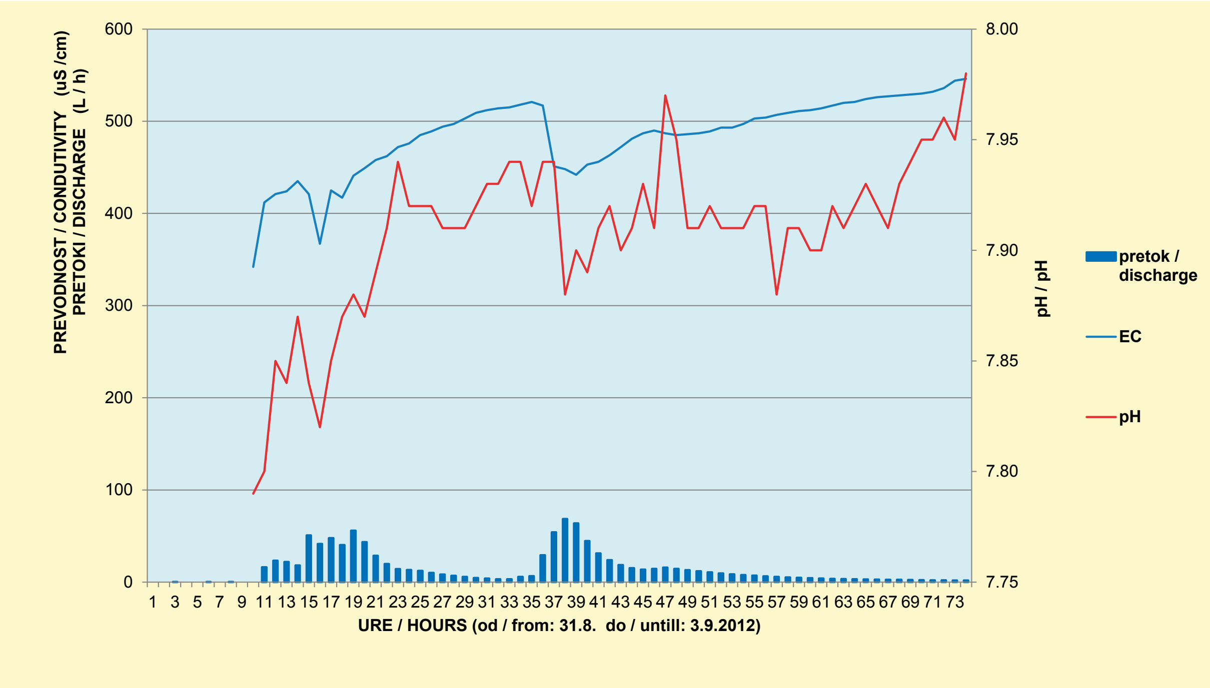
Spremembe v pretokih so povzročile tudi spremembe v fizikalnih in kemijskih lastnostih prenikle vode. Najenostavnejša metoda za ugotavljanje sprememb so bile meritve električne prevodnosti prenikle vode in meritve pH (Sliki 20, 21). Električna prevodnost je posledica množine raztopljenih ionov v vodi, ki omogočajo prevajanje električnega toka, medtem ko je pH rezultat koncentracije hidroksidnih (oziroma H^+) ionov in se izraža kot brezrazsežno število med 0 in 14 (Lazarini in Brenčič, 1989; http 6). Voda s pH manjšim od 7 je kisla, pri 7 je nevtralna, nad 7 pa je bazična. K električni prevodnosti so prispevali vsi ioni navedeni v Tabeli 6 (in še nekateri, ki niso navedeni v njej, zlasti HCO_3^-), medtem ko so k vrednosti pH največ prispevali SO_2, NO_2 in CO_2 (oziroma njihove kisline; žveplova – H_2SO_4, dušikova – HNO_3 in ogljikova – H_2CO_3) in $CaCO_3$ ter $MgCO_3$ (apnenec oziroma dolomit) oziroma hidrogenkarbonat – HCO_3^-, ki ima osrednjo vlogo pri puferskih lastnostih vode. Glavni viri H_2SO_4 in HNO_3 so bila kurišča, industrija in promet, medtem ko je bil glavni vir H_2CO_3 biološka aktivnost, zlasti bakterij in večceličnih organizmov v tleh. Le-ta se je med letom spreminjala. Pozimi je bila zaradi nizkih temperatur najnižja, medtem ko je bila poleti zaradi višjih temperatur najvišja. Višja ko je bila biološka aktivnost, višja je bila proizvodnja CO_2 in posledično ogljikove kisline, zato je bil pH prenikle vode nizek. Dlje ko se je voda zadrževala v razpokah, več apnenca oziroma dolomita se je v njej raztopilo zaradi delovanja ogljikove kisline, zato je bil tudi njen pH temu primeren – iz kislega območja se je zaradi raztapljanja apnenca oziroma dolomita reakcija vode premaknila v bazično območje.

Ob močnejših padavinah ali taljenju snega je padavinska voda vplivala na kemijsko sestavo prenikajoče vode v jami, kar je bilo možno ugotoviti samo z dovolj pogostim jemanjem vzorcev na posameznih curkih. Izbrani so bili enourni intervali, kar je dalo zanimive rezultate. Takoj na začetku povečanega pretoka, ko je pritekala padavinska voda neposredno s površja, se je začasno znižala električna prevodnost kot tudi pH prenikle vode. Vendar sta se že po nekaj urah obe vrednosti povišali, ko je začela v jamo pritekati nekoliko "starejša" in s kalcijevim karbonatom bolj nasičena voda iz drobnejših razpok, ki so bile izven neposrednega vpliva glavnega kanala in je bila voda dlje časa v stiku z okoliško kamnino (Sliki 20, 21).

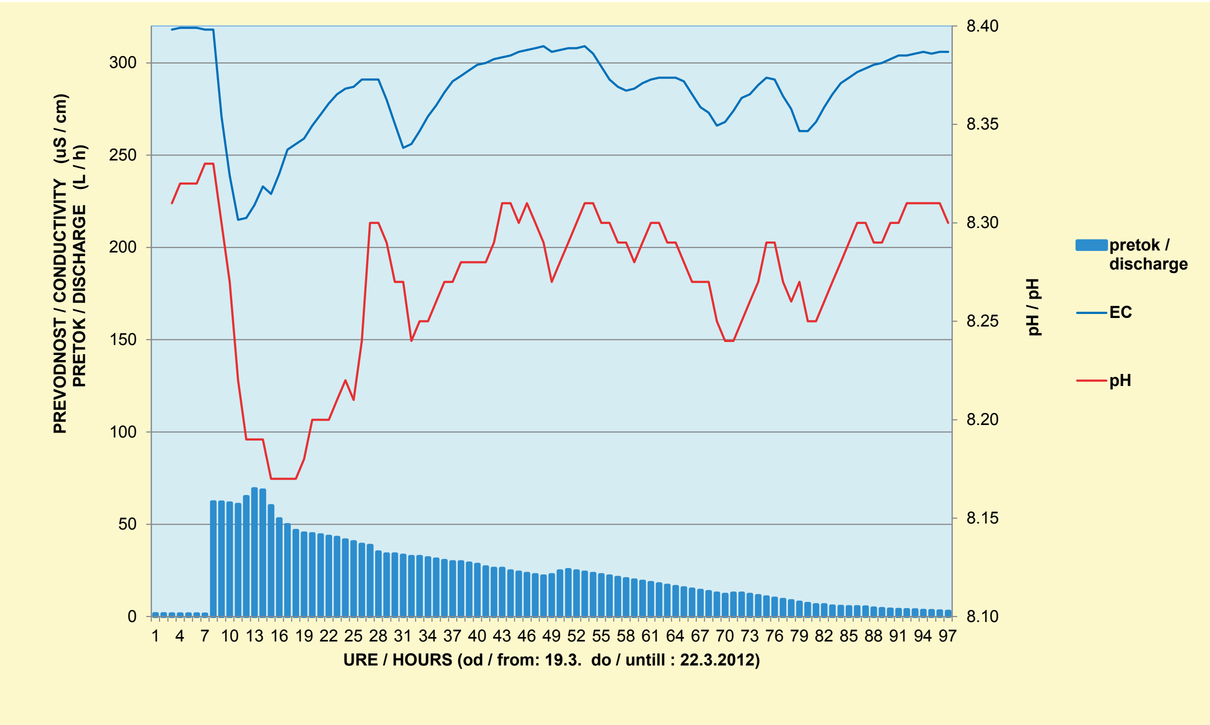
place for different types of waste material, including construction waste or bags for agriculture fertilizers.

The changes in discharge also made changes in the physical and chemical characteristics of the drip water. The simplest way to detect changes was by measuring the electric conductivity and pH levels (Figures 20, 21). The electric conductivity is a result of concentration of ions in water which enable transduction of a current, while pH is a result of hydroxide (*i.e.* H^+) ions and is expressed as a dimensionless number between 0 and 14 (Lazarini and Brenčič, 1989; http 6). Water with pH below 7 is acid, at 7 is neutral and above 7 is basic. All ions from Table 6 contributed to the electric conductivity, including some of which had not been listed there, such as HCO_3^-. The pH level was mostly contributed by SO_2, NO_2 and CO_2 (actually by their acids: the sulphuric – H_2SO_4, the nitric – HNO_3 and the carbonic – H_2CO_3), $CaCO_3$ and $MgCO_3$ (limestone or dolomite) and HCO_3^- (hydrogen carbonate) which plays the main role in the buffering capacity of water. The main sources of H_2SO_4 and HNO_3 are furnaces, industry and transport, while the main sources for H_2CO_3 is biological activity, particularly of bacteria and multicellular organisms in the soil. During the winter, their activity is low due to low temperatures, while during the summer it is at its highest point. The higher the biological activity, the more CO_2 is produced, and consequently, the presence of carbonic acid, making the pH levels of water low. The longer the water lingers in the fissures, the more limestone or dolomite are dissolved in the water due to the carbonic acid, contributing to a certain pH level, as a result of dissolution of limestone/dolomite, the acid reaction is turned into a basic reaction.

After an intensive rain or snowmelt, the precipitated water had effected the chemical composition of the drip water. This was possible to detect only by frequent sampling of the drip water, which was done in one hour intervals, producing interesting results. Immediately after an increase of discharge, when the prevailing water had run directly from surface, the electrical conductivity of drip water had temporary lowered along with the pH levels. After a few hours, both values rose, when the somewhat "older" and calcium carbonate rich water started dripping in the cave from tiny cracks, which were not under the direct influence of the main drainage channel and where the water came into contact with surrounding rocks for a longer period of time (Figures 20, 21).



Slika 20: Povezanost med spremembami električne prevodnosti, pH in pretoka v jami Velika Pasica (Slovenija) v času od 31. avgusta do 3. septembra 2012.
Figure 20: The relations between the electric conductivity, pH and the discharge in the Velika Pasica cave (Slovenia) in the period from 31st August to 3rd September 2012.



Slika 21: Povezanost med spremembami električne prevodnosti, pH in pretoka v jami Velika Pasica (Slovenija) v času od 19. do 22. marca 2012.
Figure 21: The relations between the electric conductivity, pH and the discharge in the Velika Pasica cave (Slovenia) in the period from 19th to 22nd March 2012.

ŽIVI SVET PRED JAMO IN V JAMI

RASTLINSTVO PRED JAMO

Neposredno okoli vhoda se na jugu razprostira dinarsko jelovo-bukov gozd (*Abieti-fagetum dinaricum*), ki je zaradi bližine vasi že močno preoblikovan zaradi sečnje, vendar še vedno od drevja prevladujeta bukev (*Fagus sylvatica*) in posamezne smreke (*Picea abies*), medtem ko je na severni strani vhoda pogostejša grmovnica leska (*Corylus avellana*). Položnejši del vhodne vrtače prekriva debela plast listja, ki rastlinam onemogoča rast. Strme oziroma prepadne stene nad vhodom so pokrite z praprotmi, med njimi so najpogostejše rjavi sršaj (*Asplenium trichomanes*), jelenov jezik (*Phyllitis scolopendrium*) in sladka koreninica (*Polypodium vulgare*) (Foto 29). Na odpadlih leskovih vejah se lahko v hladnem obdobju leta pod listi v bližini vhoda najdejo tudi barvita plodišča škrlatne čašice (*Sarcoscypha coccinea*) (Foto 30). Še nekoliko nižje

Foto 29: Praproti in mahovi nad vhodom v jamo Velika Pasica / Foto: A. Brancelj/.
Photo 29: Ferns and mosses above the entrance of the Velika Pasica cave /Photo: A. Brancelj/.

LIFE AROUND THE ENTRANCE OF AND IN THE CAVE

THE FLORA AT THE CAVE ENTRANCE

In the immediate vicinity of the cave entrance, facing south is a typical variety of mixed forest (*Abieti-fagetum dinaricum)*, which had been modified, due to the vicinity of the village and tree cutting. Among the trees, the most common are beech trees (*Fagus sylvatica*), along with Norway spruces (*Picea abies*). On the northern part of the entrance, there are predominantly hazel bushes (*Corylus avellana*). The less steep slopes of the entrance of the doline are covered with a thick layer of litter, preventing other plants to grow. The steep and vertical slopes just above the entrance are covered with ferns, dominated by the maidenhair spleenwort (*Asplenium trichomanes*), the hart's tongue fern (*Phyllitis scolopendrium*) and the common polypody (*Polypodium vulgare*) (Photo 29). During the period of cold weather, the scarlet elf cup (*Sarcoscypha coccinea*) (Photo 30) produces colourful cup-like fruitbodies on the dead branches of the hazel. Lower

Foto 30: Plodišče škrlatne čašice (*Sarcoscypha coccinea*) pred vhodom v jamo Velika Pasica /Foto: A. Brancelj/.
Photo 30: The fruitbody of the scarlet elf cup (*Sarcoscypha coccinea*) at the entrance of the Velika Pasica cave /Photo: A. Brancelj/.

Foto 31: Mahovi, jetrnjaki ter alge tik nad vhodom v jamo Velika Pasica /Foto: A. Brancelj/.
Photo 31: Mosses, liverworts and algae just above the entrance of the Velika Pasica cave /Photo: A. Brancelj/.

Foto 32: Bele niti plesni na odmrlem lesu v vhodni dvorani jame Velika Pasica /Foto: A. Brancelj/.
Photo 32: A colony of mould on dead wood in the entrance hall of the Velika Pasica cave /Photo: A. Brancelj/.

Foto 33: Rogovilasta lesenjača (*Xylaria hypoxylon*) na trohnečem lesu v vhodni dvorani jame Velika Pasica /Foto: A. Brancelj/.
Photo 33: The candlestick fungus (*Xylaria hypoxylon*) on rotten wood in the entrance hall of the Velika Pasica cave /Photo: A. Brancelj/.

Foto 34: Mlado plodišče žoltosočne čeladice (*Mycaena crocata*) v vhodni dvorani jame Velika Pasica /Foto: A. Brancelj/.
Photo 34: A young fruitbody of the saffron drop bonnet (*Mycaena crocata*) in the entrance hall of the Velika Pasica cave /Photo: A. Brancelj/.

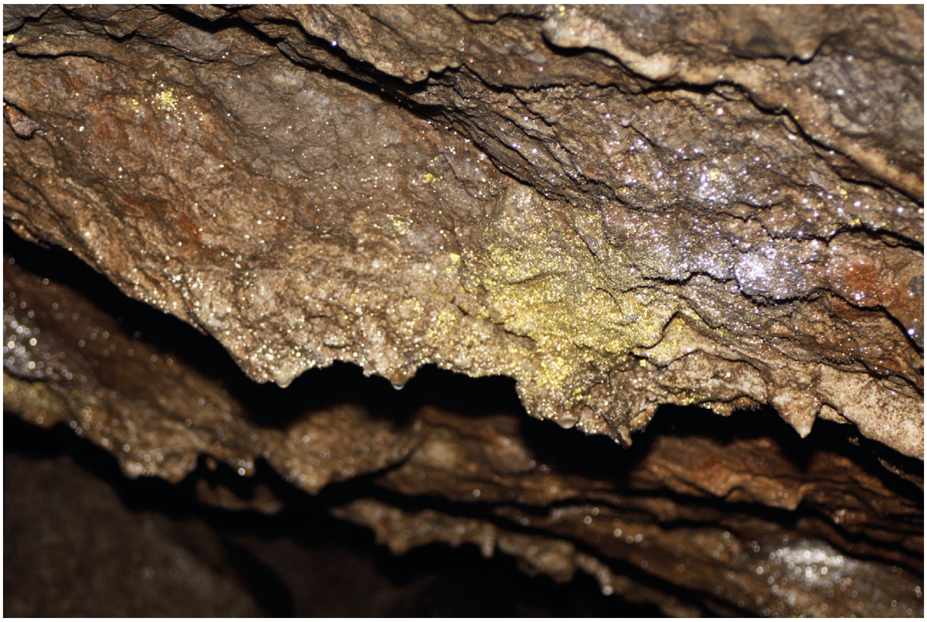
oziroma bližje vhodu začnejo prevladovati mahovi ter jetrnjaki. Tik ob vhodu jih povsem zamenjajo alge in redke steljke mahov, ki prekrivajo vlažne stene (Foto 31). Takoj za ozkim vhodom zaradi pomanjkanja svetlobe tudi alge, te najbolj prilagodljive pripadnice zelenih rastlin, ne uspevajo več.

Globlje v jami, kjer je svetlobe le še zelo malo ali nič, jih nadomestijo gobe in plesni. Na trhlem lesu v vhodni dvorani so opazne bele niti plesni (Foto 32), miceliji (podgobja) prave štorovke ali mraznice (*Armilariella mellea*) ali celo plodišča gob rogovilaste lesenjače

in the doline, rather close to the entrance, grow predominantly mosses and liverworts, which are in the vicinity of the entrance replaced by algae and a few mosses, covering wet walls (Photo 31). After the narrow entrance, where light is faint, the algae, though adapted to life in low light, had completely disappeared.

In the entrance hall, where light intensity is very low or completely absent, the plants have been replaced by tiny mushrooms and moulds. On old wet wood in the entrance hall are white threads of moulds (Photo 32), mycelium of honey fungus (*Armilariella mellea*) or fruitbodies

Foto 35: Kolonije bakterij v vhodni dvorani jame Velika psica, ki tvorijo t. i. "jamsko srebro" oziroma "jamsko zlato" /Foto: A. Brancelj/.
Photo 35: The colonies of bacteria in the entrance hall of the Velika Pasica cave, forming the so-called "cave silver" or "cave gold" /Photo: A. Brancelj/.



(*Xylaria hypoxylon*) (Foto 33) ter žoltosočne čeladice (*Mycena crocata*) (Foto 34).

Na stropu vhodne dvorane uspeva skupina organizmov, ki igrajo v jamskem okolju pomembno vlogo, in sicer so to bakterije. Bakterije okoli jamskega vhoda so še posebej opazne, saj so njihove, celo do milimeter debele kolonije pokrite z drobnimi vodnimi kapljicami, ki se ob osvetlitvi zlato ali srebrno bleščijo. Jamarji to imenujejo "jamsko zlato" oziroma "jamsko srebro" – odvisno od barve posamezne kolonije (Foto 35). So pa to zgolj kapljice kondenzirane vode. Nastanek kapljic povezujejo bodisi s kondenzacijo zračne vlage ali kot posledico bakterijske presnovne aktivnosti. Kljub pogostosti pojava, narava bakterij še ni povsem pojasnjena, saj je mešanica več skupin bakterij (Mulec in sod. 2002; Pašić in sod., 2010). Zanimivo je, da se v jamah prevleke nahajajo vedno nad najvišjo točko vhoda, kjer jih hladen zimski zrak ne doseže, so pa v coni kondenziranja vlage in nad njo oziroma v območju, kjer je nihanje temperature majhno (Porca in sod., 2012). Od vhoda proti notranjosti obseg teh bakterijskih kolonij v Veliki Pasici upada in jih za "oknom" praktično ni več.

EKOLOŠKA OZNAKA ŽIVALSTVA V JAMI

Velika Pasica je najbolj poznana po živalih. Živali, ki jih lahko najdemo v Veliki Pasici, pripadajo tako tistim, ki živijo na kopnem kot onim v vodi. Glede na

of candlestick fungus (*Xylaria hypoxylon*) (Photo 33) and saffrandrop bonnet (*Mycena crocata*) (Photo 34).

On the ceiling of the entrance hall thrives a group of organisms, namely bacteria which play an important role in the cave environment. They are particularly noticeable near the cave entrance, as their up to one millimetre thick colonies are covered with tiny droplets of water, which, when illuminated, cast off colors of silver and gold. Therefore, the cavers have named this phenomenon "cave gold" or "cave silver," depending on the colour (Photo 35). However, the droplets are only condensed water. The origin of these droplets could be explained either as the condensation of humidity in the air or as a result of a bacterial metabolic activity. Although the bacterial colonies are very common in the caves, their nature is not yet completely explained as they are actually a mixture of several groups of bacteria (Mulec et al. 2002; Pašić *et al*., 2010). In the caves, the colonies are always above the highest place of entrance, where they are protected from the cold winter air. They are in the zone of air moisture condensation or above it, *i.e.* in the zone where the temperature oscillations are minimal (Porca *et al*., 2012). In the Velika Pasica cave, the colonies of bacteria are either rare or absent behind the "window".

THE ECOLOGICAL CHARACTERISATION OF THE CAVE FAUNA

The Velika Pasica cave is well known for its fauna. Animals there live in the terrestrial as well as in the aquatic njihovo stopnjo prilagojenosti na podzemno okolje se delijo v tri ekološke skupine.

V prvo spadajo pripadniki vrst, ki so najmanj prilagojeni na jamsko okolje. Imenujejo se **troglokseni** (če so kopenski) ali pa **stigokseni** (če so prebivalci voda). Pripadniki teh vrst najpogosteje živijo v okolici vhodov, globlje v jamah pa le, če segajo jamske razpoke do površja ali jih tekoča voda zanese v jame. Za te živali predstavlja jamsko okolje le začasno življenjsko okolje, saj v njih ne morejo preživeti dlje časa. Med bolj znanimi predstavniki te skupine so med kopenskimi vrstami netopirji in polhi, ki ne kažejo nobenih posebnih morfoloških ali fizioloških prilagoditev na življenje v podzemlju, čeprav se v njem pogosto zadržujejo. Glavna omejitev je namreč hrana, ki si jo morajo iskati izven jam.

Druga skupina živali je že bolje prilagojena na podzemno oziroma jamsko okolje. Imenujejo se **troglofili** oziroma **stigofili**. Ti lahko v jamah preživijo vse svoje življenje in se tam celo razmnožujejo. Imajo tudi prilagoditve, po katerih se ločijo od bližnjih sorodnikov na površju. Med drugim so podzemni predstavniki manj intenzivno obarvani, oči imajo lahko že nekoliko pokrnele, okončine (zlasti noge in tipalke) pa podaljšane.

V tretjo skupino spadajo živali, ki so povsem prilagojene na življenje v podzemlju in to do te mere, da bi na površju zaradi svetlobe in višjih oziroma nižjih temperatur hitro poginile. Imenujejo se **troglobionti** oziroma **stigobionti**. Njihovo pripadnost tej ekološki skupini kaže svetla, bela ali celo prozorna koža oziroma povrhnjica, zelo ali celo povsem pokrnele oči in podaljšane okončine, zlasti noge in tipalke. Predstavniki nekaterih vrst imajo kot odrasli celo zmanjšano število členov, še zlasti na nogah. Za vse je značilno, da bežijo od luči, kadar se jih osvetli (Sket, 2008).

BIODIVERZITETA KOPENSKEGA ŽIVALSTVA

Poleg že prej navedenih jamskih hroščev in polžev, ki so jih našli in opisali specialisti za jamsko živalstvo, so kasnejši raziskovalci navedli še vrsto drugih živali, ki so jih našli v jami. Tako so ob registraciji jame navedli, da so videli oziroma nabrali: "*Titanethes*" (kopenski enakonožec), "Diplopoda" (dvojnonoga oziroma železna kačica), "Araneida" (pajek), "*Lipura*" in "Collembola" (pražuželki), "*Troglophilus*" (jamska

environment. According to their level of adaptation to life in the subterranean environment, they could be divided into three ecological groups.

In the first one are the representatives of the species which are the least adapted to the subterranean life. They are called **togloxenes**, if terrestrial, or **stygoxenes**, if aquatic. The members of that group are frequently found near the cave entrances. They are present in the inner parts of the cave, if cracks are close to the surface or were washed in accidentally by the water. For these animals, the cave environment is only a temporary living place, as they cannot survive there for long time. Among the most well-known terrestrial representatives of the group are bats and edible dormouse, which exhibits no specific morphological or physiological adaptations to life in caves although they do spend a part of their life there. Their main limitation is the source of food which they have to find outside the cave.

The members of the second group are better adapted to the subterranean life, including of that in caves. They are called **troglophiles** or **stygophiles**. They can also live their whole life in the caves and also reproduce there. Their adaptations differentiate them from their relatives on the surface. Among other characteristics, the subterranean representatives are less pigmented, their eyes are partly reduced and their extremities elongated, especially legs and antennules.

The species in the third group are adapted to life in the subterranean environment to such an extent that they would not survive on the surface, due to strong light and different temperature. They are called **troglobites** or **stygobites**. The features of this ecological group are pale, white or even transparent skin or cuticles, very or completely reduced eyes and elongated extremities, especially legs and antennules. The representatives of some species have reduced number of segments, especially on their legs as adults. The characteristics of this group is avoidance of light (Sket, 2008).

THE BIODIVERSITY OF THE TERRESTRIAL FAUNA

Besides the aforementioned cave-dwelling beetles and snails which had been found and registered by the specialists for the subterranean fauna, the researchers found several more species later in the cave. During the registration, they recorded the following species: "*Titanethes*" (a terrestrial isopod), "Diplopoda" (a millipede), "Araneida" (a spider), "*Lipura*" and "Collembola" (members of primitive groups of insects), "*Troglophilus*" (a cave cricket), "'Trichoptera" (a caddis fly), "Coleoptera" (a beetle), "Diptera" (a true fly/mosquito), kobilica), "Trichoptera" (mladoletnica), "Coleoptera" (hrošč), "Diptera" (dvokrilec/komar oziroma mušica), "*Zospeum*" (polž), "*Obisium*" (paščipalec) (DZRJL-1, 1927a).

Bolj podrobni so zapiski Egona Pretnerja, ki je jamo obiskal večkrat in je v jamarski zapisnik tudi navedel več vrst hroščev, ki jih je nabral. Sicer v zapisnikih ni natančnih mest, kje je posamezne osebke našel (DZRJL-4, 1935; DZRJL-6, 1946), vendar velja, da število vrst in osebkov od vhoda v notranjost upada tako po stenah kot tudi na tleh. Na tleh, med odpadlim listjem, delci vejic in kamni prevladujejo hrošči (po katerih je jama pravzaprav zaslovela). V vhodnih delih jame so pogosti primerki troglofilne podvrste *Typhloptrechus bilimeki hacqueti* in prav tako troglofilne vrste *Aphaobius milleri*. Obema delajo družbo predstavniki vrste *Batyschia montana*, ki pa imajo bolj troglobiontske značilnosti. Globlje v jami so njeni predstavniki manj pogosti. Tam jih nadomeščajo osebki troglobiontske vrste *Anophthalmus hirtus*, *Anophthalmus schmidti motschulskyi* in tudi zelo redki predstavniki vrste *Bythoxenus subterraneus*. Vse tri vrste so bile prvič opisane prav po primerkih iz Velike Pasice (Sturm, 1853; Schmidt, 1855, 1860; Pretner, 1974; Vrezec in Kapla, v tisku). Seznam hroščev v jami zaokrožuje še slepi rilčkar (*Troglorhynchus anophthalmus* (Schmidt 1854)), ki pa po Krimu ni zelo razširjen (Vrezec in Kapla, v tisku). Vrsta je pravzaprav edafska, saj normalno živi v prsti na koreninah dreves, občasno pa prispe tudi v jamo. V vhodnem delu jame so bili v vzorcih iz filtrirnih steklenic curkov VP 1 in VP 2 le ostanki mrtvih žvali, ki jih je prenikla voda sprala s stropa.

V celoti je bilo sicer doslej v Veliki Pasici in okoliških jamah najdenih deset vrst jamskih hroščev (Vrezec in Kapla, v tisku), med katerimi pa vrste *B. subterraneus* vsaj do leta 1974 niso več našli (Pretner, 1974).

Na tleh vhodne dvorane živijo še redki predstavniki polžev (Gastropoda), ki so večinoma troglokseni ali troglofili, med njimi pa živijo tudi tri vrste troglobiontskih polžev iz rodu *Zospeum* (jamničar), ki jih lahko opazimo tudi v globljih delih jame na vlažnih kapnikih, a so tam redki. Poleg dveh vrst opisanih po primerkih iz jame, *Z. spelaeum schmidti* in *Z. amoenum*, so v jami našli še osebke tretje vrste, in sicer *Z. frauenfeldi (*Freyer 1855) (Bole, 1974; Rajko Slapnik, ustni vir). Vrsta je bila sicer opisana po osebkih iz druge jame.

"*Zospeum*" (a snail), "*Obisium* " (a pseudoscorpion) (DZRJL-1, 1927a).

The records of Egon Pretner are more detailed, as he visited the cave several times and listed in his caving logs several beetle species he had collected. However, there were no details in his records, where in the cave beetles had been found (DZRJL-4, 1935; DZRJL-6, 1946), but as a rule, the number of species and specimens decrease from the entrance towards the inner part of the cave, on the floor, as well as on the walls. On the floor, among the dead leaves, parts of twigs and stones, live predominantly beetles, which had made the cave so well-known. In the entrance part are common the representatives of troglophilic subspecies *Typhloptrechus bilimeki hacqueti* as well as the troglophilic species *Aphaobius milleri*. Both are accompanied with representatives of *Batyschia montana*, which have more troglobiotic characteristics, but are less common in inner parts. They are replaced with specimens of another troglobiotic species *Anophthalmus hirtus*, *Anophthalmus schmidti motschulskyi* and also very rare *Bythoxenus subterraneus*. All three species were found in the Velika Pasica cave for the first time (Sturm, 1853; Schmidt, 1855, 1860; Pretner, 1974; Vrezec and Kapla, in print). The list of beetles from the cave ends with the blind snout beetle (*Troglorhynchus anophthalmus* (Schmidt 1854)), which is rare on Mt. Krim's massif (Vrezec and Kapla, in print). The species is actually edaphic as its representatives live in soil on the roots of trees, but visit the cave from time to time. In the entrance part of the cave the remains of the dead specimens had been collected three times in filtering bottles at VP1 and VP 2. Their remains were washed by water from the ceiling.

In total, ten cave-dwelling beetle species have been found in the Velika Pasica cave and nearby caves (Vrezec in Kapla, in print) so far, among which the *B. subterraneus* was not found in the cave at least until 1974 (Pretner, 1974).

On the floor in the entrance hall live rare representatives of snails (Gastropoda), most of them trogloxenes or troglophiles. Among them are also representatives of the three species of toglobitic snails, from the genus *Zospeum*, which can be rarely found in the inner part of the cave on wet stalactites. Besides the two species described upon the specimens from the cave, *Z. spelaeum schmidti* and *Z. amoenum*, the representatives of the third species, *Z. frauenfeldi (*Freyer 1855), were found as well (Bole, 1974; Rajko Slapnik, personal communication). The species Z. *frauenfeldi* was described upon the specimens from another cave.

Že okoli leta 1860 je bila v jami najdena tudi troglofilna vrsta dvojnonoge (Diplopoda) vrste *Trachysphaera costata* (Waga 1857), ki je bila v originalu opisana kot *Gervaisia costata* (Waga, 1857). Vrsta je bila sicer opisana po primerkih iz Poljske, vendar je Kiauta (1962) napačno navedel Veliko Pasico kot tipsko nahajališče.

Poleg te komaj 14 mm velike vrste, ki se v nevarnosti zvije v kroglico, se na vlažnem lesu v vhodni dvorani nahajajo še dvojnonoge iz skupine ploskih kačic, od katerih so predstavniki rodu *Polydesmus* troglokseni oziroma troglofili, medtem ko so njihovi sorodniki iz rodu *Brachydesmus* povsem bele barve in imajo bolj troglobiontske prilagoditve (Foto 36). Predstavniki obeh rodov se ob nevarnosti zvijejo v spiralo. Med troglobionte spada tudi še ena dvojnonoga, *Acherosoma largescutatum largescutatum*, ki je bila opisana prav po primerkih iz Velike Pasice (Strasser, 1935).

V prvem jamarskem zapisniku so raziskovalci navedli, da so videli tudi kopenskega enakonožnega raka iz rodu *Titanethes* (jamska mokrica), vendar je bolj verjetno, da so opazili podobnega, malo manjšega predstavnika iz rodu *Androniscus,* ki je prav tako pogost okoli vlažnega in razpadajočega lesa (Foto 37). Družbo jim delajo še skakači (Collembola; brezkrile žuželke), ki pa so verjetno bolj troglofilne kot troglobiontske (Foto 38). Večina skakačev namreč tako ali tako živi med vlažnim in razpadajočim listjem.

Višje, to je po stenah okoli vhoda, se zadržujejo tudi predstavniki pajkov (Aranea), ki so večinoma troglokseni, medtem ko so nekoliko globlje v jami pogosti tudi osebki navadnega čeljustarja (*Meta menardi* Latreille 1804), ki pa je troglofilen (Foto 39). V njihove majhne mreže se zapletajo drobne mušice glivarice (Diptera; družina Mycetophylidae), ki se v zimskem času zatečejo v vhodne dele jame. Družbo jim občasno dela še kakšen komar (družna Culicidae) (Foto 40). Blizu vhoda se zadržujejo tudi redki predstavniki suhih južin (Opiliones) vrste imenovane jamnik (*Amilenus aurantiacus* Simon 1881) (Foto 41), čeprav se v nekaterih drugih jamah pojavljajo masovno. Družbo mu delajo majhni, komaj nekaj milimetrov veliki in majhnim škorpijonom podobni paščipalci (Pseudoscorpiones), ki so bodisi troglokseni (gozdni paščipalec, sicer pogost pod lubjem dreves ali v mahu) ali pa troglobionti (jamski paščipalec). V jami je bil leta 1927 nabran (in leta 1930

Foto 36: Predstavnik rodu *Brachydesmus* na trhlem lesu v vhodni dvorani jame Velika Pasica /Foto: A. Brancelj/.
Photo 36: A representative of the genus *Brachydesmus* on decayed wood in the entrance hall of the Velika Pasica cave /Photo: A. Brancelj/.

Foto 37: Skupina osebkov rodu *Andronicsus* na vlažnem lesu v vhodni dvorani jame Velika Pasica /Foto: A. Brancelj/.
Photo 37: A group of specimens from the genus *Andronicsus* on dump wood in the entrance hall of the Velika Pasica cave /Photo: A. Brancelj/.

Foto 38: Predstavnik jamskih skakačev (Collembola) na vlažnem lesu v vhodni dvorani jame Velika Pasica /Foto: A. Brancelj/.
Photo 38: A representative of the cave-dwelling springtails (Collembola) on dump wood in the entrance hall of the Velika Pasica cave /Photo: A. Brancelj/.

Foto 39: Troglofilna vrsta jamski pajek (*Meta menardi* Latreile 1804) na stropu v bližini jamskega vhoda v jami Velika Pasica / Foto: A. Brancelj/.

Photo 39: The troglophilic species of cave spider (*Meta menardi* Latreile 1804) on the roof of entrance hall in the Velika Pasica cave /Photo: A. Brancelj/.

Foto 40: Samica komarja (Culicidae) med prezimovanjem v jami Velika Pasica /Foto: A. Brancelj/.

Photo 40: A female of the mosquito (Culicidae) during the hibernation period in the Velika Pasica cave /Photo: A. Brancelj/.

Foto 41: Predstavnik suhih južin (Opiliones) vrste imenovane jamnik (*Amilenus aurantiacus* (Simon 1881)) v družbi z jamskimi kobilicami (*Troglophilus neglectus* H. A. Krauss 1879) v jami Velika Pasica /Foto: A. Brancelj/.

Photo 41: A representative of the harvestmen (Opiliones) named *Amilenus aurantiacus* (Simon 1881)) in the company of cave crickets (*Troglophilus neglectus* H. A. Krauss 1879) /Photo: A. Brancelj/.

Around 1860 the representatives of troglophilic pill millipede species (Diplopoda) *Trachysphaera costata* (Waga 1857) were found in the cave, originally described as *Gervaisia costata* (Waga, 1857). The species was actually described after specimens from Poland, but Kiauta (1962) had erroneously reported the Velika Pasica cave as type locality.

Besides the representatives of this, merely 14 mm long species, whose specimens curl in a ball, when in danger, are present also representatives of flat-backed millipedes from the genus *Polydesmus*, living in the moist wood in the entrance hall. They belong to trogloxenes/troglophiles, while their relatives from the genus *Brachydesmus*, which are completely white, have troglobiotic adaptations (Photo 36). The representatives of both genera roll in a spiral when in danger. The troglobites are also representatives of another millipede species, *Acherosoma largescutatum largescutatum*, described upon the specimens from the Velika Pasica cave (Strasser, 1935).

In the first caving log, the researchers reported having found a terrestrial isopod belonging to the genus *Titanethes*, but it is more likely they had found the representatives of another genus, *Androniscus,* which are also commonly found on old wet wood, however, they are smaller (Photo 37). Frequently, they are accompanied by springtails (Collembola; wingless insects), which are probably more troglophiles than troglobites (Photo 38). Most of the springtails live among the moist and decaying leaves.

On the higher places, *i.e.* on the walls around the entrance, the spiders (Aranea) are most commonly represented. Most of them are trogloxenes, while in the more distant places the specimens of cave spider (*Meta menardi* Latreille 1804) are present, a troglophile by definition (Photo 39). They catch tiny flies from the fungus gnats group (Diptera; family Mycetophylidae), into their small nets, which find shelter during the winter in the entrance part of the cave. From time to time, the mosquitos (family Culicidae) (Photo 40) are also found in the cave. During the winter rare representatives of harvestmen (Opiliones) named *Amilenus aurantiacus* Simon 1881 (Photo 41), can be found on the walls near the entrance, although in some other caves, they do form large colonies. On the same places tiny, only a few mm long pseudoscorpion (Pseudoscorpiones) resembling a small scorpions, can be seen. Most of them are trogloxenes, like wood pseudoscorpion, commonly found under the dead bark or in the mosses but some of them are troglobites. One specimen of cave pseudoscorpions, *Chthonius raridentatus* Hadzi 1930, opisan) en primerek vrste *Chthonius raridentatus* Hadzi 1930. Primerke paščipalcev smo kasneje opazili tudi v bližini VP 3, vendar niso bili odvzeti za podrobnejše taksonomske analize. So pa bili ostanki paščipalcev večkrat najdeni v vzorcih iz filtrirnih steklenic na VP 1, VP 2 in VP 3.

Najbolj opazne žuželke, ki se večinoma zadržujejo le v vhodni dvorani, so jamske kobilice, ki ekološko spadajo v skupino troglofilov. V jami živita dve vrsti, *Troglophilus cavicola* (Kollar 1833) in *Troglophilus neglectus* H. A. Krauss 1879, katerih areala razširjenosti se v osrednji Sloveniji prekrivata. Vrsti sta si po videzu precej podobni, tako da le s podrobnejšim ogledom lahko ugotovimo, kateri vrsti osebek pripada (Foto 41, 42). Čeprav lahko večji del življenja preživijo v jamskem okolju, se pogosto podajo tudi na površje, kjer se skrivajo v temnih in vlažnih kotičkih okoli jamskega vhoda. Njihova populacija v Veliki Pasici ni bila nikoli velika, vendar so bile opazne razlike v njihovi številčnosti med posameznimi leti.

Ob prvih hladnih dnevih se že zgodaj jeseni zatečejo v vhodno dvorano predstavniki dveh vrst nočnih metuljev in sicer jamski pedic (*Triphosa dubitata* (Linnaeus 1758)) (Foto 43) ter zobati vrbovček (*Scoliopterix libatrix* (Linnaeus 1758)) (Foto 44). Medtem ko se osebki prve vrste za prezimovanje v jami pogosto združijo v skupinice do pet osebkov, so zobati vrbovčki v tej jami samotarski. Oboji v zimskem času praktično negibno ždijo na enem mestu. Vendar če jamskega pedica osvetlimo z baterijo, se kmalu prebudi iz mirovanja in začne iskati skrivališče, medtem ko so zobati vrbovčki mnogo manj občutljivi na tako motnjo. Osebki zobatega vrbovčka so med prezimovanjem pogosto prekriti s kapljicami vode, podobno kot je to pri "jamskem zlatu" (Foto 45). Pri jamskem pedicu pa prihaja verjetno tudi do spontanih premestitev z enega na drugo mesto prezimovanja, saj je bilo med dvema zaporednima obiskoma večkrat opaženo, da je število ali razporeditev metuljev ob drugem obisku drugačna, kot je bila ob našem zadnjem odhodu iz jame. Med prezimovanjem veliko osebkov obeh vrst pogine in jih kmalu prekrije plesen.

V prvem zapisniku je tudi navedeno, da so opazili primerke iz skupine žuželk Trichoptera (mladoletnice). Nekatere vrste mladoletnic res nekoliko spominjajo na metulja zobati vrbovček, tako da zamenjava z njim ni povsem izključena in da so obiskovalci zmotno

Foto 42: Samica jamske kobilice (*Troglophilus neglectus* H. A. Krauss 1879) iz jame Velika Pasica /Foto: A. Brancelj/.
Photo 42: A female of the cave cricket (*Troglophilus neglectus* H. A. Krauss 1879) from the Velika Pasica cave /Photo: A. Brancelj/.

Foto 43: Predstavnik jamskega pedica (*Triphosa dubitata* (Linnaeus 1758)) iz jame Velika Pasica /Foto: A. Brancelj/.
Photo 43: A representative of the tissue (*Triphosa dubitata* (Linnaeus 1758)) during winter hibernation in the Velika Pasica cave /Photo: A. Brancelj/.

Foto 44: Predstavnik vrste zobati vrbovček (*Scoliopterix libatrix* (Linnaeus 1758)) iz jame Velika Pasica med zimsko hibernacijo / Foto: A. Brancelj/.
Photo 44: A representative of the herald (*Scoliopterix libatrix* (Linnaeus 1758)) during winter hibernation from the Velika Pasica cave /Photo: A. Brancelj/.

Foto 45: S kapljicami kondenzirane vlage pokrita krila zobatega vrbovčka (*Scoliopterix libatrix* (Linnaeus 1758)) iz jame Velika Pasica med zimsko hibernacijo /Foto: A. Brancelj/.
Photo 45: Droplets of condensed water on the wings of the herald (*Scoleopterix libatrix* (Linnaeus 1758)) during the winter hibernation from the Velika Pasica cave /Photo: A. Brancelj/.

Foto 46: Mrtev odrasel osebek mladoletnice (Trihoptera) iz notranjega dela jame Velika Pasica (fotografirano 23. oktobra 2011) /Foto: A. Brancelj/.
Photo 46: A dead adult specimen of the caddisfly (Trichoptera) in the inner part of the Velika Pasica cave (Photo made on 23th October 2011) /Photo: A. Brancelj/.

Foto 47: Predstavniki vrste mali podkovnjak (*Rhinolophus hipposideros* (Bechstein 1800)) se v jami Velika Pasica zadržujejo le pozimi in zlasti v vhodnih delih /Foto: D. Tome/.
Photo 47: Representatives of the lesser horseshoe bat (*Rhinolophus hipposideros* (Bechstein 1800)) are present in the Velika Pasica cave only during the winter, most commonly in the entrance part of the cave /Photo: D. Tome/.

was collected in the cave in 1927, and described in 1930. During the study, one specimen of pseudoscorpions was noticed near the VP 3, but was not collected for detailed taxonomic studies. The remains of cave pseudoscorpions were found several times in filtering bottles at VP 1, VP 2 and VP 3.

The most noticeable insects, which most of the time dwell in the entrance hall, are cave crickets, which are ecologically troglophiles. In the cave live two species, *Troglophilus cavicola* (Kollar 1833) and *Troglophilus neglectus* H. A. Krauss 1879, whose areals slightly overlap in central Slovenia. The species look very similar, thus only upon a very detailed examination, reveals the species of specimens in question (Photos 41, 42). Although they can spend the majority of life in the cave, they do come to the surface from time to time, where they hide in dark and moist places near the cave entrance. Their population in the Velika Pasica cave has never been large, but the differences in population size were noticed.

During the first cold days in early autumn, the representatives of two nocturnal butterflies visit the cave, namely the tissue (*Triphosa dubitata* (Linnaeus 1758)) (Photo 43) and the herald (*Scoliopterix libatrix* (Linnaeus 1758)) (Photo 44). While the specimens of the first species frequently form small groups of up to five specimens, the heralds in this cave are solitary. The specimens of both species stay for a long time motionless in the same place during hibernation. However, when the specimens of the tissue are shined on by lamp, they soon wake up from the hibernation and looks for a shelter, while the heralds are much less sensitive to such a disturbance. The specimens of the herald were during the hibernation frequently covered with tiny water droplets, similar to those in "cave gold" (Photo 45). There might have been a few spontaneous movements in the tissue, from one resting place to another during the winter hibernation. During the two consecutive visits, the number and/or distribution of specimens at the second visit was different than that of the previously recorded one from the last visit. During the hibernation many specimens die and are soon covered with mould.

In the first cave log, the researchers reported to have found specimens of insects from the group Trichoptera (cadiesflies). The adult specimens of some cadiesflies actually resemble the herald, thus misinterpretation could not be completely excluded by the researchers. The caddiesflies are normally common along the streams and rivers, because their larvae live in the water, while the adults stay on riparian vegetation. The wind can carry adults quite far from the zamenjali zobatega vrbovčka z mladoletnico. Mladoletnice so sicer pogoste vzdolž potokov in rek, saj njihove ličinke živijo v vodi, medtem ko se odrasle živali zadržujejo na rastlinju ob reki. Sunki vetra lahko odrasle živali odnesejo tudi na večje razdalje. Med večletnimi raziskovanji v jami je bil le enkrat, tik ob merilnem mestu VP 3, najden že precej razpadel odrasel osebek mladoletnice (Foto 46).

Druga skupina žuželk s podobnimi življenjskimi zahtevami kot mladoletnice so mušice iz skupine trzač (Chironomidae). Odrasle živali spominjajo na komarje, vendar se ne hranijo s krvjo. Njihove ličinke živijo v tekočih ali stoječih vodah. Deset ličink trzač je bilo v času intenzivnih raziskovanj v jami najdenih le enkrat (leta 2008) v vodni kotanjici visoko pod stropom blizu VP 3. Skupina je togloksena, vendar je oplojena samica očitno zašla v jamo, našla vodno kotanjo in vanjo odložila jajca, iz katerih so se razvile mlajše ličinke. Vsekakor ličinke niso imele možnosti, da bi se razvile v odrasle živali, ker ni bilo dovolj hrane zanje in ker se je luža pogosto presušila.

Redni prebivalci jame v zimskem času so tudi netopirji. Veliko let so se v jami zadrževali le predstavniki malih podkovnjakov (*Rhinolophus hipposideros* (Bechstein 1800)), navadno 10–15 osebkov (Foto 47). V jami so bili prisotni od vhoda pa vse do VP 3, medtem ko niso bili nikoli opaženi v zadnji dvorani. Za obdobje 2010–2014 so bili podatki o številu prezimujočih osebkov sporočeni tudi na Center za kartografijo favne in flore, kjer izvajajo monitoring netopirjev (Presetnik in Podgorelec, 2011). Tudi mali podkovnjaki so se med zimskim spanjem občasno premikali z enega mesta na drugo. To je bilo ugotovljeno tako, da je bilo mesto, kjer je bila žival opažena zadnjič, ob naslednjem obisku prazno. Obiski raziskovalcev in jamarjev verjetno niso bili neposreden vzrok za premik, saj so bili ti premiki opaženi tudi na mestih, ki so bili visoko pod stropom ali pa daleč od poti gibanja obiskovalcev. V zimi 2012/2013 je bil v jami prvič opažen tudi en osebek velikega podkovnjaka (*Rhinolophus ferrumequinum* (Schreber 1774)), medtem ko sta bila v letu 2013/2014 prisotna dva. Drugih netopirjev v jami nismo opazili.

Z netopirji povezane živali so se občasno pojavljale tudi v vodnih vzorcih, ki smo jih pobirali od leta 2006 dalje. V dveh vzorcih na točkah VP 3 sta bila tako najdena dva klopa vrste *Eschatocephalus vespertilionis* (C.

Foto 48: Klop vrste *Eschatocephalus vespertilionis* (C. L. Koch 1844) je pogost na netopirjih /Foto: A. Brancelj/.
Photo 48: A tick of the species *Eschatocephalus vespertilionis* (C.L. Koch 1844) is commonly found on the bats /Photo: A. Brancelj/.

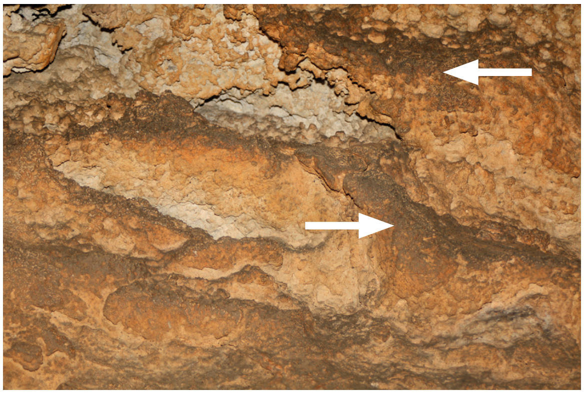


Foto 49: Stečine polhov (*Glis glis* (Linnaeus 1766)) so pogoste na stenah v vhodni dvorani jame Velika Pasica /Foto: A. Brancelj/.
Photo 49: The tracks of the edible dormouse (*Glis glis* (Linnaeus 1766)) are common on the walls in the entrance hall of the cave Velika Pasica /Photo: A. Brancelj/.

Foto 50: Jamski medvedje (*Ursus spelaeus* Rosenmüller 1794) so ob pogostih obiskih jame Velika Pasica nekatere dele skal gladko spolirali (fotografirano 23. novembra 2011) /Foto: A. Brancelj/.
Photo 50: The cave bears (*Ursus spelaeus* Rosenmüller 1794) had polished some parts of rocks into smooth surfaces during their frequent visits of the Velika Pasica cave (Photo made on 23th November 2011) /Photo: A. Brancelj/.

Foto 51: Zasigane kosti jamskega medveda (*Ursus spelaeus* Rosenmüller 1794) /Foto: A. Brancelj/.
Photo 51: The bones of cave bear (*Ursus spelaeus* Rosenmüller 1794) covered with speleothem /Photo: A. Brancelj/.

Foto 52a: Prva znana jamska vodna žival iz jame Velika Pasica je bila slepa kapniška postranica *Niphargus stygius* (Schiödte 1847) /Foto: A. Brancelj/.
Photo 52a: The first known stygobiotic species from the Velika Pasica cave was the blind stalactite amphipod *Niphargus stygius* (Schiödte 1847) /Photo: A. Brancelj/.

Foto 52b: Slepa kapniška postranica *Niphargus stygius* (Schiödte 1847) /Foto: A. Kapla/
Photo 52b: The blind stalactite amphipod *Niphargus stygius* (Schiödte 1847) /Photo: A. Kapla/.

streams. During the several year long research in the cave, a dead specimen of an adult caddiesfly was found only once, located close to VP 3 (Photo 46).

Another group of insects with similar ecological requirements as caddiesflies are flies from the group non-biting midges (Chironomidae). The adults resemble mosquitoes, but they do not feed on blood. Their larvae live in running or standing water bodies. Ten larvae of midges were found during intensive sampling only once, in 2008, in a small pool close to the ceiling near VP 3. The non-biting midges are trogloxenes but fertilised female somehow entered the cave, found a small pool and laid eggs in it. The young larvae managed to hatch but had no chance of reaching the adult stage, as there was not enough food for them and the pool soon dried up.

Another regular inhabitants of the cave during the winter period are bats. For many years only representatives of a lesser horseshoe bat (*Rhinolophus hipposideros* (Bechstein 1800)) were known, numbers reaching usually from 10 to 15 specimens (Photo 47). They were dispersed from the entrance to the VP 3, but not recorded in the fourth, the most distant hall. Between the years 2010 and 2014, the data on the number of hibernating bats were reported to the Centre for Cartography of Fauna and Flora, which are in charge for monitoring of the bats (Presetnik and Podgorelec, 2011). Also, the lesser horshoe bats make occasional moves from one location to another during the hibernation. This was proved by finding an empty location, which had been previously occupied during the last visit. The visits of the cavers and researchers were probably not the reason for the movements, as the latter had been observed also for places located high on the ceiling or far from normal visitor path. A specimen of the greater horseshoe bat (*Rhinolophus ferrumequinum* (Schreber 1774)) was recorded in winter 2012/2013 for the first time, while in the winter 2013/ 2014, two had been recorded. The representatives of other species of bats were not observed.

Since 2006 some animals connected with bats have been occasionally collected in the water samples. For example, in the two samples at VP 3, two specimens of tick *Eschatocephalus vespertilionis* (C. L. Koch 1844) (Ixodidae) were collected, which had probably hosted on the bats hibernating near the water jets. Attentive visitors can find ticks on the walls, as well (Photo 48).

There were only footprints, tracks and signs of other mammals visiting the cave, limited to the entrance hall: a marten (excrements); a wood mouse (footprints in the mud)

L. Koch 1844) (Ixodidae), katerih gostitelji so bili lahko netopirji, ki so se zadrževali okoli curka prenikajoče vode. Pozornejši obiskovalci pa jih lahko najdejo tudi na jamskih stenah (Foto 48).

Od drugih sesalcev so bili v jami opaženi le sledovi in še to le v vhodni dvorani: kuna (iztrebek); gozdne miši (odtisi nog v blatu) in polh (odtisi nog v blatu, iztrebki, stečine). Polh (*Glis glis* (Linnaeus 1766)) je sicer pogost v gozdovih okoli jame, vendar ni bil v jami opažen nikoli. So pa v vhodni dvorani po stenah zelo pogoste njegove stečine, ki so zaznane kot nekoliko temnejše lise po policah na jamskih stenah (Foto 49). V jamo hodijo polhi poleti verjetno pit vodo, saj so bile njihove sledi in številni iztrebki najdeni v času suše okoli blatnih kotanj in enkrat celo na merilniku pretoka prenikle vode. Niso pa bili nikoli opaženi med zimskim spanjem.

V jamo se je zatekal tudi jamski medved (*Ursus spelaeus* Rosenmüller 1794), ki je izumrl ob koncu zadnje ledene dobe (pred okoli 30.000 leti; http 7). Sledovi njegovih obiskov so zabeleženi v obliki gladko spoliranih površin okoli meter nad jamskim dnom v neposredni bližini brezna pri VP 2 (Foto 50). Na enem mestu so v jami prisotne tudi njegove kosti (Foto 51).

BIODIVERZITETA VODNEGA ŽIVALSTVA

Do leta 2000 je bila iz jame kot ena od redkih vodnih vrst poznana le kapniška slepa postranica *Niphargus stygius* (Schiödte 1847) (Foto 52a, b), ki so jo avtorji prvega jamarskega zapisnika navedli kot "*Niphargus* sp. " v jami Mala Pasica (DZRJL-1, 1927b). Poleg nje so kasneje biologi našli še drobnega jamskega vodnega polžka iz rodu *Hauffenia* (kasneje določenega kot *H. michleri* (Kuscer 1932) ter jamskega ceponožca vrste *Speocyclops infernus* (Kiefer 1930) (Brancelj, 2000) (Foto 53). Za majhno jamo, nahaja se 300 m visoko nad sedaj aktivno hidrološko mrežo, so bile te tri vodne vrste, vse stigobiontske, že kar presenetljivo veliko število.

Podrobno jemanje vzorcev živalstva iz različnih tipov lužic v jami leta 2000 pa je razkrilo nepričakovano veliko število vodnih organizmov, ki jih ne bi pričakovali v jami plitvo pod površjem in še tik pod vrhom hriba (Tabela 7). Luže so bile v času prvega vzorčenja razdeljene v tri skupine: A) na strmih pobočjih oziroma na stenah, ki jih neposredno polni prenikla voda, z malo

and an edible dormouse (footprints in the mud, excrements and tracks). The edible dormouse (*Glis glis* (Linnaeus 1766)) is common in the nearby woods, but had never been seen in the cave. However, in the entrance hall their trails are very common, which can be noticed as darker lines along the rocky shelfs on the cave walls (Photo 49). In the summer, they visit the cave to drink water there as their footprints and numerous excrements were found around the pools and once even on the discharge meter. They had never been observed during hibernation.

The cave has also been visited by a cave bears (*Ursus spelaeus* Rosenmüller 1794), which had been extinct since the end of the last glacier period (about 30,000 years ago; http 7). Signs of their visits could be recognised as smoothly polished surfaces of stones about one metre above cave floor near shaft at VP 2 (Photo 50). On one place, there were also remains of their bones (Photo 51).

THE BIODIVERSITY OF THE AQUATIC FAUNA

The cave has been known since 2000 for one of the few aquatic species, the "blind stalactite amphipod," *Niphargus stygius* (Schiödte 1847) (Photos 52a, b), which was recorded in the first caving log as "*Niphargus* sp." from the Mala Pasica cave (DZRJL-1, 1927b). Besides the latter, the biologists found the representatives of tiny stygobiotic snail from the genus *Hauffenia* (later identified as *H. michleri* (Kuscer 1932) and stygobiotic copepod *Speocyclops infernus* (Kiefer 1930) (Brancelj, 2000) (Photo 53). For a small cave, situated about 300 m above an actual active hydrological network finding all three stygobiotic species, is a surprisingly high number.

The detailed samplings in the cave from different types of pools in 2000 revealed a surprisingly high number of aquatic organisms which would not be expected in a cave, right below the surface as well as just below the top of a hill (Table 7). During the first samplings, the pools were separated into three types: A) pools on the wall or steep slopes, filled directly by the drip water and with low amount of organic material on the bottom; B) rime stone pools on the floor, rich in organic matter and C) pools on clay substrate. During the eight sampling campaigns, 135 samples were collected and only ten with no animals. In the samples were predominantly the representatives of the group Harpacticoida (Brancelj, 2002). Eleven species of copepods and one species of amphipods were collected

Foto 53: Vrsta *Speocyclops infernus* (Kiefer 1930) je bila dolgo časa edina znana vrsta rakov ceponožcev (Copepoda, Cyclopoida) iz jame Velika Pasica /Foto: A. Brancelj/.
Photo 53: The *Speocyclops infernus* (Kiefer 1930) was for a long time the only known species of the copepods (Copepoda, Cyclopoida) from the Velika Pasica cave /Photo: A. Brancelj/.

organske snovi na dnu; B) na dnu rovov v sigastih ponvicah, bogatih z organsko snovjo in C) lužice na ilovnatih tleh. V osmih vzorčevalnih akcijah je bilo tedaj pobranih 135 vzorcev in le v desetih ni bilo vodnih živali. V vzorcih so prevladovali ceponožci iz skupine Harpacticoida (Brancelj, 2002). V 125 vzorcih z živalmi je bilo takrat nabranih 11 vrst ceponožcev in ena vrsta postranice. Med 11 vrstami ceponožcev je bila ena vrsta najdena samo enkrat (*Elaphoidella cvetkae* Petkovski 1983) in še takrat le ena samica. Predstavniki ostalih vrst so bili v vzorcih še večkrat prisotni, vendar nekateri le z nekaj osebki. Primerjava prisotnosti vrst in števila osebkov posameznih vrst v različnih tipih lužic je pokazala, da luže za večino nabranih vrst ne predstavljajo optimalnega okolja. Nasprotno, za večino je bilo okolje tuje in neprimerno, saj zaradi pomanjkanja hrane in zaradi tekmovalnosti med vrstami, kar je v najhujši obliki predstavljalo celo medsebojno plenjenje, so populacije posameznih vrst izginjale iz lužic (Brancelj, 2002). Tudi znaki razmnoževanja (samci in samice v parih (kopula),

from 125 samples. Among the 11 species of copepods, one recorded species was only once represented by a single female (*Elaphoidella cvetkae* Petkovski 1983). The representatives of other species were present in the samples several times, although some of them with a low number of specimens. The comparison in number of species and the number of their specimens revealed that the pools were not an optimal habitat for the majority of collected species. Quite the opposite, for most of them the environment was hostile as a result of lack of food and intense competition, which in the most extreme situation resulted in predation. Thus, the populations of some species disappeared from the pools (Brancelj, 2002). The signs of reproduction (males and females in couples (*copula*), females with spermatophores, females with eggs) were rarely observed in the pools, which was an additional sign that the environment was not optimal for those species. However, it appeared that representatives of some species were more common than others. As species with higher

Tabela 7: Seznam vodnih organizmov, pobranih iz luž in curkov prenikle vode iz jame Velika Pasica (Slovenija) ter bližnjega vodnega zbiralnika in izvira Močilo (kot bentos ali plavje) v obdobju od leta 2000 do leta 2015; * - stigobiont; # - stigofil; + - edafski (v vlažni prsti); ? - neznan ekološki status. Podčrtano – vrste, najdene v jami Velika Pasica.
Table 7: The list of the aquatic organisms collected from puddles and water jets of drip water in the Velika Pasica cave (Slovenia) as well as from the nearby reservoir and spring Močilo (as benthos or drift) in the period from 2000 to 2015; * - stygobite; # - stygophile; + - edaphic (in dump soil); ? - unknown ecological status. Underlined – species collected in the Velika Pasica cave.

Višji takson / *Higher taxon*	Skupina /*Rod, Vrsta* / Group /*Genus, Species*	Opomba / *Comment*
Praživali / *Protozoans* (Protozoa)	Ciliata (nedoločeno, 1 vrsta)* / (*undetermined, 1species*)	epibiont na ceponožcih / *epibiont on the copepods*
	Suctoria (nedoločeno, 1 vrsta)* / (*undetermined, 1species*)	epibionti na ceponožcih / *epibiont on the copepods*
Vrtinčarji / *Turbellarians* (Turbellaria)	Rhabdocoela (nedoločeno, 1 vrsta)? / (*undetermined, 1species*)	zbranih 6 osebkov / *6 specimens collected*
Gliste / *Nematodes* (Nematoda)	več vrst (nedoločeno)? / *several species (undetermined)*	tudi edafske / *edaphic included*
Kotačniki / *Wheel animals* (Rotatoria)	*Adineta gracilis* Jansen 1893+	H. Segers; ustno / *pers. comm.*
	Habrotrocha sp.+	H. Segers; ustno / *pers. comm.*
	Keratella hiemalis Karlin 1943+	samo v zbiralniku / *only in the reservoir*
Polži / *Snails* (Gastropoda)	*Hauffenia michleri* (Kuscer 1932)*	tudi v zbiralniku / *also in the reservoir*
	Frauenfeldia kusceri (A. Wagner 1914)*	samo v zbiralniku / *only in the reservoir*
Mnogoščetinci / *Polychetes* (Polychaeta)	*Aelosoma* sp.*	B. Sambugar; ustno / *pers. comm.*
Maloščetinci / *Earthworms* (Oligochaeta)	*Enchytraeus* gr. *buchholzi*+	B. Sambugar; ustno / *pers. comm.*
	Fridericia sp. A+	B. Sambugar; ustno / *pers. comm.*
	Fridericia sp. B+	B. Sambugar; ustno / *pers. comm.*
	Haplotaxis gordioides (Hartman 1821)#	B. Sambugar; ustno / *pers. comm.*
Dvoklopniki / *Seed shrimps* (Ostracoda)	*Pseudocandona albicans* (Brady 1864)#	tudi plavje iz izvira / *also the drift from the spring*
Ceponožci / *Copepods* (Copepoda)	*Acanthocyclops v. venustus* (Norman & Scott 1906)*	samo iz zbiralnika in plavje iz izvira / *only from the reservoir and the drift from the spring*
	Bryocamptus balcanicus (Kiefer 1933)*	v lužah v letu 2000 / *in the puddles in 2000*
	Bryocamptus pyrenaicus (Chappuis 1923)*	luže v jami, plavje iz izvira / *the puddles in the cave, the drift from the spring*
	Bryocamptus pygmaeus (G.O. Sars 1862)#	plavje iz izvira, bentos / *the drift from spring, benthos*
	Bryocamptus typhlops (Mrazek 1893)*	
	Diacyclops clandestinus Kiefer 1933*	plavje iz izvira / *the drift from the spring*
	Diacyclops languidoides (Lilljeborg 1901)*	plavje iz izvira / *the drift from the spring*

Višji takson / *Higher taxon*	Skupina /*Rod*, *Vrsta* / Group /*Genus, Species*	Opomba / *Comment*
	Elaphoidella cvetkae Petkovski 1983*	en osebek v luži leta 2000 / *one specimen found in a puddle in 2000*
	Elaphoidella millennii Brancelj 2009*	tudi plavje iz izvira / *also the drift from the spring*
	Elaphoidella tarmani Brancelj 2009*	tudi plavje iz izvira / *also the drift from the spring*
	Epactophanes richardi Mrazek 1893#	samo v zbiralniku / *only in the reservoir*
	Graeteriella unisetigera (Graeter 1908)*	samo v izviru / *only in the spring*
	Maraenobiotus slovenicus Brancelj & Karanovic 2015*	samo v izviru / *only in the spring*
	Moraria poppei (Mrazek 1893)#	tudi plavje iz izvira / *also the drift from the spring*
	Moraria varica (Graeter 1910)#	tudi plavje iz izvira / *also the drift from the spring*
	Morariopsis dumonti Brancelj 2000*	
	Paracyclops fimbriatus (Fischer 1853)#	samo v zbiralniku / *only in the reservoir*
	Parastenocaris nolli alpina Kiefer 1969*	
	Phyllognathopus vigueri (Maupas 1892)+	tudi plavje iz izvira / *also the drift from the spring*
	Speocyclops infernus (Kiefer 1930)*	tudi plavje iz izvira / *also the drift from the spring*
Postranice / *Amphipods* (Amphipoda)	*Niphargus stygius* (Schiodte 1847)*	tudi v zbiralniku in izviru / *also in the reservoir and spring*
Enakonožci / Isopods (Isopoda)	*Monolistra caeca ssp.**	samo v zbiralniku / *only in the reservoir*

samice s paketi spermijev (spermatofori), samice z jajci) so bili v lužicah le redko opaženi, kar je bil še dodaten znak, da okolje ni najbolj primerno za te vrste. Vendar se je pokazalo, da so posamezne vrste v nekaterih tipih lužic bolj pogoste kot v drugih. Kot vrste, ki zahtevajo/prenašajo okolje z več organske snovi, so se izkazali predstavniki vrst *Elaphoidella millennii* Brancelj 2009, *Moraria varica* (Graeter 1910), *Moraria poppei* (Mrazek 1893), *Morariopsis dumonti* Brancelj 2000 in *Phyllognathopus vigueri* (Maupas 1892).

Osebki drugih treh vrst, *Bryocamptus balcanicus* (Kiefer 1933), *Parastenocaris nolli alpina* Kiefer 1969 in *Bryocamptus typhlops* (Mrazek 1893), so bili bolj pogosti v lužicah z le malo organske snovi. Predstavniki ostalih štirih vrst, *Bryocamptus pyrenaicus* (Chappuis 1923), *E. cvetkae*, *E. tarmani* Brancelj 2009 in *S. infernus*, so bili

requests/tolerance on organic material appeared to be *Elaphoidella millennii* Brancelj 2009, *Moraria varica* (Graeter 1910), *Moraria poppei* (Mrazek 1893), *Morariopsis dumonti* Brancelj 2000, and *Phyllognathopus vigueri* (Maupas 1892).

The specimens of other three species, *Bryocamptus balcanicus* (Kiefer 1933), *Parastenocaris nolli alpina* Kiefer 1969 and *Bryocamptus typhlops* (Mrazek 1893) were common in the pools with a low amount of organic material. The specimens of four species, *Bryocamptus pyrenaicus* (Chappuis 1923), *E. cvetkae*, *E. tarmani* Brancelj 2009 and *S. infernus* were common in the pools with some organic material and clay on the bottom. The pools with clay bottom were considered to be the least suitable habitat, where only specimens of *S. infernus* were present.

bolj pogosti v lužicah z nekaj organske snovi in ilovico po tleh. Za najmanj primerne so se izkazale lužice, kjer je prevladovala po dnu le ilovica. V teh lužah so bili pogosto le osebki vrste *S. infernus*.

Poleg naštetih vrst ceponožnih rakov so bili v lužicah najdeni takrat še nedoločeni osebki dvoklopnikov (Ostracoda), ki so bili kasneje določeni kot *Pseudocandona albicans* (Brady 1864) (Foto 54) in predstavniki postranic (*N. stygius*). Slednji so zaradi velikosti in plenilskega načina prehranjevanja močno vplivali na sestavo živalstva v lužicah. To je bil tudi eden od verjetnih razlogov, zakaj so bile druge vrste vodnih organizmov v lužah razmeroma redke. Poleg njih so bili v nekaterih vzorcih iz luž prisotni še predstavniki deževnikom podobnih vrst (Oligochaeta), ki poleg dvoklopnikov prav tako niso bili navedeni v članku o razporeditvi ceponožcev v Veliki Pasici (Brancelj, 2002).

Vzorčenja vodnega zbiralnika (je iz dveh delov: usedalnika z dotokom izvirske vode, volumen zbiralnika 2 m^3; in glavnega zbiralnika oziroma shranjevalnika, volumen zbiralnika 400 m^3) ter izvira Močilo so pokazala, da je vodna favna v njih dokaj drugačna od tiste iz jame, čeprav so sistemi hidrološko povezani. V vzorcih, ki so bili odvzeti iz vodnega zbiralnika oziroma izvira Močilo, so bile nekatere tipično epikraške vrste odsotne, medtem ko so se pojavile nekatere dodatne vrste, značilne za okolje, kjer so večja in bolj stalna podzemna vodna telesa. Med vrstami, ki ne živijo v jami, je vrsta kotačnika *Keratella hiemalis* Karlin 1943 (Rotatoria), sicer zelo pogosta v površinskih stoječih vodah ter stigobiontska izvirska vrsta polža *Fraunfeldia kusceri* (A. Wagner 1914) (Gastopoda) (Tabela 7). Med vrstami na seznamu podzemnih vodnih organizmov izstopa ceponožec vrste *Acanthocyclops v. venustus* (Norman & Scott 1906), ki je za podzemne ceponožce razmeroma velik (1,0–1,3 mm), kar kaže da je prebivalec nekoliko večjih podzemnih prostorov in ni član epikraške združbe. Dodatne vrste, ki so sicer pogoste v podzemnih vodah, a niso del epikraške združbe so še ceponožci *Diacyclops clandestinus* Kiefer 1933, *D. languidoides* (Liljeborg 1901), *Epactophanes richardi* Mrazek 1893, *Graeteriella unisetigera* (Graeter 1908), *Maraenobiotus slovenicus* Brancelj & Karanovic 2015 in *Paracyclops fimbriatus* (Fischer 1853). Večina jih je pogostih tudi v vlažni prsti okoli močil (helokreni izviri), medtem ko se v samem epikrasu praviloma ne pojavljajo.

Besides the above listed species of copepods, at that time unknown specimens of seed shrimps (Ostracoda), were found in the pools, which were later identified as *Pseudocandona albicans* (Brady 1864) (Photo 54), and representatives of amphipods (*N. stygius*). The latter significantly effected the community's composition of fauna in the pools as a result of their size and feeding habits. This was probably the main reason for the scarcity of other organisms in the pools. Beside the amphipods, other earthworms-like specimens (Oligochaeta) were present in the pools. During the first study, they were not included in the article, along with ostracods, on the distribution of copepods in the Velika Pasica cave (Brancelj, 2002).

The sampling of the water reservoir, which is composed of two sections: the sedimentation basin with the inflow of spring water, with volume of 2 m^3 and of the main reservoir; with volume of 400 m^3 and the Močilo temporary spring revealed, that the fauna there was different from that in the cave, although the systems are hydrologically interconnected. On the one hand, in the samples collected from the reservoir and the spring some typical epikarst species were absent, while on the other, some animals characteristic for bigger and more stable aquifers, were present. Among the species never found in the cave, was a wheel animal *Keratella hiemalis* Karlin 1943 (Rotatoria), a common species in the stagnant epigean water bodies, and stygobiotic spring-dwelling snail species *Fraunfeldia kusceri* (A. Wagner 1914) (Gastropoda) (Table 7). Among the species from the list of the groundwater species, copepod *Acanthocyclops v. venustus* (Norman & Scott 1906) stands out, which is relatively big for groundwater-dwelling copepods (1.0–1.3 mm), indicating that it is an inhabitant of bigger subterranean systems and is not a member of epikarst community. An additional species, rather common in the groundwater, but not a part of the epikarst community were the copepods *Diacyclops clandestinus* Kiefer 1933, *D. languidoides* (Liljeborg 1901), *Epactophanes richardi* Mrazek 1893, *Graeteriella unisetigera* (Graeter 1908), *Maraenobiotus slovenicus* Brancelj & Karanovic 2015 and *Paracyclops fimbriatus* (Fischer 1853). Several of them are common in wet soil around sepeage (helocrene) springs but they are not preset in the epikarst.

Among the more interesting members of stygobiotic fauna are the representatives of about one

Foto 54: Predstavnik rakov dvoklopnikov (Ostracoda) vrste *Pseudocandona albicans* (Brady 1864) spada med troglofilne vrste /Foto: A. Brancelj/.
Photo 54: A representative of the seed shrimps (Ostracoda), *Pseudocandona albicans* (Brady 1864), belonging to the troglophiles /Photo: A. Brancelj/.

Med bolj zanimivimi najdbami so tudi osebki okoli centimeter velikih enakonožcev (Isopoda) iz skupine jamskih ježkov (rod *Monolistra*, Spaeromatidae), ki so bili doslej najdeni le v vodnem zbiralniku. Pripadajo nedoločeni podvrsti *Monolistra ceaeca* (Boris Sket, ustni vir). Dve podvrsti sta znani iz več izvirov na vznožju Krima (http 8), tako visoko pa še ni bila najdena.

Skupno je bilo doslej v jami Velika Pasica, vodnem zbiralniku ter izviru Močilo najdenih najmanj 37 vrst vodnih organizmov, ki jih uvrščamo v skupini stigobiontov in stigofilov (vključno z nekaj edafskimi vrstami) (Tabela 7). Jama je s tem uvrščena na seznam tistih z veliko vrstno raznolikostjo (biodiverziteto), pri čemer velja omeniti, da je to posledica zelo podrobnih raziskav njene favne. Kljub temu je zaradi svoje visoke nadmorske višine še vedno posebnost med jamami.

Že leta 2000 je vzorčenje vodnega živalstva pokazalo, da je biodiverziteta in število osebkov v jami Velika Pasica največja v vzorcih v bližini stalnih curkov, katerih aktivnost se je povečala po močnejšem dežju oziroma taljenju snega. Dodatna naključna in nesistematična vzorčenja po letu 2000 so le potrdila omenjena opazovanja. Zato je bila leta 2006 sprejeta odločitev, da se natančneje spremlja fizikalne, kemijske in biološke spremenljivke v štirih stalnih curkih prenikle vode, ki so bili do takrat ugotovljeni v jami.

centimetre long isopods (Isopoda) from a group of "cave hedgehogs" (genus *Monolistra*, Spaeromatidae), which were so far found only in the reservoir. They belong to undetermined species *Monolistra ceaeca* (Boris Sket, personal communication). Two subspecies were found in several springs on the foothill of Mt. Krim (http 8) but it was be found at such an altitude for the first time.

In the Velika Pasica cave, in the reservoir and the Močilo temporary spring have so far been found 37 species of aquatic organisms which belong to stygobites or stygophiles (including some edaphic species) (Table 7). The cave could be included on the list of caves with high biodiversity, which is actually a result of a very detailed research on fauna there. And taking its high elevation into consideration, it is still unique among the caves.

In 2000 the sampling of aquatic fauna had already indicated that the biodiversity and abundance of the specimens in the Velika Pasica cave was the highest in the vicinity of the water jets, whose activity increased after a heavy rain or snowmelt. Additional random and non-systematic samplings after 2000 confirmed above mentioned observations. As a result, a decision was made in 2006 for more a detailed monitoring of physical, chemical and biological parameters at the four permanent water jets, which had been recognised in the cave.

EKOLOGIJA VODNIH VRST

Vzpostavljena je bila mreža štirih merilnih mest za natančno spremljanje fizikalnih, kemijskih in favnističnih značilnosti posameznih curkov. Z vzorčenjem curkov prenikle vode so bile v fine mreže ulovljene živali, ki jih je voda odnesla kot plavje (drift). Plavje je opredeljeno kot pojav, pri katerem vodne organizme nosi vodni tok in ima različne vzroke: A) so del normalnega življenjskega cikla živali, B) gre za beg pred plenici, C) je reakcija na nenadno poslabšanje življenjskih razmer, D) nesrečen/slučajen dogodek (Waters, 1965). Za plavje iz epikrasa nad jamo smo predvidevali, da je v večini primerov splet nesrečnih okoliščin, kjer so živali s tokom vode prispele v curek in jih je izpralo na dno jamskih rovov, kjer je bila njihova usoda različna (Brancelj, 2004, 2005, 2009, 2011).

V obdobju od maja 2006 do oktobra 2013 je bilo v vsakem curku pobranih po 88 vzorcev živali, ki so bili pobirani v 1–2 mesečnih intervalih. Iz curkov prenikle vode je bilo ulovljenih 1.760 osebkov ceponožnih rakov in dvoklopnikov , ki so pripadali 12 vrstam stigobiontov oziroma stigofilom (Tabela 7). Poleg *E. cvetkae*, najdene leta 2000, v curkih tudi nikoli ni bila najdena vrsta *B. balcanicus*, sicer pogosta v lužah leta 2000. Večina osebkov v vzorcih je pripadala ceponožcem (10 vrst), po ena vrsta pa skupinama dvoklopnikov in postranic.

Primerjava med številom ulovljenih osebkov ter volumnom precejene vode je pokazala, da je bila gostota plavja med 2 (VP 1) in 20 (VP 2) organizma na m^3 vode (Tabela 8). Upoštevajoč še ostale skupine (med njimi so bili najštevilčnejši maloščetinci) je bila gostota plavja še nekoliko večja. V primerjavi s plavjem iz alpskih izvirov (Mori in sod., 2015) so vrednosti v jami, zlasti iz curkov VP 2 in VP 3, celo višje.

Podoben seznam vrst iz leta 2000 in 2006–2013 (razen dveh vrst) potrjuje hipotezo, da je plitvi kraški vodonosnik nad jamskimi rovi pravo življenjsko okolje za osebke večine najdenih vrst. Vendar jih nekaj prenikajoča voda občasno v obliki plavja odnese iz špranj in zato so to osebki, ki za nadaljnje razmnoževanje predstavljajo izgubljeno populacijo (angl.: sink population) (Brancelj in Culver, 2005).

Poleg ceponožcev, dvoklopnikov in postranic, katerih predstavniki so bili določeni do vrst, so bili v vzorcih še predstavniki drugih skupin. Zlasti pogosti

THE ECOLOGY OF THE AQUATIC SPECIES

A network of four measuring locations was established for the detailed monitoring of the physical, chemical and faunistic characteristics of the water jets. During the sampling of individual water jets, the organisms which had been washed away by water as drift, were collected. The definition of the drift is when aquatic organisms are transported by the water current and has different causes: A) it is a part of normal life cycle of organisms, B) escape from the predators, C) a reaction to sudden worsening of life conditions, D) an accidental/random event (Waters, 1965). The drift of the organisms from the epikarst zone was hypothesised as an accident, where animals had entered the current and were washed on the floor of galleries, where they were left to their fate (Brancelj, 2004, 2005, 2009, 2011).

In a period between May 2006 and October 2013, 88 samples of fauna were collected in each water jet, which had been sampled in 1–2 month intervals. 1,760 specimens of the copepods and ostracods, which belonged to 12 species of stygobites or stygophiles (Table 7) were collected. Along with *E. cvetkae*, found only once in 2000, the specimens of *B. balcanicus* were also absent in the water jets, which used to be quite common in the pools in 2000. Most of the species belonged to the copepods (10 species), while the ostracods and the amphipods were represented with one species each.

The comparison of the number of collected specimens and the volume of filtered water revealed that the density of the drift was between 2 (VP 1) and 20 (VP 2) specimens per m^3 of water (Table 8). Considering the members of other groups, with oligochaets as the most common, the density of the drift was even higher. In comparison to the drift from the Alpine springs (Mori *et al.*, 2015) the values from the cave, particularly from VP 2 and VP 3 were higher.

A similar list of the species from 2000 and 2006–2013, except for two, supports the hypothesis that the shallow karstic aquifer just above corridors is the real habitat for most of the species. Some specimens were occasionally washed away by the drift and consequently represent the sink population in terms of reproduction (Brancelj and Culver, 2005).

Besides the copepods, ostracods and amphipods whose representatives were determined to the species level, other groups were present in the samples as well. The most common among them were the wheel animals (Rotatoria) (Photo 55) and the earthworms (Oligochaeta), but they were not used in detailed analyses due to the incomplete taxonomic determination.

Tabela 8: Seznam stigobiontskih (poudarjeno) in stigofilnih (podčrtano) vrst iz štirih curkov v jami Velika Pasica (Slovenija), ki so bilo pobrani v obdobju od maja 2006 do februarja 2013; skupaj 88 vzorcev na curek. (# - Ostracoda; * - Amphipoda). Dodana je še statistika vrst ter podatki o pretoku in gostoti plavja (drifta).
Table 8: The list of stygobiotic (bold) and stygophilic (underline) species from the four water jets in the Velika Pasica cave (Slovenia) collected in the period from May 2006 to February 2013; in total 88 samples per water jet. (# - Ostracoda; * - Amphipoda). At the bottom of the table are the species statistics, the data on discharge and the density of drift.

	VP 1	VP 2	VP 3	VP 4	
Vrsta / *Species*	Št. osebkov / *No. of specimens*	Št. osebkov / *No. of specimens*	Št. osebkov / *No. of specimens*	Št. osebkov / *No. of specimens*	Skupaj št. osebkov / *No. of specimens*
Bryocamptus pyrenaicus (Chappuis 1923)	3	3	140	-	146
Bryocamptus typhlops (Mrazek 1893)	1	52	1	1	55
Elaphoidella millennii Brancelj 2009	3	-	35	1	39
Elaphoidella tarmani Brancelj 2009	-	-	2	-	2
Moraria poppei (Mrazek 1893)	-	7	2	-	9
Moraria varica (Graeter 1910)	-	-	-	240	240
Morariopsis dumonti Brancelj 2000	48	632	147	2	829
****Niphargus stygius*** (Schiodte 1847)	3	-	-	1	4
Parastenocaris nolli alpina Kiefer 1969	4	-	-	-	4
Phylognathopus viguieri (Maupas1892)	1	1	1	-	3
#*Pseudocandona albicans* (Brady 1864)	186	2	9	-	197
Speocyclops infernus (Kiefer 1930)	130	15	61	6	212
Skupno št. stigobionskih (stigofilnih) vrst / *Total No. of stygobiotic (stygophilic) species*	7(2)	4(3)	6(3)	5(1)	8(4)
Skupno št. ceponožcev / *Total No. of. the copepods*	190	710	389	250	1539
Skupno št. vseh osebkov / *Total No. of all specimens*	379	712	398	251	1740
Celoten volumen prenikle vode v obdobju (m^3) / *Total volume of drip water in the study period (m^3)*	230	36	82	78	426
Povprečen pretok v obdobju ($L\ h^{-1}$) / *The average discharge in the study period ($L\ h^{-1}$)*	3,74	0,57	1,33	1,26	
Št. osebkov na volumen vode (osebkov m^{-3}) / *No. of specimens per volume of discharged water (specimens m^{-3})*	1,65	19,78	4,85	3,21	4,08

so bili kotačniki (Rotatoria) (Foto 55) in maloščetinci (Oligochaeta), vendar zaradi pomanjkljive določitve nismo mogli uporabiti podatkov za podrobnejše ekološke raziskave.

V skupinah, kjer so bili osebki določeni do vrst, so v treh curkih (VP 2, VP 3 in VP 4) več kot 95 % vseh osebkov predstavljali ceponožci, le v VP 1 so prevladovali dvoklopniki nad ceponožci (186 osebkov

In the groups where specimens were determined to the species level, in three water jets (VP 2, VP 3 and VP 4) more than 95 % of all the specimens were the copepods. Only in VP 1 were the ostracods predominant over copepods (186 specimens of ostracods: 130 specimens of *S. infernus* and 48 specimens of *M. dumonti*). Many specimens of *M. dumonti* were infested with numerous epibionts from the Suctoria group (Photo 19).

dvoklopnikov : 130 osebkov vrste *S. infernus* in 48 osebkov vrste *M. dumonti*). Med osebki *M. dumonti* so bili nekateri poseljeni s številnimi enoceličnimi epibionti iz skupine Suctoria (Foto 28).

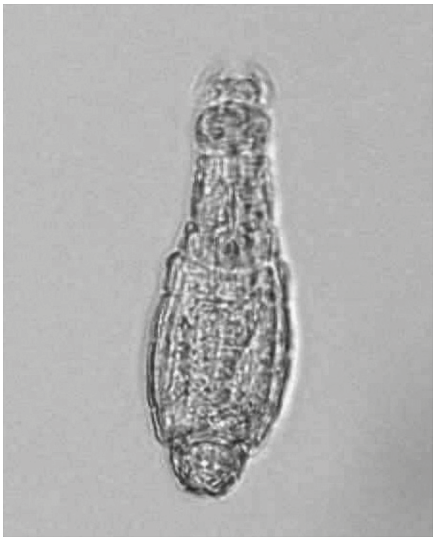
Število osebkov posameznih vrst je bilo v vzorcih zelo različno (Tabela 8). Najpogostejši so bili osebki vrste *M. dumonti,* saj so predstavljali skoraj polovico vseh ujetih (47,6 % oziroma 829 osebkov od skupno 1740 ujetih). Sledile so ji še štiri vrste, kjer je bilo v celotnem obdobju ulovljenih več kot 100 osebkov (*M. varica* – 240 osebkov, *S. infernus* – 212 osebkov, *P. albicans* – 197 osebkov in *B. pyrenaicus* – 146 osebkov). Glede na številčnost je očitno, da je za te vrste epikras verjetno primarno okolje, od koder se v obliki plavja pomikajo v nižje ležečo vadozno (hidrološko nezasičeno) cono. Vendar je vrsta *P. albicans* pogosta tudi na vlažnih mestih okoli manjših izvirov (Fabio Stoch, ustni vir). Kar pet vrst pa je takih, da je bilo v vseh letih iz curkov ujetih manj kot 10 osebkov (*M. poppei, N. stygius, P. nolli alpina, P. viguieri* in *E. tarmani*). Tako leta 2000 kot tudi v obdobju 2006–2013 sta bili vrsti *M. poppei* in *N. stygius* razmeroma pogosti v lužicah na dnu jamskih rovov, kjer so jima delali družbo še osebki stigofilne vrste *P. viguieri*. Za vse tri po dosedanjih podatkih in opazovanjih vemo, da so pogostejše v okoljih z več organske snovi, tako da epikras verjetno ni njihovo najugodnejše okolje. Za dve vrsti, *P. nolli alpina* in *E. tarmani* pa je na razpolago premalo podatkov za oceno njihove ekološke preference. Osebki vrste *P. nolli alpina* so sicer široko razširjeni po Dinarskem krasu Slovenije, a nikjer niso pogosti. V nasprotju s prejšnjo, je vrsta *E. tarmani* znana le po osebkih iz Velike Pasice, izvira Močilo in 10 km oddaljenega izvira Šumik. Vsega je bilo doslej najdenih 12 osebkov te vrste; v letu 2000 osem in štirje v obdobju 2006–2015.

Vrstna sestava živalstva se v treh curkih med letoma 2006 in 2012 ni veliko spreminjala (Slika 22; povzeto po Wei Liu, 2014), kar kaže na razmeroma stabilne ekološke razmere v zaledju curkov VP 1, VP 2 in VP 3. Nasprotno pa je sestava živalstva v curku VP 4 imela v obdobju 2006–2008 velike spremembe, potem pa se je od 2009 ustalila in imela značilno drugačno sestavo živalstva v primerjavi z ostalimi curki. Po povišanih vrednostih nekaterih kemijskih parametrov, zlasti nitratov, sulfatov, kalija in magnezija (Tabela 6), predvidevamo, da je do sprememb v živalstvu prišlo

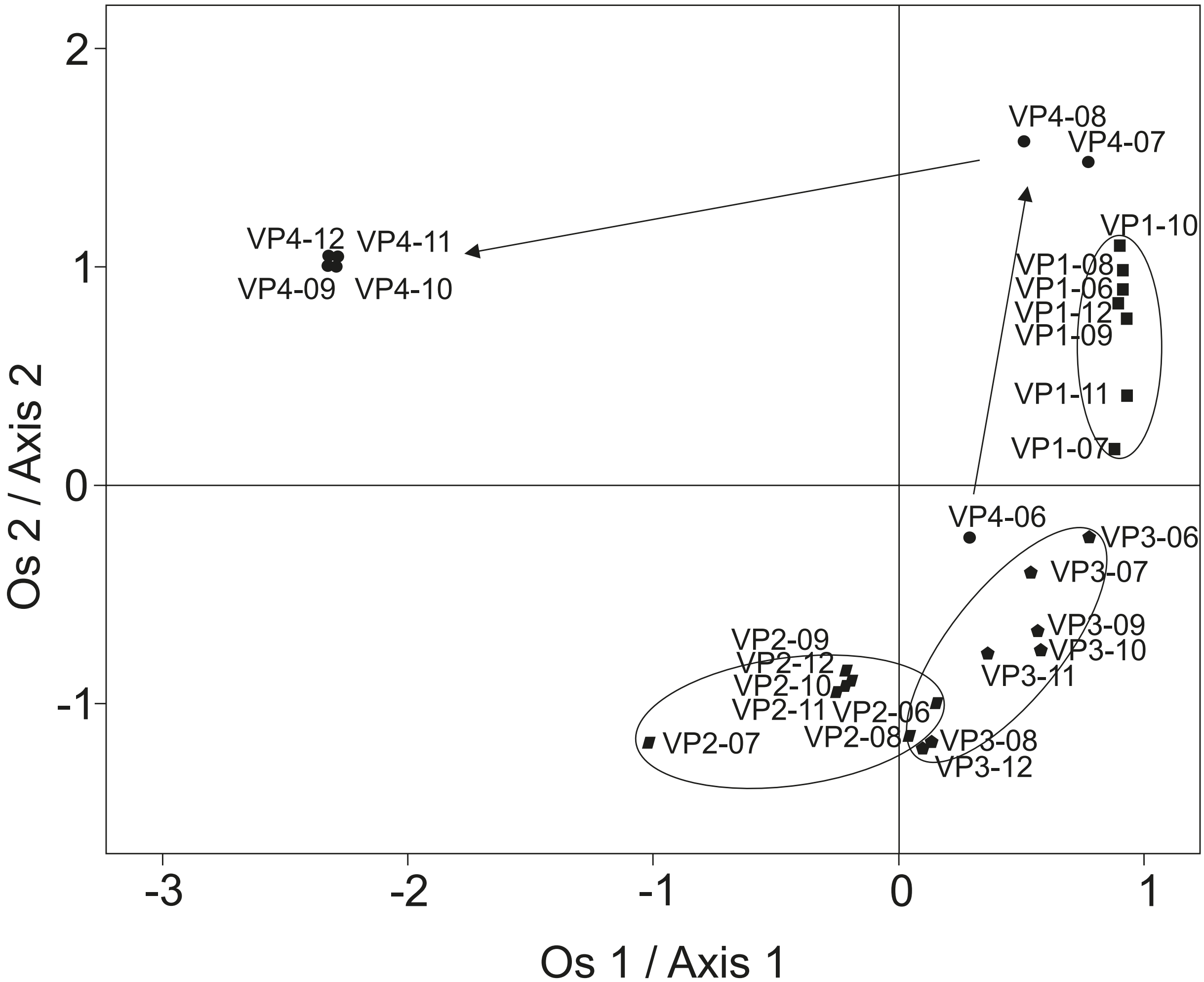
The numbers of specimens of a particular species were different in the samples (Table 8). The most common were the representatives of *M. dumonti,* which represented almost half of the collected specimens (47.6 % = 829 specimens out of 1740 collected), followed by the four additional species with more than 100 specimens collected in the sampling period (*M. varica* – 240 specimens, *S. infernus* – 212 specimens, *P. albicans* – 197 specimens and *B. pyrenaicus* – 146 specimens). Regarding their high numbers, it can be presumed that the epikarst is an original habitat for these species, from where they were transported into the lower, unsaturated vadose zone as drift. At least one species, *P. albicans*, frequently inhabits the wet soil around the small springs as well (Fabio Stoch, personal communication). On the other hand, there were five species where in eight years less than ten specimens per species were collected (*M. poppei, N. stygius, P. nolli alpina, P. viguieri* and *E. tarmani*). In 2000, as well as in the period between 2006 and 2013, the representatives of *M. poppei* and *N. stygius* were common in the pools on the cave's floor, where they were accompanied by specimens of stygophilic *P. viguieri*, as well. According to the data and observations, all three species prefer the environment with a higher amount of organic matter, thus the epikarst is probably not their optimal environment. For the two species, *P. nolli alpina* and *E. tarmani,* there was not enough data for the evaluation of their ecological preferences. The specimens of *P. nolli alpina* are quite widespread in the Dinaric Karst in Slovenia but they are not abundant. On the contrary, *E. tarmani* is known only from the Velika Pasica cave, the Močilo temporary spring and the Šumik spring, 10 km from the type locality. So far, 12 specimens of *E. tarmani* were collected; eight in 2000 and four in a period between 2006 and 2015.

The species composition of fauna from the three water jets had not changed much in the period between 2006 and 2012 (Figure 22; after Wei Liu, 2014), which is an indication of stable ecological conditions in the catchment area of the water jets VP 1, VP 2 in VP 3. However, the fauna composition in VP 4 had undergone significant changes in the period between 2006 and 2008, then stabilised after 2009, when it got significantly different community structure compared the other three water jets. According to the increased values of some chemical parameters, particularly nitrates, sulphates, potassium and magnesium (Table 6), it is concluded that the changes in the fauna composition were induced by local pollution as a result of the deposition of waste construction material during nearby house rebuilding in 2003.

Foto 55: Predstavniki vrste *Adineta gracilis* Jansen 1893 spadajo med kotačnike (Rotatoria), katerih življenjsko okolje je vlažna prst /Foto: A. Brancelj/.
Photo 55: The representatives of the species *Adineta gracilis* Jansen 1893 are members of the wheel animals (Rotatoria), living in dump soil /Photo: A. Brancelj/.



zaradi lokalnega onesnaženja, kot posledica odlaganja gradbenega materiala ob obnavljanju bližnje hiše okoli leta 2003 in kasneje tudi vreč umetnih gnojil, vendar so bile te kmalu odstranjene. Gradbeni material in izpiranje ostankov gnojil je verjetno privedlo do tega, da so bolj občutljive vrste propadle, medtem ko je na



Slika 22: Ne-metrično večdimenzionalno skaliranje (NMDS) za letne sestave populacij dvanajstih vrst iz skupine ceponožcev (Copepoda), dvoklopnikov (Ostracoda) in postranic (Amphipoda) na štirih curkih (VP 1–VP 4) v jami Velika Pasica (Slovenija) od 2006 do 2012. Stress value: 0.173. Legenda: VP1_06: sestava živalstva v letu 2006 na VP 1 (povzeto po Wei Liu, 2014).
Figure 22: The non-metric multidimensional scaling (NMDS) diagram representing the annual data on the populations of the twelve species of the copepods, ostracods and amphipodsa at the four permanent water jets (VP 1–VP 4) in the Velika Pasica cave (Slovenia) from 2006 to 2012. Stress value, 0.173. Legend: VP1_06: the faunal composition in 2006 at the VP1 water jet location (after Wei Liu, 2014).

nitrate odporna vrsta *M. varica* povečala svojo prisotnost v zaledju curka VP 4.

Poleg neenakomerne prisotnosti osebkov posameznih vrst v vzorcih je bila prisotna tudi navezanost vrst na posamezne curke. Če bi bili ceponožni raki enakomerno razporejeni po epikraškem območju, bi bilo pričakovati, da bo njihovo število v curkih sorazmerno in zato med curki ne bi smelo biti večjih razlik ne v vrstni sestavi ne v zastopanosti vrst. Vendar rezultati kažejo precej drugačno sliko. Medtem ko so bili osebki nekaterih vrst v posameznem curku pogosti, so bili drugi zelo redki ali povsem odsotni (Tabela 8). Za curek VP 1, ki je imel največji in najbolj dinamičen pretok, sta bili značilni vrsti *P. albicans* in *S. infernus*. V VP 2 je bila prevladujoča vrsta *M. dumonti* (88,7 % vseh osebkov), medtem ko si je ta vrsta v VP 3 prvo mesto delila z vrsto *B. pyrenaicus* (147 osebkov in 140 osebkov od skupno 398). V VP 4 pa je s 95,6 % prevladovala vrsta *M. varica*.

Medtem ko je analiza povezav med kemijskimi parametri v curkih in vrstami pokazala, da sta vrsti *M. dumonti* in *S. infernus* razmeroma neodvisni od kemijske sestave prenikle vode, pa so osebki dvoklopnika vrste *P. albicans* kazali rahlo pozitivno povezavo s koncentracijami kalcija in negativno povezavo s pH (Slika 23a-c). Nasprotno z njimi so osebki vrste *M. varica* kazali značilno pozitivno povezavo s povišanimi vrednostmi nitratov, sulfatov, magnezija, kalija in tudi temperaturo, torej s parametri, ki so imeli najvišje izmerjene parametre prav v curku VP4. V ostalih treh curkih je bil glavni dejavnik, ki je določal vrstno sestavo in tudi število osebkov v vzorcih, pretok oziroma njegova dinamika.

Tri vrste, *M. dumonti, B. typhlops*, in *M. poppei*, so bile pogostejše v curku VP 2, za katerega je bil značilen nizek pretok in njegove počasne spremembe. V to skupino lahko prištevamo tudi vrsto *M. varica* iz VP 4, kjer je bil pretok prav tako razmeroma nizek in dinamika počasna. Štiri vrste, *B. pyrenaicus*, *S. infernus*, *E. millennii* in *P. albicans*, pa so bile pogostejše v curkih VP 1 in VP 3, za katere je bila značilna nižja koncentracija ionov, a zato večji in bolj dinamični pretoki (Slika 24).

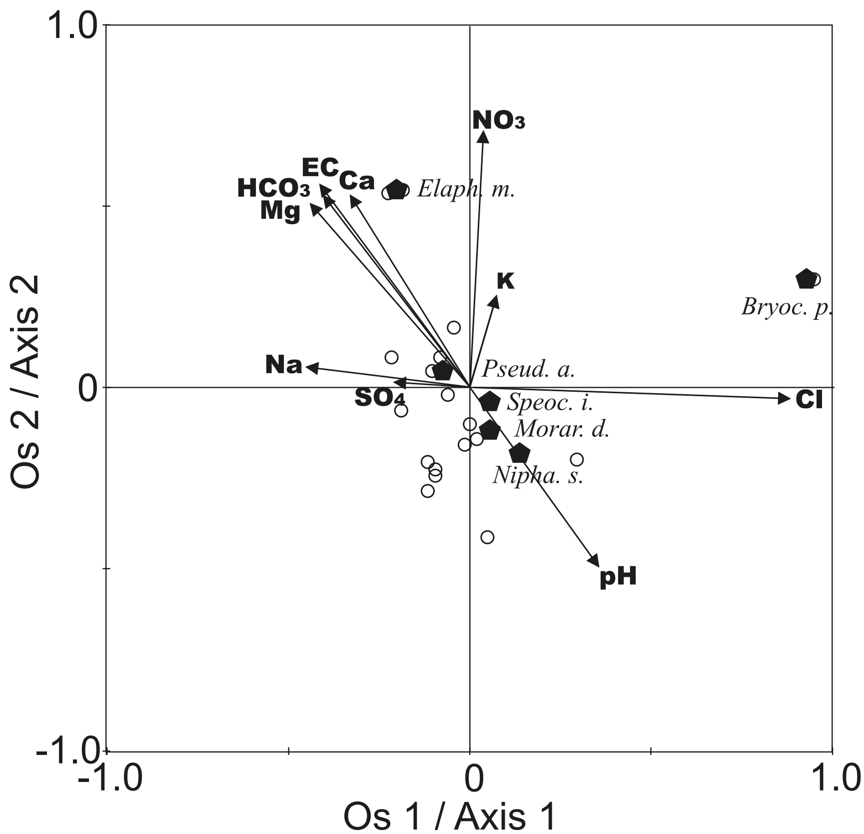
What is more, it was additionaly polluted by the deposition of empty bags for fertilisers, which were later removed. The waste construction material and the leaching of fertilisers probably lead to the extinction of sensitive species, while the nitrate-tolerant species *M. varica* thrived there.

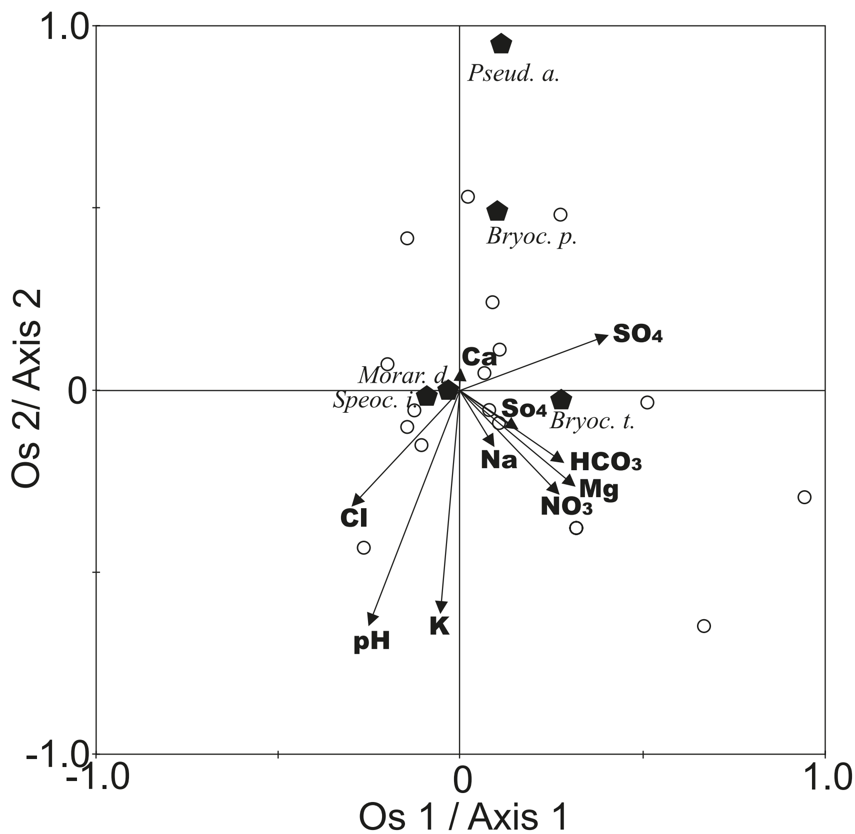
In the samples, along with the irregular presence of specimens of different species, also specific affinities of species to individual water jets were observed. In case the copepods were evenly distributed in the epikarst, their numbers in the samples would be expected to be proportional and there should not be any differences in the species composition and their relative abundance between the water jets. The results showed quite a different picture. While the specimens of some species were common in a particular water jet, the others were rare or even absent (Table 8). For the water jet VP 1, which had the largest and the most dynamic discharge, the species *P. albicans* and *S. infernus* were the most characteristic. In VP 2 the predominant species was *M. dumonti* (88.7 % of all specimens there), while at VP 3 the most common were *M. dumonti* and *B. pyrenaicus* (147 specimens and 140 specimens respectively, out of 398 specimens collected). At VP 4, *M. varica* was predominant, with 95.6 % of specimens collected there.

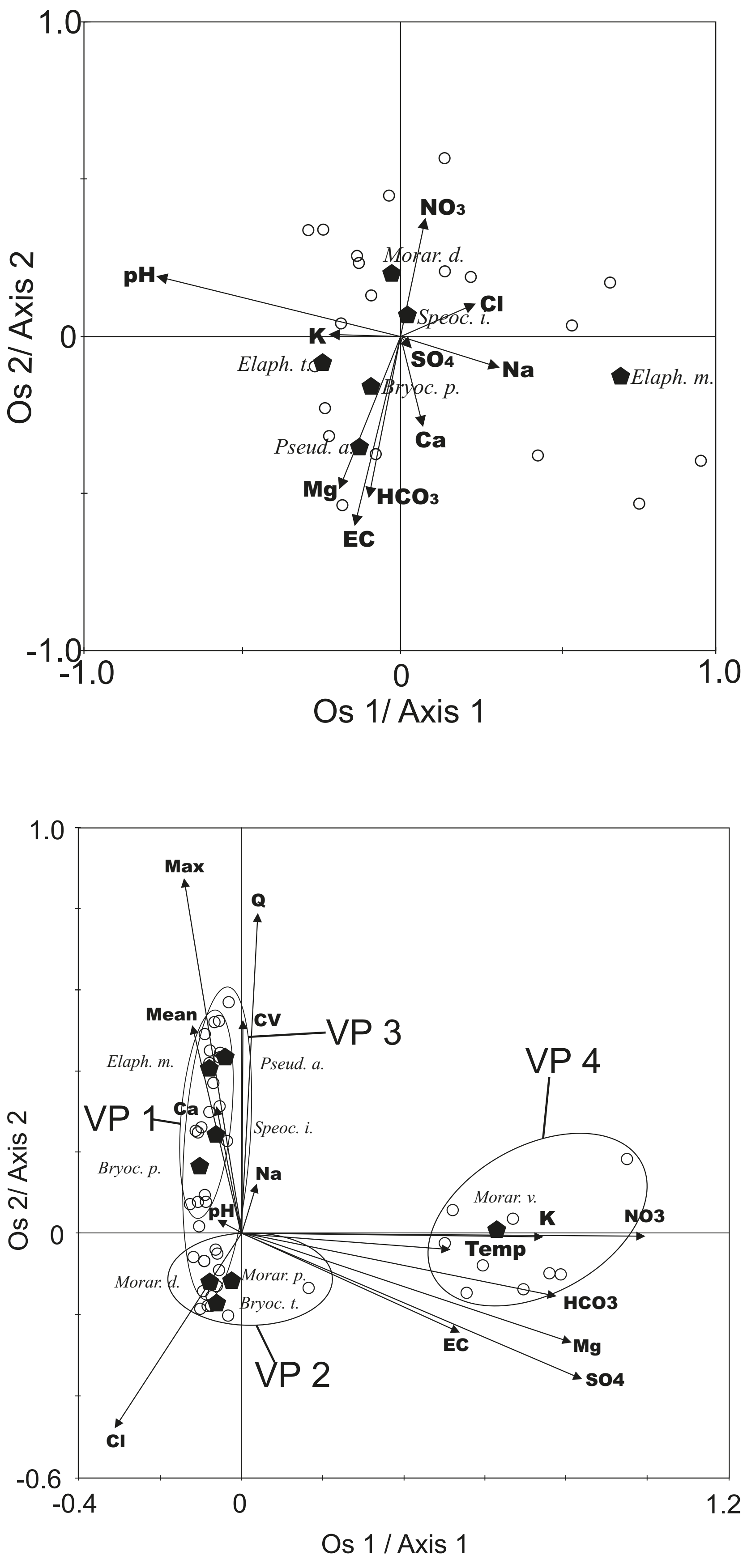
The analyses of relations between the chemical parameters of drip water and species showed that the two species, *M. dumonti* and *S. infernus*, are quite independent to the chemical composition of drip water, while the specimens of ostracods *P. albicans* showed slight positive correlation with the calcium concentration and negative with the pH (Figures 23a-c). Contrary to those species, the specimens of *M. varica* showed significant correlation with the increased values of nitrates, sulphates, magnesium, potassium and also temperature, thus with parameters which had the highest values in VP 4. In other three water jets, the main parameter which determined the fauna composition, was the discharge and its dynamic.

Three species, *M. dumonti*, *B. typhlops* and *M. poppei*, were more common at VP 2, which was characterised by a low discharge and slow hydrological dynamic. In the same group could be included also *M. varica,* common at VP 4, where the discharge was also low and the dynamic slow. Four species, *B. pyrenaicus*, *S. infernus*, *E. millennii* and *P. albicans*, were common at VP 1 and VP 3, characterised by the lower concentration of ions and larger and more dynamic discharges (Figure 24).

Slika 23: Kanonična korespondenčna analiza (CCA) trirazsežnega diagrama za 20 vzorcev iz curkov VP 1 (a), VP 2 (b), VP 3 (c) v jami Velika Pasica (Slovenija) prikazuje povezavo med epikraškimi nevretenčarji in desetimi okoljskimi parametri. Puščice: okoljski parametri; peterokotniki: vrste; krogi: vzorci. EC: elektroprevodnost; Cl^-, NO^{3-}, $SO4^{2-}$, HCO^{3-}, Na^+, K^+, Ca^{2+}, Mg^{2+}: glavni ioni v prenikli vodi. Imena vrst so v *italic*: prvih pet črk rodu in prvo ime vrste – glej Tabela 7.
Figure 23: The canonical correspondence analysis (CCA) of a triplot diagram on 20 samples of the permanent water jet locations VP1 (a), VP 2 (b) VP 3 (c) in the Velika Pasica cave (Slovenia) shows the relationship between the epikarst invertebrates and ten hydro-chemical parameters. Arrows: the environmental parameters; pentagrams: species; open circles: samples. EC: the electrical conductivity; Cl^-, NO_3^-, SO_4^{2-}, HCO_3^-, Na^+, K^+, Ca^{2+} and Mg^{2+}: the main ions in drip water. The names of the species are in *italic*: the first five letters of the genus name and the first letter of the species name – see Table 7.







↓ **Slika 24:** Kanonična korespondenčna analiza z izločenim trendom (DCCA) za povezave med plavjem iz epikrasa, enajstimi hidrokemijskimi parametri, štirimi hidrološkimi parametri in štiriinštiridesetimi vzorci iz štirih curkov (VP 1–VP 4) v jami Velika Pasica (Slovenija). Puščice: hidrokemijski in hidrološki parametri; peterokotniki: vrste; krogi: vzorci. Vsak vzorec vsebuje podatke o sestavi živalstva, hidroloških in hidrokemijskih značilnostih. Imena organizmov v *italic*: prvih pet črk rodu in prvo ime vrste – glej Tabela 7. EC: elektroprevodnost; Cl^-, NO^{3-}, $SO4^{2-}$, HCO^{3-}, Na^+, K^+, Ca^{2+}, Mg^{2+}: glavni ioni v prenikli vodi. Mean – srednji pretok; Max – največji pretok; CV – koeficient variacije pretokov; Q – celokupni volumen vode.

Figure 24: The detrended canonical correspondence analysis (DCCA) of a triplot on the relationships between the drift fauna from the epikarst, eleven hydro-chemical parameters, four hydrological parameters and forty-four samples from four permanent water jets (VP1–VP4) in the Velika Pasica cave (Slovenia). Arrows: the hydro-chemical and hydrological parameters; pentagrams: species; open circles: samples. Each sample contains the data on fauna composition, hydrological and hydro-chemical characteristics. The names of species are in *italic*: the first five letters of the genus name and the first letter of the species name – see Table 7. EC: the electrical conductivity; Cl^-, NO_3^-, SO_4^{2-}, HCO_3^-, Na^+, K^+, Ca^{2+} and Mg^{2+}: the main ions in drip water. Mean – medium discharge; Max – maximum discharge; CV – the coefficient of variation of discharge; Q – the total volume of water.

TELESNE PRILAGODITVE ZA ŽIVLJENJE V EPIKRASU

Prav na podlagi raziskav živalstva v Veliki Pasici so bile prvič opažene posebne telesne oblike na posameznih delih telesa, ki se jih lahko poveže z življenjem v ozkih špranjah v epikrasu. Tam namreč obstaja stalna nevarnost, da vodni tok odnese živali navzdol, v luže na dnu rovov ali v globlje nezasičene ali zasičene predele kraškega vodonosnika. Pri več vrstah ceponožnih rakov iz skupine Harpacticoida, ki se večinoma plazijo po podlagi in se le redko odločijo za kratko plavanje, so na nogah in na koncu telesa, imenovanem vilice (furka), pa tudi na tipalkah (antenah) prisotne posebne strukture, ki jih povezujemo z življenjem v ozkih špranjah, kjer se pretaka voda (Brancelj, 2000, 2009, 2013). Takih prilagoditev pri drugih ceponožcih, ki živijo v okolju, kjer so prostori večji in pretoki vode manjši, doslej še niso opazili. Vrste iz epikrasa imajo na nogah močne in zaobljene trne, ki so pri ostalih manjši, manj robustni in imajo ostre konice. Peti par plavalnih nog (P5) ima zelo kratke in močne trne z ostrimi bodicami na zunanjem delu. Pri ostalih ne-epikraških vrstah so te ščetine dolge in mehke (Slika 25).

Izrastka na zadnjem delu telesa (vilice oziroma furka) sta v primerjavi s površinskimi ali drugimi jamskimi vrstami bolj razmaknjena, s čimer ima žival boljši oprijem v ozkih špranjah, po katerih teče voda. Tudi ščetine in dlačice, ki so na vilicah, so pri epikraških vrstah kratke in oblikovane v trne, medtem ko so pri ostalih vrstah dolge in mehke in nekoliko spominjajo na ptičje pero. Zlasti obe stranski ščetini sta pri epikraških vrstah zelo močni. Na trebušni strani, na osnovi vilic, so pri epikraških vrstah do štirje veliki in močni trni, ki jih pri ostalih vrstah ni ali so veliko šibkejši.

Prve antene (antenule) so v primerjavi z ostalimi vrstami precej krajše in bolj čokate in le malo štrlijo iz čelnega profila glave.

Vse navedene telesne značilnosti so pri skupini epikraških harpakticidov (Harpacticoida) močno poudarjene. Posamezni znaki (npr. močnejši trni na nogah) se občasno pojavijo še pri kakšni bentoški vrsti (npr. *Elaphoidella elaphoides* (Chappuis 1923) (Janetzky in sod., 1996), več znakov v navedenih kombinacijah pa nikoli.

Nekoliko manj opaznih telesnih prilagoditev na

THE MORPHOLOGICAL ADAPTATIONS TO LIFE IN THE EPIKARST

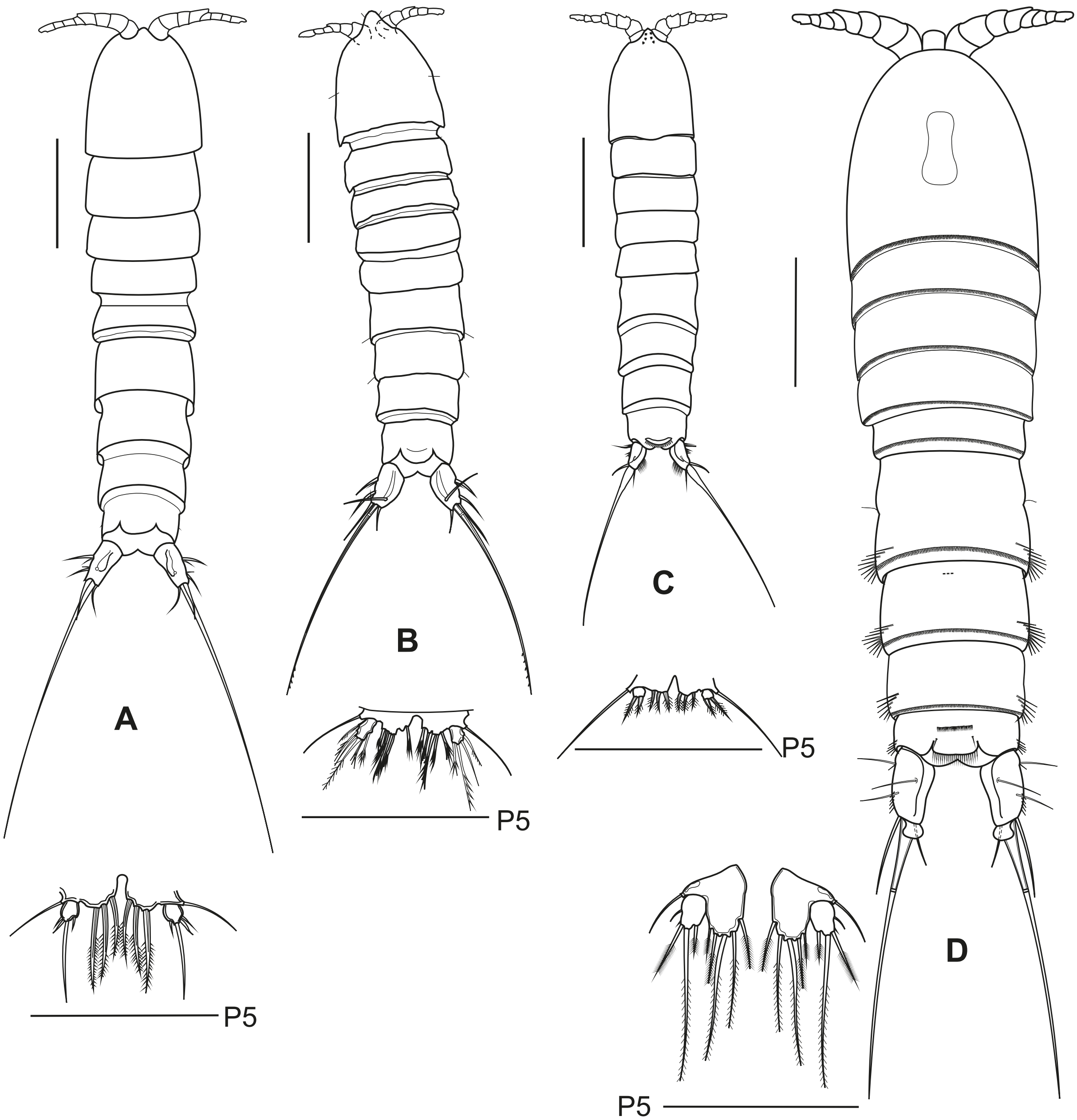
Based on the taxonomic research of the fauna from the Velika Pasica cave, specific morphological features were noticed for the first time, which could be related to life in narrow fissures in the epikarst. There is a permanent threat that the animals would be washed away by the current into the pools in the corridors or lower in the unsaturated or saturated zones of the karst aquifer. Several species of the copepods from a group of Harpacticoida, which normally crawl over the substrate and only occasionally go for a short swim, have special structures, characteristic for life in narrow fissures where the water currents exist. The structures are on the rear end of a body, called furca, on the legs, and also on antennules (Brancelj, 2000, 2009, 2013). Such structures were not observed in the species, living in a larger space, where the water currents are less intensive. The species living in the epikarst have strong spines with rounded tips on their legs, while in other harpacticoids the spines are smaller, and with sharp tips. The fifth pair of swimming legs (P5) has very short and robust spines with sharp spinules along the outer parts of the body. In non-epikarst species, these structures are present as long and soft setae (Figure 25).

The terminal segments on the rear end of body (furca) are, in comparison with other epigean or hypogean species, much more divergent, enabling the animals a better grip in the narrow fissures where the water runs. Setae and spinules which are present on the furca are in the epikarst species short in spiniform, while in the other species are long, soft and feather-like. Especially both main lateral setae are short, spiniform and robust. On the ventral side, close to the base of the furca, there are up to four large and robust spines found in the epikarst species, which are in other species weak or even absent.

The first antennae (antennules) are in comparison with many other species short and more robust and only slightly extends over frontal profile of the head.

All the above mentioned features are very empasized in the group of the epikarst harpacticoids (Harpacticoida). Individual characteristics (*i.e.* more robust spines on the legs) are present also in some other benthic species (for example in *Elaphoidella elaphoides* (Chappuis 1923) (Janetzky *et al*., 1996), however, several characteristics never appear in the above mentioned combinations.

The less evident morphological adaptations to life in the epikarst could be observed in *S. infernus*, which is the only



Slika 25: Slike treh predstavnikov epikraških harpakticidov (Copepoda): A: *Elaphoidella millennii* Brancelj 2009; B: *Morariopsis dumonti* Brancelj 2000; C: *Paramorariopsis irenae* Brancelj 2006, z dobro vidnimi močnimi ščetinami na zadnjem delu telesa (vilicah = furka) kot prilagoditvami za življenje v epikrasu. Za primerjavo je izvirska vrsta *Pilocamptus schroederi* (van Douwe, 1915) (D). Posebej so prikazane ščetine na petem paru nog (P5). Črtica = 100 µm.

Figure 25: The figures of the three representatives of the epikarstic harpacticoids (Copepoda): A: *Elaphoidella millennii* Brancelj 2009; B: *Morariopsis dumonti* Brancelj 2000; C: *Paramorariopsis irenae* Brancelj 2006 with well visible strong spines at the rear end of its body (furca) as an adaptation tor life in the epikarst. For comparison is an illustration of the species living in springs, *Pilocamptus schroederi* (van Douwe, 1915) (D). Armature on the fifth pair of swimming legs (P5) is presented separately. Scale bar = 100 µm.

življenje v epikrasu je opaznih pri vrsti *S. infernus*, ki je predstavnik edinega epikraškega rodu iz skupine Cyclopoida v Evropi. Kot večina ciklopoidov je dober plavalec in se uspešno upira vodnemu toku, kljub temu, da ima na vsakem paru nog na zunanji (exopod) in notranji (endopod) veji le po dva člena, medtem ko imajo površinske vrste praviloma po tri. Poleg tega so tudi pri njem opazni močno povečani trni na zunanji strani vseh štirih parov plavalnih nog. Dodatno ima na osnovi prvega para nog še po en močan in oster trn, ki spominja na močno sidro. Močni trni na nogah, predvsem pa oba trna na bazi prvih nog, so prilagoditve, ki osebkom omogočajo, da se obdržijo na hrapavih stenah špranj, kadar se pretok poveča. V nasprotju s harpaktikoidi ciklopoidi nimajo opaznih sprememb na vilicah, ki bi bile povezane s spremembami ščetin in dlak v trne. Vse te so razmeroma dolge in mehke.

representative of the epikarst genus from a group of Cyclopoida in Europe. Like most of cyclopoids, it is a good swimmer, which is why it can efficiently resist the water current, although it has only two segments on each of the four pairs of legs (on the inner (endopod) and outer (exopod) branch of the leg), while the epigean species have normaly three. The outer edges of four swimming legs also possess strong spines. In addition, these specimens have a strong spine, resembling a strong anchor on the base of each of the first swimming legs. Strong spines on the legs and particularly both spines at the base of the first pair of legs are adaptations, enabling the specimens to keep themselves on rough walls, when the discharge increases. Contrary to harpacticoids, the cyclopoids have no special morphological transformations on the furca, related to modifications of setae and spinules into spines. All of them are relatively long and soft.

SKLEPI

Jama Velika Pasica je sicer nekoliko oddaljena od gosteje naseljenih območij Slovenije, vendar se uvršča med jame, s katerimi so ljudje že v preteklosti imeli pogoste stike. Leži neposredno na robu naselja, ki je nastalo že v 15. stoletju. Njena razmeroma lahka dostopnost iz doline pa tudi tehnično nezahteven obisk njene notranjosti, sta jo po odkritju endemnih vrst jamskih hroščev in polžev sredi 19. stoletja zelo hitro postavili v središče pozornosti biologov, zlasti zbiralcev hroščev in polžev pa tudi turistov. To je v nekaj desetletjih nenadzorovanih in pogosto vandalskih obiskih pustilo v njej neizbrisljive posledice. Kljub temu pa se je v zadnjem desetletju izkazala s strokovnega vidika za izjemno zanimivo jamo, saj so se v njej začele ali vsaj intenzivirale nekatere znanstvene raziskave, ki so jo s tem potisnile v ospredje hidroloških, taksonomskih in ekoloških raziskav. Izstopa zlasti veliko število novoodkritih jamskih živali, skupaj kar trinajst vrst in podvrst v tako majhni jami.

Druga izjemnost tudi v svetovnem merilu je, da so se istočasno v jami izvajale intenzivne in dolgoletne meritve pretokov prenikle vode in njenih temperatur, pa tudi pogoste analize fizikalnih in kemijskih lastnosti vode, ki so razkrile nekaj novih, do sedaj nepoznanih dejstev o pretakanju vode v plitvem krasu.

Osemletno zelo podrobno spremljanje fizikalnih in kemijskih razmer in sestave živalstva v štirih curkih prenikle vode v jami Velika Pasica je dalo podroben in zanimiv vpogled v dogajanje v epikraški coni. Velja poudariti, da so bile meritve in opazovanja res opravljeni v območju epikrasa, torej le nekaj metrov pod površjem, medtem ko so bile številne študije, sicer označene kot "epikraške", dejansko opravljene v globljih, vadoznih conah. To nikakor ne zmanjšuje njihovih

CONCLUSIONS

The Velika Pasica cave is located on the less populated area of Slovenia, however, such caves have been of interest to many for a long time. It is located on the outskirts of the settlement, founded in 15th century. An easy access to the cave and a technically easy accessibility, has made the cave a place of great interest regarding biologists, particularly beetle and snail collectors, as well as tourists, after the discovery of the endemic cave-dwelling beetles and snails in the middle of 19th century. Several decades of uncontrolled and frequently vandalizing visits have had dire consequences. However, in the last decade, the cave appears to have become exceptionally interesting from the scientific point of view, as research has either finally started or even intensified, thus bringing into forefront intensive hydrological, taxonomical and ecological research. The high number of new cave-dwelling species for science really stands out, reaching 13 species and subspecies in total, in such a small cave.

Another exceptional result, also on the global scale, were the intensive as well as long-lasting measurements of the discharge of drip water and its temperature, performed in the cave, as well as frequent analyses of its physical and chemical characteristics, which revealed some new, so far unknown facts on flow of water in shallow karst.

Eight years of intensive records of physical and chemical properties of the drip water and structure of the aquatic fauna in the four permanent water jets in the Velika Pasica cave gave detailed and interesting insight in the processes within the epikarst. It is important to emphasize, that the measurements and observations were made in the epikarst, *i.e.* only few metres below the surface, while some previous studies elsewhere designated as "epikarst" were actually made deeper, *i.e.* in vadose zone. This certainly does not raise any doubts regarding the results and conclusions made, but must rezultatov in zaključkov, vendar jih je potrebno vrednotiti realno – študije niso bile opravljene v epikraški coni.

Še eno dejstvo, ki ga ne moremo prezreti, je to, da je bila študija v jami Velika Pasica opravljena v okolju, kjer je v znatnih količinah prisoten dolomit. Glede na mineralne, še bolj pa na geološke značilnosti, so hidrološke razmere v omenjeni jami vsekakor nekoliko drugačne od razmer v »klasičnih« kraških jamah. Mešanica amorfne sedimentne karbonatne kamnine in kristaliničnega minerala omogoča večjo vsebnost kapilarne vode in s tem posledično drugačne oziroma ugodnejše ekološke pogoje za epikraške živali, kot so v čistem apnencu.

Fizikalne in kemijske lastnosti prenikle vode so zaradi dolomitne sestave kamnine nekoliko specifične (vsaj višja koncentracija Mg^{2+}), a v osnovi ne odstopajo bistveno od lastnosti v čistem apnencu. S pogostimi in natančnimi meritvami fizikalnih in kemijskih parametrov vode si je bilo razmeroma enostavno pridobiti vsaj grobo sliko njenih prostorskih in časovnih sprememb. V curkih, kjer je bila pot vode skozi zrak do merilca razmeroma kratka in zato ni moglo priti do večjih sprememb v temperaturi prenikle vode zaradi poti skozi zrak, so bile povprečne razlike med temperaturo vode in okoliškega zraka okoli ± 0,2 °C. To pomeni, da so temperature zraka in prenikle vode v jami dobro usklajene in da je temperatura zraka dober približek za ekološke razmere na stropu jame, medtem ko se bližje površju te temperature seveda lahko značilno razlikujejo in tudi bolj nihajo tekom dneva in sezon.

Z dolgotrajnim spremljanjem plavja živali iz epikrasa pa ni možno oblikovati kakšnega splošnega modela, kot je to za fizikalne in kemijske lastnosti prenikle vode. S pogostim vzorčenjem si je sicer možno ustvariti dokaj jasno sliko o številu vrst in tudi njihovi prostorski razporeditvi. Velika neznanka ostaja podatek o velikosti populacij posameznih vrst, o razmerju med spoloma ter deležu odraslih in mladičev. Z dosedanjimi metodami pobiranja vzorcev iz epikrasa še ni možno dobiti pravih informacij o tem. Niso poznani mehanizmi, ki živali odplavijo iz epikrasa. Je to vedênje, je to beg pred plenilci, je to umikanje pred neugodnimi fizikalnimi ali kemijskimi pogoji v epikrasu ali pa zgolj naključje, da žival pade s stropa? Vsekakor so raziskave v jami pokazale, da take izgube osebkov posameznih

be evaluated in a realistic way – the studies were not conducted in the epikarst zone.

There is yet another fact that cannot be overlooked; the study in the Velika Pasica cave had been conducted in the area with dolomite. According to the mineral and even more so, to the geological characteristics, the hydrological conditions in the cave slightly differ from those in the "classic" karstic caves. The mixture of the amorphic sedimentary carbonate stoneware and of the crystalline mineral enable a higher share of the capillary water and consequently different, *i.e.* better ecological conditions for the epikarst fauna, compared to the conditions in the limestone.

The physical and chemical characteristics of drip water were due to the presence of dolomite slightly specific (at least higher concentrations of Mg^{2+}), but in principle not much different from those in pure limestone. With frequent and detailed measurements of the physical and chemical characteristics of drip water, it was easier to get a rough idea of their oscillations in time and space. In the permanent water jets, where travel distance of the drop to the instrument through the air was short and thus were not significant change in the water temperature as a result of the "air distance," the average difference in temperature was ± 0.2 °C, meaning that air temperature and the temperature of the drip water are well correlated. The air temperature is a good approximation of the ecological conditions on the ceiling of the cave, while the temperatures close to the surface can differ and have higher daily and seasonal oscillations.

With the long-lasting observation of the drift fauna from the epikarst, no robust model could be constructed as that for the physical and chemical characteristics of the drip water. With frequent sampling, it would be rather easy to get a clear picture on the number of species and their spatial distribution. The main question regarding the size of their populations, sex ratio and age structure remains, however, unanswered, and with the methods used so far, it is still impossible to get answers. The mechanisms, washing the fauna away from the epikarst are not yet known. Is the cause for an animal to fall down from the ceiling, a behaviour, a way of escaping the predators, a form of avoidance of unfavoured physical and chemical conditions in the epikarst or just a mere accident? Be that as it may, the research has so far revealed, that the loss of the specimens, even on a long term does not effect their populations significantly.

The main question "How big is the population?" still remains unanswered. As already mentioned, no method exists vrst skozi curke tudi na daljši rok bistveno ne prizadenejo njihovih populacij.

Vendar odgovor na bistveno vprašanje "Kako velika je populacija?" še ni znan. Kot je bilo že omenjeno, zaenkrat še ni poznana metoda, s katero bi se lahko neposredno preiskovalo špranje in razpoke v epikrasu. Teoretično je sicer možno, da se v zaledje curka spusti kemikalija, ki bi organizme v epikrasu omrtvila ali celo usmrtila. Če bi se nato nekaj časa spremljala dinamika organizmov, ki bi jih voda odplavila, ter vremenske razmere (padavine), bi se dobilo boljši vpogled v količinsko in vrstno sestavo živalstva v izbranem curku. Uporaba gasilske cisterne v tem primeru ne bi bila dovolj, saj se ne pozna velikosti zaledja curka. Vendar bi še vedno ostajal dvom, ali je vodni tok odplavil res vse organizme iz epikrasa. Drugi problem je bolj praktične narave, saj bi uporaba kemikalij lahko vplivala na kakovost pitne vode tudi v nekaj kilometrov oddaljenih zajetjih pitne vode in kjer se kemikalije lahko zadržujejo dolgo časa.

Raziskovanje epikraškega živalstva tako ostaja še vedno omejeno bolj na kakovostne vidike kot je ugotavljanje prisotnost vrst in odkrivanje novih vrst za znanost, medtem ko količinski vidiki, zlasti velikost populacij in njihova vloga pri določanju kakovosti epikraške vode, ostajajo na ravni predvidevanj. Lahko pa bodo nova spoznanja v prihodnje prispevala nove raziskovalne metode – in seveda tudi obratno.

In še povsem za na koncu. Jama Velika Pasica in z njo povezana Mala Pasica ter občasni izvir Močilo je nahajališče 22 vrst stigobiontov ter 9 troglobiontov (Tabeli 2, 7; vključno z vrstama *Zospeum frauenfeldi* in *Trachysphaera costata*). Z 31 pravimi podzemnimi vrstami tako spada po številu vseh jamskih vrst na deveto mesto na svetovni lestvici in na sedmo mesto glede na število vodnih vrst (Tabela 9).

at the moment, to make direct observations of cracks and fissures in the epikarst. In theory, it would be possible to release some chemicals in the catchment area of the water jets, thus narcotising or possibly killing the organisms in the epikarst. Provided the dynamic of the organisms, washed away from the epikarst, were observed, under the right weather conditions, a better insight would be gained, in the quality as well as the quantity of fauna in the selected water jet. Using the fireman cistern would not be enough as the size of the catchment area of the selected water jet is unknown. There would also be doubt whether the majority of animals had really been washed out from the epikarst. Another problem is more of a practical nature. The use of chemicals could effects the quality of drinking water in wells, several kilometres from the injection places of the chemical, lingering in the catchment area for a long time.

Therefore, the research of the epikarst fauna remains limited to qualitative aspects, such as the research of biodiversity and the description of the new species for science, while the quantitative aspects, especially the size of populations and their role in the conditioning of water in the epikarst, remains at the level of speculations. Perhaps the new knowledge will contribute to the new research methods in the future – and vice versa.

To conclude: The Velika Pasica Cave and the Mala Pasica interconnected with it, as well as the nearby temporary spring Močilo, is a place where up to 22 stygobites and 9 troglobites can be found (Tables 2, 7; including *Zospeum frauenfeldi* and *Trachysphaera costata*). With the 31 obligate cave-dwelling species, the cave takes the ninth place in the world, however, according to the total number of stygobites only, the seventh place (Table 9).

Tabela 9: Jame z največjim znanim številom troglobiontov in stigobiontov (povzeto po Culver & Sket, 2000, 2002; Dehervang & Bedos, 2012).
Table 9: The caves with the highest known number of troglobites and stygobites (after Culver & Sket, 2000, 2002; Dehervang & Bedos, 2012).

Jama / Cave	Država / Country	Dolžina rovov (km) / Length of corridors (km)	Št. stigobiontov / No. of stygobites	Št. troglobiontov / No. of troglobites	Skupaj / Total	Mesto na lestvici (skupno število vrst) / Position on the list (total No. of species)	Mesto na lestvici (samo stigobionti) / Position on the list (stygobites only)
Postojnsko-planinski jamski sistem	Slovenija / Slovenia	20,5	48	36	84	1	1
Vjeternica	Bosna in Hercegovina / Bosnia and Herzegovina	6,7	39	21	60	2	2
Pestera de la Movile	Romunija / Romania	0,3	18	29	47	3	8
Križna Jama	Slovenija / Slovenia	8,2	29	16	45	4	3
Logarček	Slovenija / Slovenia	4,3	28	15	43	5	4
Mammoth Cave	ZDA / USA	652	15	26	41	6	9
Šica-Krka	Slovenija / Slovenia	0,82	27	7	34	7	5
Jamski sistem Baget	Francija / France	več jam in izvirov / several caves and springs	24	9	33	8	6
Velika Pasica	Slovenija / Slovenia	0,1	22	9	31	9	7

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REFERENCE REFERENCES

Aljančič M., 1994: V družbi z gospodom Schmidtom v treh kranjskih jamah. Proteus, 56 (9): 318-321.

Bakalowicz M., 2005: Epikarst. V / In: Culver, D. C. & White, W. B. (ur. / eds.). *Encyclopedia of caves*. Elsevier: Academic Press; Amsterdam, p. 220-222.

Bole J., 1974: Rod *Zospeum* Bourguignat 1856 (Gastropoda, Ellobiidae) v Jugoslaviji = Die Gattung Zospeum Bourguignat 1856 (Gastropoda, Ellobiidae) in Jugoslawien. Razprave, 17 (5): 249-291.

Brancelj A., 2000: *Morariopsis dumonti* n. sp. (Crustacea: Copepoda: Harpacticoida) - a new species from an unsaturated karstic zone in Slovenia. Hydrobiologia, 436: 73-80.

Brancelj A., 2002: Microdistribution and high diversity of Copepoda (Crustacea) in a small cave in central Slovenia. Hydrobiologia, 477: 59-72.

Brancelj A., 2004: Biological sampling methods for epikarst water. V / In: *Epikarst*. Proceedings of the symposium held October 1 through 4, 2003, Shepherdstown, West Virginia, USA. Special Publish 9. Jones W.K., Culver D.C., Herman, J.S. (ur. / eds.). Karst Waters Institute; Charles Town, p. 99-103.

Brancelj A., 2005: Sampling methods for collecting Copepoda from small water bodies. V: 9th international conference on Copepoda, Hammamet, Tunisia, 11-15 July 2005. Abstract book. Univesity of 7 November at Carthage, Faculty of sciences of Bizerte, Tunisia, p. 25.

Brancelj A., 2009: Fauna of an unsaturated karstic zone in central Slovenia: two new species of Harpacticoida (Crustacea: Copepoda), *Elaphoidella millennii* n. sp. and *E. tarmani* n. sp., their ecology and morphological adaptations. Hydrobiologia, 621: 85–104.

Brancelj A., 2011: Copepoda from freshwater caves with special emphasis on epikarst. V: 11th International Conference on Copepoda, Merida, Mexico, July 10-15, 2011. Abstracts volume; The World Association of Copepodologists (WAC), p. 18.

Brancelj A., 2012: Male skrivnosti jame Velika Pasica na Gornjem Igu. Dvorana Center, Banija 4, Ig, 12. 3. 2012; neobjavljeno predavanje.

Brancelj A., 2013: Epikras : življenjsko okolje specializirane in bogate vodne favne : predstavitev posebnega življenjskega prostora v kraški vodi, zelo bogatega s ceponožnimi raki in drugimi malimi zverinicami. Proteus, 75: 199-209.

Brancelj A., Culver D. C., 2005: Epikarst communities. V / In: Culver, D.C. & White, W.B. (ur. / eds.). *Encyclopedia of caves*. Elsevier: Academic Press; Amsterdam, p. 223-229.

Brancelj A., Vrezec A., 2006: Jama Velika Pasica na Gornjem Igu - primer podzemnega laboratorija. Mostiščar, 12 (10): 18-20.

Cigna A. A., 2004: Climate of caves. V / In : Gunn, J. (ur. / ed.). *Encyclopedia of Caves and Karst Science.* Fitzroy Dearborn; New York, p. 228-230.

Culver D. C., Sket B., 2000: Hotspots of subterranean biodiversity in caves and wells. Journal of Cave and Karst Studies, 62:11-17.

Culver D. C., Sket B., 2002: Biological monitoring in caves. Acta Carsologica, 31: 55-64.

Deharveng L., Bedos A., 2012: Diversity patterns in the tropics. V/In: White, W.B. & Culver, D. C. (ur. / eds.). *Encyclopedia of caves* (2nd edition). Elsevier: Academic Press; Amsterdam, p. 238-250.

DZRJL-1, 1927a: VELIKA PASICA pri Zgornjem Igu. Št. eksk.: 95; 15. 5. 1927.

DZRJL-1, 1927b: MALA PASICA pri Zgornjem Igu. Št. eksk.: 96; 15. 5. 1927.

DZRJL-2, 1934a: VELIKA PASJICA pri Gorenjem Igu. Št. eksk.: 451; 11. 3. 1934.

DZRJL-2, 1934b: MALA PASJICA pri Gorenjem Igu. Št. eksk.: 452; 11. 3. 1934.

DZRJL-3, 1934: VELIKA PASICA na Gornjem Igu. Št. eksk.: 496; 26. 8. 1934.

DZRJL-4, 1935: VELIKA PASICA. Št. eksk.: 572-573; 10. In 26. 7.1935.

DZRJL-5, 1939a: Vel. Pasjica. Št. eksk.: 1018; 25. 6. 1939.

DZRJL-5, 1939b: Mal. Pasjica. Št. eksk.: 1019; 25. 6.1939.

DZRJL-6, 1946: VELIKA PASICA. Št. eksk.: 1359 in 1364; 6. 1. 1946 in 17. 2. 1946.

DZRJL-7, 1972: Poročilo o ekskurziji v jamo "Velika Pasica" pri Gornjem Igu; 30. 1. 1972 in 20. 2. 1972.

DZRJL-8, 1975: Dopolnilni zapisnik; Velika Pasica; 12. 7. 1975.

DZRJL-9, 1976: Zapisnik terenskih ogledov; Mala Pasjica; 8. 2. 1976.

DZRJL, 2014: Jamarski kataster Društva za raziskovanje jam Ljubljana.

Frauenfeld G., 1854: Ueber einen bisher verkannten Laufkäfer, beschrieben von L. Müller; und einen neuen augenlosen Rüsselkäfer, beschrieben von F. Schmidt; ferner einige von Schmidt in Schischka neu entdeckte Höhlenthiere. Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien (Abhandlungen), Wien, 4: 23-34.

Frauenfeld G., 1856: Die Gattung *Carychium*. Sitzungsberichte der Akademie der Wissenschaften in Wien, 19: 70-94.

Gams I., 2003: *Kras v Sloveniji v prostoru in času*. Založba ZRC, ZRC SAZU; Ljubljana, Pp. 516.

Gardini G., 2014: The species of the *Chthonius heterodactylus* group (Arachnida, Pseudoscorpiones, Chthoniidae) from the eastern Alps and the Carpathians. Zootaxa, 3887(2): 101-137.

Hadži J., 1930: Prilog poznavanju pećinskih pseudoscorpija. Glas Srpske Kraljevske Akademije, Beograd, 67: 115-148.

http 1: http://www.nib.si/index.php/aktualno/novice/273-merilno-mesto-v-jami-velika-pasica-med-najbolje-opremljenimi-laboratoriji-na-svetu-.html (dostop: 14. 2. 2015 / accessed: 14. 2. 2015)

http 2: http://ig.donbosko.si/cerkev-svetega-lenarta-na-gornjem-igu (dostop: 14. 2. 2015 / accessed: 14. 2. 2015)

http 3: http://www.jknm.si/si/jame/obcine/?v=ig (dostop: 14. 2. 2015 / accessed: 14. 2. 2015)

http 4: http://www.dnevnik.si/slovenija/ljubljana/1042270724 (dostop: 14. 2. 2015 / accessed: 14. 2. 2015)

http 5: http://www.mojaobcina.si/ig/novice/turizem/obisk-jame-m-in-velika-pasica-na-gornjem-igu.html (dostop: 10. 12. 2014 / accessed: 10. 12. 2014)

http 6: http://sl.wikipedia.org/wiki/PH (dostop: 10. 1. 2015 / accessed: 10. 1. 2015)

http 7: http://en.wikipedia.org/wiki/Cave_Bear (dostop: 30. 1. 2015 / accessed: 30. 1. 2015)

http 8: http://www.pascalis-project.com (dostop: 25. 12. 2014 / accessed: 25. 12. 2014)

Janetzky W., Enderle R., Noodt,W., 1996: *Crustacea, Copepoda, Gelyelloida und Harpacticoida. Süßwasserfauna von Mitteleuropa, 8/4-2*. Stuttgart: Gustav Fischer Verlag, Pp. 227.

Kiauta B., 1962: Ferdinand Schmidt, prvi raziskovalec jamskih živali. Kronika (Ljubljana), 10 (1): 54-59.

Kiefer F., 1930: Neue höhlenbewohnende Ruderfuβkrebse. Zoologischer Anzeiger, 87 (9/10): 222-228.

Klimchouk A. B., 2004: Towards defining, delimiting and classifying epikarst: its origin, processes and variants of geomorphic evolution. V / In: *Epikarst*. Proceedings of the symposium held October 1 through 4, 2003, Shepherdstown, West Virginia, USA. Special Publish 9. Jones W.K., Culver D.C., Herman, J.S. (ur. / eds.). Karst Waters Institute; Charles Town, p. 23-35.

Lazarini F., Brenčič J., 1989: *Splošna in anorganska kemija*. Državna založba Slovenije; Ljubljana, Pp. 557.

Mori N., Kanduč T., Opalički M., Brancelj A., 2015: Groundwater drift as a tracer for identifying sources of spring discharge. Groundwater, 53: 123–132, doi: 10.1111/gwat.12314.

Mulec J., Zalar P., Zupan N., Rupnik M., 2002: Screening for culturable microorganisms from cave environments (Slovenia). Acta Carsologica, 31: 177-187.

Pašić L., Kovče B., Sket B., Herzog-Velikonja B., 2010: Diversity of microbial communities colonizing the walls of a Karstic cave in Slovenia. FEMS Microbiology Ecology, 21: 50-60.

Pipan T., 2003: Ekologija ceponožnih rakov (Crustacea: Copepoda) v prenikajoči vodi izbranih kraških jam : doktorska disertacija = Ecology of copepods (Crustacea: Copepoda) in percolation water of the selected karst caves : dissertation thesis. Ljubljana, Pp. 130.

Pleničar M., 1970: Tolmač k Osnovni geološki karti SFRJ, List Postojna: 62. Zvezni geološki zavod Beograd. (= Basic geological survey; section Postojna).

Porca E., Jurado V., Zgur-Bertok D., Saiz-Jimenez C., Pašić L., 2012: Comparative analysis of yellow microbial communities growing on the walls of geographically distinct caves indicates a common core of microorganisms involved in their formation. FEMS Microbiology Ecology, 81: 255-266.

Presetnik P., Podgorelec M., 2011: Monitoring populacij izbranih ciljnih vrst netopirjev v letih 2010 in 2011 (Drugo delno poročilo). Naročnik: Ministrstvo za okolje in prostor, Ljubljana. Center za kartografijo favne in flore, Miklavž na Dravskem polju. Pp. 76; digitalne priloge.

Pretner E., 1974: Zgodovinski pregled koleopteroloških raziskovanj v jamah Slovenije. Historische Übersicht der koleopterologischen Forschungen in den Höhlen Sloweniens. Acta Carsologica, 6: 307-316.

Rouch R., 1968: Contribution à la connaissance des Harpacticides hypogès (Crustacés ; Copépodes). Annales de Spéléologie, 23: 5–167.

Schmidt F., 1855: Beschreibung zweier neuer Höhentiere, eines Käfers und einer Schnecke. Verhandlungen des Zoologisch-Botanischen Vereins in Wien, 5: 3-4.

Schmidt F., 1860: Drei Neue Hölenkäfer aus Krain. Verhandlungen des Zoologisch-Botanischen Vereins in Wien, 10: 669-672.

Sket B., 1981: *Niphargobates orophobata* n.g., n. sp., (Amphipoda, Gammaridae s. l.) from cave waters in Slovenia (NW Yugoslavia) = *Niphargobates orophobata* n.g., n. sp., (Amphipoda, Gammaridae s. l.) iz jamskih voda Slovenije (SZ Jugoslavija). Biološki vestnik, 29: 105-118.

Sket B., 2008: Can we agree on an ecological classification of subterranean animals? Journal of natural history, 42: 1549-1563.

Sket B., Gogala M., Kuštor V., (ur. / eds.), 2003: *Živalstvo Slovenije*. Tehniška založba Slovenije; Ljubljana, Pp. 664.

Strasser K., 1935: Neue Acherosomen. Prirodoslovne Razprave, 2: 231-244.

Sturm F., 1853: Deutschlands Insecten. Gedruckt auf Kosten des Verfassers, Nürnberg; p. 22-93.

Ur. l. RS, 2004: Uradni list RS, 2004: Zakon o varstvu podzemnih jam. Uradni list RS, 02/04.

Vrezec A., Kapla A., (v tisku / in print): Favna jamskih hroščev Krima: raziskanost in izoliranost. Naše jame, 48.

Waga M., 1857: Description d'une nouvelle espèce Européenne de Crustacés, *Philoscia notata*, et d'un nouveau Myriapode, *Gervaisia costata*. Congres de Montpellier, Séance du 14 Juin 1857. Annales Société de Entomologie, France, 5: 827- 832, Fig. 2-4.

Waters T. F., 1965: Interpretation of invertebrate drift in streams. Ecology, 46: 327-333.

Wei Liu A., 2014: Epikarst control of the discharge, water quality and biodiversity in the Velika Pasica cave (Central Slovenia: dissertation). Nova Gorica, Pp. 168. http://www.ung.si/~library/doktorati/okolje/42WeiLiu.pdf.

Wei Liu A., Brancelj A., 2011: Response of cave drip water to different recorded rainfall patterns in Velika Pasjica cave, central Slovenia. V / In: Bertrand, Catherine (ur.), et al.: Proceedings of the 9th Conference on Limestone Hydrogeology, Besançon, France, September 1-3, 2011 = [Actes du 9ème Colloque d'hydrogéologie en pays calcaire]. Besançon: Université de Franche-Comté, Université de Neuchâtel, p. 307-310.

Wei Liu A., Brancelj A., 2013: A study of temperature characteristics in the shallow karstic Velika Pasica Cave, Slovenia. V: 16th International Congress of Speleology, Brno, Czech Republic, July 21-28, 2013. Filippi, M. (ur. / ed.), Bosák, P. (ur. / ed.). *Proceedings*. Brno: International Union of Speleology: Czech Speleological Society, 2: 427-431.

Wei Liu A., Brancelj A., 2014: Hydrochemical response of cave drip water to snowmelt water, a case study from Velika Pasica Cave, Central Slovenia = Spremembe hidrokemijskih lastnosti prenikle vode v jami kot posledica dotoka snežnice: primer jame Velika Pasica, osrednja Slovenija. Acta Carsologica, 43: 65-74, doi: 10.3986/ac.v43i1.613.

Wei Liu A., Brancelj A., Brenčič M., 2014: The hydrochemical response of cave drip waters to different rain patterns (a case study from Velika Pasica cave, central Slovenia). Carpatian journal of earth and environmental sciences, 9: 189-197.

Wikipedia, 2015: http://en.wikipedia.org/wiki/Karst (dostop: 10. 1. 2015 / accessed: 10. 1. 2015)

Williams P. W., 1983: The role of the subcutaneous zone in karst hydrology. Journal of Hydrology, 61: 45-67.

Wilson L. G., Everett L. G., Cullen S. J., (ur. / eds.), 1994: *Handbook of vadose zone characterization & Monitoring*. CRC Press, Levis Publishers; Boca Raton, Pp. 752.

GESELNO KAZALO / SUBJECT INDEX

(številka v oklepaju se nanaša na geslo v angleškem besedilu, ki je na drugi strani kot v slovenskem)
(the number in the parenthesis refers to the index in English being on different page as in Slovene)

SPLOŠNO / GENERAL

KRAJI / LOCATIONS

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Višje skupine / Higher taxa

Rodovi / Genera

Vrste / Species

O AVTORJU

Rodil se je l. 1957 v Iški. Osnovno šolo je obiskoval v Iški vasi, kasneje v Ljubljani. Po zaključku gimnazije se je leta 1976 vpisal na študij biologije na Univerzi v Ljubljani, kjer je leta 1981 opravil diplomo iz ekologije volka v gojitvenem lovišču Jelen-Snežnik. Na isti univerzi je leta 1991 opravil tudi doktorat iz sekundarne produkcije vodnih bolh v Blejskem jezeru.

Od leta 1982 je zaposlen na Nacionalnem inštitutu za biologijo v Ljubljani, najprej kot mladi raziskovalec, od leta 1993 pa kot vodja Oddelka za raziskovanje sladkovodnih in kopenskih ekosistemov. Od leta 1996 predava tudi na Univerzi v Novi Gorici in sicer limnologijo ter ekologijo podzemnih vod. Je znanstveni svetnik na inštitutu in redni profesor na univerzi.

Še kot dijak je postal član Društva za raziskovanje jam, kjer se je z jamarstvom amatersko ukvarjal do zaključka doktorata. Profesionalno se je z jamskim živalstvom začel ukvarjati leta 1983, ko je v okviru magistrske naloge proučeval ekologijo in razširjenost ceponožnih rakov v Postojnsko-planinskem jamskem sistemu. Ekologiji in taksonomiji podzemnih ceponožcev se je nato posvečal ves čas svojega raziskovalnega dela.

Leta 1990 je opisal prvo slepo jamsko vodno bolho (Cladocera), nato pa še tri. Med ceponožnimi raki je opisal preko 25 novih vrst za znanost tako iz Slovenije kot tudi iz tujine. Na tem področju intenzivno sodeluje s tajskimi raziskovalci, dva sta opravila doktorat pod njegovim somentorstvom. Bil je tudi mentor kitajskemu študentu, ki je opravil doktorat o hidrologiji in ekologiji epikrasa v jami Velika Pasica.

Njegova osebna bibliografija obsega blizu 500 naslovov, od tega preko 90 izvirnih znanstvenih člankov. Večina jih je objavljenih v priznanih tujih revijah. Med njimi je ena tretjina člankov posvečena ekologiji in taksonomiji podzemnih ceponožcev.

ABOUT THE AUTHOR

The author was born in 1957 in the Iška village. He attended primary school in the Iška Vas village and continued his education in Ljubljana. After graduating in 1976, he applied for Biology at the University of Ljubljana. In 1981 he wrote a thesis on the ecology of the wolf in the Jelen-Snežnik breeding and hunting reservation, Slovenia. In 1991, he wrote a PhD thesis at the same university on the secondary production of the water fleas in the lake Blejsko jezero.

He has been working at the National Institute of Biology in Ljubljana since 1982, starting his career as a young researcher. He has been the Head of Department for Freshwater and Terrestrial Ecosystems Research since 1993. He has been a lecturer on limnology and ecology of ground water at the University of Nova Gorica since 1996. He is a senior researcher at the institute and a full professor at the university.

In the secondary school he started pursuing caving as a hobby and became a member of the Society for Cave Exploration Ljubljana, until 1991, when he finished his PhD thesis. The cave-dwelling animals became his area of interest in 1983, when he started studying the ecology and presence of copepods in the Postojna-Planina Cave System within the framework of his master thesis. During his career, he has always shown great interest in the ecology and taxonomy of the subterranean copepods.

In 1990 he described the first blind cave-dwelling water flea (Cladocera), followed with three more species. He discovered more than 25 new species of copepods on the local as well as on the international level. He has cooperated closely with Thai scientists, two of whom he was a cosupervisor during their PhD studies. He was also a supervisor of a Chinese student who wrote his PhD thesis on hydrology and ecology of the epikarst in the Velika Pasica cave.

His personal bibliography includes approximately 500 entries, 90 of which are original scientific papers and most of them were published in renowned international journals. One third of them were written on the subject matter of ecology and taxonomy of subterranean copepods.

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