

# 23<sup>rd</sup> International Conference on Subterranean Biology

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The 23<sup>rd</sup> biennial International Conference on Subterranean Biology was held on the campus of the University of Arkansas in Fayetteville from June 13 to June 17, 2016. As is usual for these meetings, there was a strong international representation, with 125 participants from 17 countries, including for the first time, a strong group from the People’s Republic of China. It was the first meeting held in the United States and only the third meeting in the Americas (previous meetings were in Brazil and Mexico). It was also the first meeting covered by a reporter from *Science* (Pennisi 2016). It was also the most digital of meetings – the abstracts were available in a digital version and the conference itself was documented in social media, including Facebook and Shutterfly. The talks were organized into two broad themes – the ecological theater and the evolutionary play – taken from the book with the same name, written by the famous ecologist, G. Evelyn Hutchinson.

The results of the evolutionary play are of course species, and the description of new species has long been a strength in the research reported at these meetings, and given the high endemism of the subterranean fauna, it has long been the primary activity of speleobiologists. This meeting was no exception, with reports of new species descriptions and diversity patterns from around the world, including Australia (Cooper, Harms, Perina), Brazil (Ferreira, Soares, Souza) and China (Tian), all are areas of high, but largely undescribed, subterranean species richness. Phylogeography, a strong

theme in the past several conferences, continues to be a prominent research topic, with an entire session devoted to it. Both the number of genes sequenced and the breadth of the taxa analyzed continues to grow. This was especially noteworthy in Trontelj's presentation on the evolutionary history of the very large amphipod genus *Niphargus*. Also noteworthy is the diminished role of the Pleistocene as an agent forcing animals into caves and isolating them there. This is a big change in thinking that has occurred over the past several decades. According to by Delić, climate changes in the Pleistocene act more as selective agents, promoting thermal adaptation. But, we have probably not heard the last of the Pleistocene.

One of the newer approaches to research on evolution of cave animals is that of evolutionary developmental biologists, who analyze particular pathways of development of troglomorphic features, such as eye and pigment loss, and identify individual genes responsible for the changes. A theme of these talks was that there is often a trade-off between a reduced feature, such as eyes, and elaborated features, such as tastebuds (Jeffery, Ma). While the debate between the relative roles of selection and genetic drift continues, there are more and more examples of selection, even in unlikely systems such a melanin loss. Bilandžija showed that blockage of melanin production can lead to adaptive behavior changes resulting from increased levels of catecholamine. Many of the talks about the Mexican cavefish *Astyanax mexicanus* highlighted its potential use as a biomedical model. At a least a superficial sense, we learned that the Mexican cavefish is eyeless (Gross), has a deformed skull (O'Quinn) without pigment (Ma), fat (Rohner), and neurotic (Yoshizawa), and for these reasons may be a good model of some human diseases. It was this possibility that was the subject of Pennisi's *Science* article.

Just as our understanding of the evolutionary play in the subterranean world has grown by leaps and bounds, so has our understanding of the ecological theater. The scope of the theater itself was subject of a number of talks, including the presence of troglobionts and stygobionts in wetlands (Gottstein), sinkholes (Lewis), wells (Hahn, Siemensmeyer), calcrete (Cooper, Harms, Humphreys), scree slopes (Rendoš), canga (Soares), and deep caves (Borko). As usual, efficient sampling of the subterranean fauna remains elusive, but the technique of environmental DNA analysis has proved very useful in locating new sites of the black *Proteus* (Gorički) as well as fish and crayfish (Gabriel).

The mapping of subterranean biodiversity continues to be a hot topic, with several presenters (Ferreira, Reboleira) identifying caves with ten or more troglobionts and/stygobionts, the number ten being used by Culver and Sket (2000) to identify cave biodiversity hotspots. Several presenters (Lukić, Malard, Niemiller ) discussed geographic patterns based on literally thousands of georeferenced data points, and this scale of analysis promises to be the wave of the future. While the forefront on analysis of the evolutionary play relies heavily on advances in molecular genetics and development, advances in understanding subterranean biodiversity rely on advances in data manipulation and statistical analysis.

There is perhaps no more fundamental question about the ecological theater of subterranean organisms than what subterranean organisms eat. Several talks (Hutchins, Engel) pointed to the growing recognition of the importance of chemoautotrophy.

The subterranean ecological theater is, by definition, dark. Yet, many, but not all, cave organisms avoid light; a few are indifferent to it. The response to light among different groups is perplexing but interesting, and not just due to differences in time since isolation in the dark. A surprising number of talks focused on this topic (Fišer, Fong, Worsham).

Conservation of the subterranean fauna was an overarching theme as well. Not only were there several sessions devoted explicitly to conservation, including an update on White-nose Syndrome, which affects many North American cave dwelling bats (Watson), many speakers in other sessions pointed to the vulnerability and rarity of the subterranean cave fauna. The most eloquent plea for speleobiologists to redouble their efforts at protection was that of Dante Fenolio, when he introduced his new book, *Life in the Dark*.

One of G. Evelyn Hutchinson's favorite sayings was that everything was relevant to an ecologist except perhaps the irregular Greek verbs. The meeting seemed to cover almost everything except the irregular Greek verbs, and one person's summary only weakly conveys the richness and diversity of the presentations. A list of oral presentations given at the meeting follows and abstracts of these and the posters can be found at [www.speleobiology.com/icsb2016/conference-info/program/2016-icsb-abstracts/](http://www.speleobiology.com/icsb2016/conference-info/program/2016-icsb-abstracts/)

A number of participants remarked positively about the large number of students and post-doctoral fellows in attendance. This was made possible by the generosity of several donors, which, on behalf of the Steering Committee, I wish to acknowledge:

- Den and Sheila Roenfeldt family
- Cave Conservancy of the Virginias
- Cave Conservancy Foundation
- Crustacean Society
- International Society of Subterranean Biology.

## References

- Culver DC, Sket B (2000) Hotspots of subterranean biodiversity in caves and wells. *Journal of Cave and Karst Studies* 62: 11–17.
- Pennisi E (2016) Blind cave fish may provide insights into human health. *Science* 352: 1502–1503. doi: 10.1126/science.352.6293.1502

## Oral presentations

### **Microbial indicators of air and water quality in a tropical cave.**

Abris, Mattheus Imcon<sup>1</sup>; Palanca, Mishael Grace<sup>1</sup>; De Leon, Marian P.<sup>2</sup>;  
Banaay, Charina Gracia B.\*<sup>1,3</sup>

<sup>1</sup>Environmental Biology Division, Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines Los Baños, Laguna, Philippines

<sup>2</sup>Museum of Natural History, University of the Philippines Los Baños, Laguna, Philippines

<sup>3</sup>Faculty of Management and Development Studies, University of the Philippines Open University, Los Baños, Laguna, Philippines

### ***Astyanax mexicanus* as a natural model for metabolic adaptation.**

Aspiras, Ariel<sup>1</sup>; Tabin, Cliff<sup>1</sup>; Rohner, Nicolas<sup>2</sup>

<sup>1</sup>Department of Genetics, Harvard Medical School, Boston, Massachusetts, United States

<sup>2</sup>Stowers Institute for Medical Research, Kansas City, Missouri, United States

### **Character systems and criteria for species diagnosis in *Plutomurus* (Collembola, Tomoceridae), with description of two new species from Georgian caves (Caucasus).**

Barjadze, Shalva\*<sup>1</sup>; Baquero, Enrique<sup>2</sup>; Soto-Adames, Felipe<sup>3</sup>; Giordano, Rosanna<sup>3</sup>; Jordana, Rafael<sup>2</sup>

<sup>1</sup>Institute of Zoology, Ilia State University, Tbilisi, Republic of Georgia

<sup>2</sup>Department of Environmental Biology, University of Navarra, Pamplona, Navarra, Spain

<sup>3</sup>Department of Entomology, University of Illinois at Urbana-Champaign, Champaign, Illinois, United States

### **Brazilian subterranean amphipods with notes on their ecology and conservation.**

Bastos-Pereira, Rafaela\*; Ferreira, Rodrigo Lopes

Study Center on Subterranean Biology, Biology Department, Federal University of Lavras, Lavras, Minas Gerais, Brazil

### **Microbiological monitoring in Romanian show caves.**

Bercea, Silviu<sup>1</sup>; Nastase-Bucur, Ruxandra<sup>1</sup>; Kenez, Marius<sup>1</sup>;

Constantin, Silviu<sup>2</sup>; Moldovan, Oana Teodora\*<sup>1</sup>

<sup>1</sup>Department of Cluj, Emil Racovitza Institute of Speleology, Cluj-Napoca, Romania

<sup>2</sup>Department of Geospeology and Palentology, Emil Racovitza Institute of Speleology, Bucuresti, Romania

**Evolution of melanin pigment regression in cave animals.**

Bilandžija, Helena

Department of Biology, University of Maryland, College Park, Maryland, United States; Department of Molecular Biology, Ruđer Bošković Institute, Zagreb, Croatia; Croatian Biospeleological Society, Zagreb, Croatia

**Deep cave fauna – fact or fiction?**

Borko, Špela\*; Delić, Teo; Trontelj, Peter

Department of Biology, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia

**Geographically structured genetic diversity in the cave beetle *Darlingtonia kentuckensis* Valentine 1952 (Coleoptera: Carabidae: Trechinae).**

Boyd, Olivia F.\*<sup>1</sup>; Johnson, Jarrett<sup>2</sup>; Philips, T. Keith<sup>2</sup>

<sup>1</sup>Department of Integrative Biology, Oregon State University, Corvallis, Oregon, United States

<sup>2</sup>Department of Biology, Western Kentucky University, Bowling Green, Kentucky, United States

**Speleotranscriptome profiling casts light on differential expression and polymorphism in cave and surface populations of the amphipod *Gammarus minus*.**

Carlini, David B.

Department of Biology, American University, Washington, District of Columbia, United States

**A working relationship between the Missouri Department of Conservation and caving organizations.**

Colatskie, Shelly\*; Elliott, Anthony

Missouri Department of Conservation, Powder Valley Conservation Nature Center, 11715 Cragwold Road, Kirkwood, Missouri 63122, United States

**Regressive evolution of beetles from the subterranean archipelago of Western Australia: insights from comparative transcriptomics.**

Cooper, Steven John Baynard<sup>1,2</sup>; Tierney, Simon Martin<sup>1</sup>; Hyde, Josephine Charlotte Anne<sup>1</sup>; Saint, Kathleen Margaret<sup>2</sup>; Bertozzi, Terry<sup>1,2</sup>; Austin, Andrew Donald<sup>1</sup>; Humphreys, William Frank<sup>3</sup>

<sup>1</sup>Australian Centre for Evolutionary Biology and Biodiversity, and School of Biological Sciences, The University of Adelaide, Adelaide, South Australia, Australia

<sup>2</sup>Evolutionary Biology Unit, South Australian Museum, North Terrace,  
Adelaide, South Australia, Australia

<sup>3</sup>Terrestrial Zoology, Western Australian Museum, Welshpool, Western Australia,  
Australia

**Predicting the occurrence of cave-inhabiting fauna based on features of the surface environment.**

Culver, David C.<sup>1</sup>; Christman, Mary C.<sup>2</sup>; Doctor, Daniel H.<sup>3</sup>; Niemiller, Matthew L.<sup>\*4</sup>; Weary, David J.<sup>3</sup>; Young, John A.<sup>5</sup>; Zigler, Kirk S.<sup>6</sup>

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<sup>2</sup>Departments of Biology and Department of Statistics, University of Florida, Gainesville, Florida, and MCC Statistical Consulting LLC, Gainesville, Florida, United States

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<sup>4</sup>Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, Champaign, Illinois, United States

<sup>5</sup>U.S. Geological Survey, Leetown Science Center, Kearneysville, West Virginia, United States

<sup>6</sup>Department of Biology, The University of the South, Sewanee, Tennessee, United States

**Phylogeography, haplotype diversity and niche differentiation among freshwater crab *Sundathelphusa* species (Decapoda: Brachyura: Gecarcinucidae) in the subterranean habitat of Quezon, Philippines.**

Cunanan, Dianne Jaula<sup>\*</sup>; Husana, Daniel Edison

Environmental Biology Division, Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines Los Baños, College, Laguna, Philippines

**Thermal adaptation, a new driver of ecological speciation in subterranean fauna.**

Delić, Teo<sup>\*</sup>; Trontelj, Peter; Fišer, Cene

Subterranean Biology Lab, Department of Biology, University of Ljubljana, Ljubljana, Slovenia

**Distribution and diversity of stygobionts in Poland.**

Dumnicka, Elzbieta<sup>\*</sup>; Galas, Joanna

Institute of Nature Conservation, Polish Academy of Sciences, al. A. Mickiewicza 33, 31-120 Krakow, Poland

**Traits of terrestrial subterranean biota of the Western Carpathians (Central Europe) are affected by productivity of above ground ecosystems.**

Elhottová, Dana<sup>1</sup>; Kováč, Lubomír\*<sup>2</sup>; Nováková, Alena<sup>3</sup>; Chroňáková, Alica<sup>1</sup>; Mock, Andrej<sup>2</sup>; Krištúfek, Václav<sup>1</sup>; Mulec, Janez<sup>4</sup>; Lukešová, Alena<sup>1</sup>; Luptáčík, Peter<sup>2</sup>; Parimuchová, Andrea<sup>2</sup>; Papáč, Vladimír<sup>5</sup>; Miklisová, Dana<sup>6</sup>; Fenda, Peter<sup>7</sup>; Jászay, Tomáš<sup>8</sup>; Košel, Vladimír<sup>9</sup>

<sup>1</sup>Biology Centre ASCR, v. v. i., Institute of Soil Biology, České Budějovice, Czech Republic

<sup>2</sup>Department of Zoology, Institute of Biology and Ecology, Faculty of Science, P. J. Šafárik University, Košice, Slovakia

<sup>3</sup>Institute of Microbiology of the CAS, v. v. i., Prague, Czech Republic

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<sup>5</sup>State Nature Conservancy SR, Slovak Caves Administration, Rimavská Sobota, Slovakia

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<sup>7</sup>Department of Zoology, Faculty of Natural Sciences, Comenius University, Bratislava, Slovakia

<sup>8</sup>Šarišské múzeum, Bardejov, Slovakia

<sup>9</sup>Hornádska 24, 821 07 Bratislava, Slovakia

**A macroecological take on European groundwater biodiversity patterns.**

Eme, David<sup>1,2</sup>; Zagmajster, Maja<sup>3</sup>; Delić, Teo<sup>3</sup>; Douady, Christophe<sup>1</sup>; Fišer, Cene<sup>3</sup>; Flot, Jean-François<sup>4</sup>; Galassi, Diana M.P.<sup>5</sup>; Konecny-Dupré, Lara<sup>1</sup>; Marmोनier, Pierre<sup>1</sup>; Stoch, Fabio<sup>5</sup>; Zakšek, Valerija<sup>3</sup>; Malard, Florian\*<sup>1</sup>

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<sup>2</sup>Department of Life and Environmental Sciences, University of Iceland, Reykjavik, Iceland

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<sup>4</sup>Evolutionary Biology & Ecology, Université Libre de Bruxelles, Brussels, Belgium

<sup>5</sup>Department of Life, Health & Environmental Sciences, University of L'Aquila, L'Aquila, Italy

**Prevalence of microbial taxonomic groups to specific subterranean habitats may shed light on ubiquity of microbial function in cave ecosystems.**

Engel, Annette Summers

Earth and Planetary Sciences, University of Tennessee, Knoxville, Tennessee, USA

**Threats to the conservation of stygobionts.**

Fenolio, Danté

Conservation &amp; Research, San Antonio Zoo, San Antonio, Texas, United States

**Iron ore plateaus in the Amazon forest: hotspots of subterranean biodiversity?**

Ferreira, Rodrigo Lopes

Study Center on Subterranean Biology, Biology Department, Federal University of Lavras. Lavras, Minas Gerais, Brazil

**Brazilian troglomorphic fauna: besides raising the knowledge, are we contributing to their conservation?**

Ferreira, Rodrigo Lopes\*; Souza-Silva, Marconi

Study Center on Subterranean Biology, Biology Department, Federal University of Lavras. Lavras, Minas Gerais, Brazil.

**Brazilian vs. Slovenian aquatic subterranean biodiversity: the case of Arcias and Postojna-Planina cave systems**Ferreira, Rodrigo Lopes<sup>1</sup>; Souza-Silva, Marconi<sup>1\*</sup>; Fišer, Cene<sup>2</sup>; Zagamjster, Maja<sup>2</sup>; Prevorčnik, Simona<sup>2</sup>; Sket, Boris<sup>2</sup><sup>1</sup>Center of studies on Subterranean Biology, General Zoology sector, Department of Biology, Federal University of Lavras, Minas Gerais, Brazil<sup>2</sup>Department of Biology, Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, 1000 Ljubljana, Slovenia.**Searching for reproductive barriers between sympatric surface and subterranean ecomorphs of *Asellus aquaticus*.**

Fišer, Žiga\*; Trontelj, Peter

Department of Biology, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia

**Variation in phototactic behavior among surface and subterranean gammarid and crangonyctid amphipod species from different habitats.**Fong, Daniel Wu<sup>1\*</sup>; Wanner, Maria J.<sup>2</sup><sup>1</sup>Department of Biology, American University, Washington, District of Columbia, United States<sup>2</sup>Department of Biology, Gettysburg College, Gettysburg, Pennsylvania, United States

**Adult lens cuticle deposition in a microphthalmic cave beetle.**

Friedrich, Markus<sup>\*1,2</sup>; Kulacic, Jasmina<sup>1</sup>

<sup>1</sup>Department of Biological Sciences, Wayne State University, Detroit, Michigan, United States

<sup>2</sup>Department of Cellular Biology and Anatomy, Wayne State University, Detroit, Michigan, United States

**Cave animals at the dawn of speleogenomics.**

Friedrich, Markus

Department of Biological Sciences and Department of Cellular Biology and Anatomy, Wayne State University, Detroit, Michigan, United States

**Environmental DNA for monitoring and detection of rare and endangered cavefish and cave crayfish in the Ozark Highlands.**

Gabriel, Ana E.<sup>\*1</sup>; Van Den Bussche, Ronald A.<sup>1</sup>; Brewer, Shannon K.<sup>2</sup>; Stark, Richard<sup>3</sup>; Niemiller, Matthew L.<sup>4</sup>; Fenolio, Dante B.<sup>5</sup>

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<sup>2</sup>U.S. Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit

<sup>3</sup>U.S. Fish and Wildlife Service

<sup>4</sup>Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign

<sup>5</sup>San Antonio Zoo

**Long term population trends of biota in White Cave, Mammoth Cave National Park (2003-2016).**

Gilmore, Terrence<sup>1</sup>; Lavoie, Kathleen<sup>\*1</sup>; Helf, Kurt<sup>2</sup>; Poulson, Thomas<sup>3</sup>

<sup>1</sup>Biological Sciences, State University of New York College at Plattsburgh, Plattsburgh, New York 12901

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<sup>3</sup>318 Marlberry Circle, Jupiter, Florida, United States

**Searching for black *Proteus* (*Proteus anguinus parkelj*) in karst groundwater with the help of eDNA.**

Gorički, Špela<sup>\*1</sup>; Stanković, David<sup>1,2</sup>; Năpăruș-Aljančič, Magdalena<sup>1</sup>; Snoj, Aleš<sup>3</sup>; Aljančič, Gregor<sup>1</sup>

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<sup>3</sup>Department of Animal Science, Biotechnical faculty, University of Ljubljana, Ljubljana, Slovenia

**Microhabitat selection of subterranean amphipods in the Western Balkan peat bog.**

Gottstein, Sanja\*<sup>1</sup>; Brigić, Andreja<sup>1</sup>; Kerovec, Mladen<sup>1</sup>; Ternjej, Ivančica<sup>1</sup>

<sup>1</sup>Department of Biology, Faculty of Science, University of Zagreb, HR-10000 Zagreb, Croatia

**Genetic analysis of craniofacial changes in blind Mexican Cavefish, *Astyanax mexicanus*.**

Gross, Joshua

Department of Biological Sciences, University of Cincinnati, 312 Clifton Court, Rieveschl Hall Room 711B, Cincinnati, Ohio 45221-0006, United States

**Challenges and rewards of subterranean fauna environmental impact assessment.**

Halse, Stuart

Bennelongia Environmental Consultants, 5 Bishop Street, Jolimont, Western Australia 6014, Australia

**Biodiversity in complex subterranean systems: a tale of arachnids in arid Western Australia.**

Harms, Danilo\*<sup>\*</sup>; Halse, Stuart; McRae, Jane; Scanlon, Michael; Curran, Michael  
Bennelongia Environmental Consultants, 5 Bishop Street, Jolimont WA 6014, Australia.

**Shape variation within the Southern Cavefish, *Typhlichthys subterraneus* (Percopsiformes: Amblyopsidae).**

Hart, Pamela\*<sup>\*</sup>; Burress, Edward; Armbruster, Jonathan.

Department of Biological Sciences, Auburn University, Auburn, Alabama, United States

**Patterns on patterns: The rise and rise of Australian subterranean biodiversity.**

Humphreys, William F.

Department of Terrestrial Zoology, Western Australian Museum, Locked Bag 49, Welshpool DC, Western Australia 6986, Australia; School of Animal Biology, University of Western Australia, Crawley, Western Australia 6009, Australia.

**Conservation of subterranean species and habitats in Australia.**

Humphreys, William F.\*<sup>1,2</sup>; Humphreys, Garth <sup>2,3</sup>

<sup>1</sup>Department of Terrestrial Zoology, Western Australian Museum, Locked Bag 49, Welshpool DC, Western Australia 6986, Australia; School of Earth and Environmental Sciences, University of Adelaide, South Australia 5005, Australia.

<sup>2</sup>School of Animal Biology, University of Western Australia, Crawley, Western Australia 6009, Australia.

<sup>3</sup>Biota Environmental Sciences Pty Ltd, PO Box 155, Leederville, Western Australia 6903, Australia.

**Phylogeography of crab genus *Sundathelphusa*: history of extensive migration, cave colonization and refugia in the Philippines.**

Husana, Daniel Edison\*<sup>1</sup>; Haga, Takuma<sup>2</sup>; Kase, Tomoki<sup>3</sup>

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<sup>2</sup>Toyohashi Museum of Natural History, 1-238 Oana, Oiwa-cho, Toyohashi, Aichi 441-3147, Japan

<sup>3</sup>Invertebrate Paleontology Division, National Museum of Nature and Science, 4-1-1 Amakubo, Tsukuba City, Ibaraki 305-0005 Japan

**Biodiversity, stability, and trophic complexity in the Edwards Aquifer, United States:**

**The influence of chemolithoautotrophy on stygobiont community structure.**

Hutchins, Benjamin T.\*<sup>1,2</sup>; Engel, Annette Summers<sup>3</sup>; Nowlin, Weston H. <sup>2</sup>; Schwartz, Benjamin F.<sup>3,4</sup>

<sup>1</sup>Texas Parks and Wildlife Department, Austin Texas, United States

<sup>2</sup>Texas State University, Aquatic Station, Department of Biology, San Marcos, Texas, United States

<sup>3</sup>University of Tennessee, Department of Earth and Planetary Sciences, Knoxville, Tennessee, United States

<sup>4</sup>Edwards Aquifer Research and Data Center, Texas State University, San Marcos, Texas, United States

**Conservation status of stygobionts in Texas, United States.**

Hutchins, Benjamin T.

Texas Parks and Wildlife Department, Austin, Texas, United States

**Homocystinuria in Cavefish: Molecular analysis of an *Astyanax* eye QTL reveals the role of cystathionine  $\beta$ -synthase in eye degeneration.**

Jeffery, William

Department of Biology, University of Maryland, College Park, Maryland, United States

**Investigating the physico-chemical niche of obligate subterranean amphipods in shallow subterranean waters of the DC metro area.**

Keany, Jenna<sup>\*1</sup>; Culver, David<sup>1</sup>; Knee, Karen<sup>1</sup>; Fong, Daniel<sup>2</sup>

<sup>1</sup>Department of Environmental Science, American University, Washington, District of Columbia, United States

<sup>2</sup>Department of Biology, American University, Washington, District of Columbia, United States

**As above, so below? Testing for gene flow between cave and surface-dwelling populations of *Garra barreimiae*.**

Kirchner, Sandra<sup>\*1,2</sup>; Sattmann, Helmut<sup>3</sup>; Plan, Lukas<sup>4</sup>; Krenn, Harald<sup>1</sup>; Victor, Reginald<sup>5</sup>; Haring, Elisabeth<sup>1,2</sup>; Kruckenhauser, Luise<sup>2</sup>

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<sup>2</sup>Central Research Laboratories, Natural History Museum, Burgring 7, 1010 Vienna, Austria

<sup>3</sup>Third Zoological Department, Natural History Museum, Burgring 7, 1010 Vienna, Austria

<sup>4</sup>Department for Geology & Paleontology, Natural History Museum, Burgring 7, 1010 Vienna, Austria

<sup>5</sup>Department of Biology, Sultan Qaboos University, Al Khoudh, Muscat 123, Oman

**Synchronous ceiling-floor pitfall trapping allows study of microdistribution and habitat preferences of terrestrial subterranean fauna in caves.**

Kozel, Peter<sup>\*1,3</sup>; Pipan, Tanja<sup>1</sup>; Culver, David<sup>2</sup>; Šajna, Nina<sup>3</sup>; Polak, Slavko<sup>4</sup>; Novak, Tone<sup>3</sup>

<sup>1</sup>Karst Research Institute ZRC SAZU, Postojna, Slovenia;

<sup>2</sup>Department of Environmental Science, American University, Washington, District of Columbia, United States

<sup>3</sup> Department of Biology, Faculty of Natural Sciences and Mathematics, University of Maribor, Slovenia

<sup>4</sup> Zavod Znanje, OE Notranjska Museum Postojna, Slovenia

**Long-term cave adaptation and diversification in the *Ptomaphagus birtus*-group (Coleoptera: Leiodidae: Cholevinae).**

Leray, Vincent L.<sup>1</sup>; Zigler, Kirk S.\*<sup>2</sup>; Friedrich, Markus<sup>3</sup>

<sup>1</sup>American University, Washington, District of Columbia, United States

<sup>2</sup>University of the South, Sewanee, Tennessee, United States

<sup>3</sup>Wayne State University, Detroit, Michigan, United States

**Improving outcomes and modifying policies with evidence-based research on the karst of the Hoosier National Forest.**

Lewis, Julian J.\*; Lewis, Salisa L.

Lewis and Associates LLC, 17903 State Road 60, Borden, Indiana, United States

**Disjunct distribution of terrestrial troglobiotic species in Europe: the case of Collembola.**

Lukić, Marko\*<sup>1,2,3</sup>; Delić, Teo<sup>3</sup>; Zagamajster, Maja<sup>3</sup>; Bedos, Anne<sup>4</sup>; Deharveng, Louis<sup>4</sup>

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<sup>4</sup>Muséum National d'Histoire Naturelle, UMR7205 CNRS/MNHN, Paris, France

**Molecular analysis of melanophore lineage genes in cavefish depigmentation.**

Ma, Li\*<sup>1</sup>; Stahl, Bethany<sup>1,2</sup>; Adams, Hannah<sup>1</sup>; Gross, Joshua<sup>1</sup>

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<sup>2</sup>Department of Biological Sciences, Florida Atlantic University, Jupiter, Florida, United States

**Home range and habitat use of foraging *Myotis grisescens* from five maternity sites in northern Arkansas using aerial tracking.**

Moore, Patrick Ryan\*; Morris, Keith; Rolland, Virginie; Risch, Thomas Stephen  
Department of Biological Sciences, Arkansas State University, Jonesboro, Arkansas 72467, United States

**Estimating the trophic ecology of aquatic invertebrate using stable isotopes.**

Nair, Parvathi\*<sup>1</sup>; Nowlin, Weston<sup>1</sup>; Diaz, Pete<sup>2</sup>

<sup>1</sup>Department of Biology, Texas State University, San Marcos, Texas, United States

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**Conservation of amblyopsid cavefishes (Percopsiformes: Amblyopsidae) of the Ozark Highlands and Interior Low Plateau karst regions, USA.**

Niemiller, Matthew L.

Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, Champaign, Illinois, United States

**Ecological and consumer-driven nutrient recycling in a subterranean aquatic community.**

Nowlin, Weston H.\*<sup>1</sup>; Loney, Lauren<sup>1</sup>; Hutchins, Benjamin<sup>2</sup>; Schwartz, Benjamin F.<sup>3</sup>

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**Are cave sampling methods effective to assess subterranean fauna richness?**

Oliveira, Marcus Paulo Alves\*; Ferreira, Rodrigo Lopes

Department of Biology, Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil

**The evolution of scleral ossification in the Mexican Cavefish**

(*Astyanax mexicanus*).

O'Quin, Kelly E.\*<sup>1</sup>; Doshi, Pooja<sup>2</sup>; Lyon, Anastasia<sup>1</sup>; Hoenemeyer, Emma<sup>1</sup>; Yoshizawa, Masato<sup>3</sup>; Jeffery, William R.<sup>2</sup>

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<sup>3</sup>Department of Biology, University of Hawaii at Manoa, Honolulu, Hawaii, United States

**Conserving cave invertebrate fauna in Virginia (USA).**

Orndorff, William David

Virginia Department of Conservation and Recreation, Natural Heritage Program, Richmond, Virginia, United States

**Niche bacterial and archaeal community compositions as indicators of ecosystem processes and health in Bahamian and Mexican anchialine caves.**

Paterson, Audrey T.\*<sup>1</sup>; Iliffe, Thomas M.<sup>2</sup>; Bracken-Grissom, Heather<sup>3</sup>; Pérez-Moreno, Jorge L.<sup>3</sup>; Porter, Megan<sup>4</sup>; Gonzalez, Brett C.<sup>4</sup>; Engel, Annette Summers<sup>1</sup>

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**Remarkable biodiversity of a neglected group of stygofauna: Bathynellidae (Bathynellacea, Crustacea) in the north of Western Australia.**

Perina, Giulia\*<sup>1,2</sup>; Huey, Joel<sup>2</sup>; Camacho, Ana<sup>3</sup>; Horwitz, Pierre<sup>1</sup>; Koenders, Annette<sup>1</sup>

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<sup>2</sup>Western Australian Museum, Welshpool, Western Australia, Australia

<sup>3</sup>Museo Nacional de Ciencias Naturales (CSIC), Dpto. Biodiversidad y Biología Evolutiva, Madrid, Spain

**Uncovering divergent lineages and phylogeographic structure in an obligate cave-dwelling Salamander (*Eurycea spelaea*).**

Phillips, John G.\*<sup>1</sup>; Fenolio, Dante B.<sup>2</sup>; Emel, Sarah L.<sup>1,3</sup>; Bonnett, Ronald M.<sup>1</sup>

<sup>1</sup>Department of Biological Sciences, University of Tulsa, 800 South Tucker Drive, Tulsa, Oklahoma, United States

<sup>2</sup>San Antonio Zoo, San Antonio, Texas, United States

<sup>3</sup>Department of Biology, Temple University, Philadelphia, Pennsylvania, United States

**Phylogeny and systematic of the enigmatic Anthroherponina (Leptodirini, Cholevinae, Leioididae, Coleoptera).**

Polak, Slavko\*<sup>1</sup>; Delić, Teo<sup>2</sup>; Trontelj, Peter<sup>2</sup>

<sup>1</sup>Notranjska museum Postojna, Institute Znanje Postojna, Kolodvorska cesta 3, SI-6230 Postojna, Slovenia

<sup>2</sup>Department of Biology, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia

**Cuticular hydrocarbon analysis of cave versus surface Hawaiian planthoppers.**Porter, Megan Linnay<sup>\*1</sup>; Yew, Joanne<sup>2</sup><sup>1</sup>Department of Biology, University of Hawai'i at Mānoa, Honolulu, Hawaii, United States<sup>2</sup>Pacific Bioscience Research Center, University of Hawai'i at Mānoa, Honolulu, Hawaii, United States**Food limitation is necessary to explain elaborated troglomorphy in some species.**

Poulson, Thomas L.

318 Marlberry Circle, Jupiter, Florida, United States

**The evolution of craniofacial shape change in the blind Mexican Cavefish.**Powers, Amanda<sup>\*</sup>; Davis, Erin; Kaplan, Shane; Gross, Joshua

Department of Biological Sciences, University of Cincinnati, Cincinnati, Ohio, United States

**Developmental and genetic analysis of eye and pigment loss in the cave isopod *Asellus aquaticus*.**Mojaddidi, Hafasa<sup>1</sup>; Klein, Emily<sup>2</sup>; Trontelj, Peter<sup>3</sup>; Protas, Meredith<sup>1\*</sup><sup>1</sup>Department of Natural Sciences and Mathematics, Dominican University of California, San Rafael, California, United States<sup>2</sup>Department of Biology, Whitman College, Walla Walla, Washington, United States<sup>3</sup>Department of Biology, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia**Portugal - the emergence of a new hotspot of subterranean biodiversity in Europe.**

Reboleira, Ana Sofia P. S.

Natural History Museum of Denmark (Zoological Museum), University of Copenhagen, Universitetsparken 15, DK-2100 København Ø, Denmark.

**“Troglobiário” – a cave lab building bridges between citizens and science.**Reboleira, Ana Sofia P. S.<sup>\*1,2</sup>; Fernandes, Maria Jesus<sup>3</sup>; Martins, Olímpio<sup>3</sup><sup>1</sup>Natural History Museum of Denmark, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen, Denmark

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<sup>3</sup>Parque Natural das Serras de Aire e Candeeiros, Instituto de Conservação da Natureza e das Florestas, I.P., Portugal

**Unsafe sex – interesting interactions between cave inhabitants.**

Reboleira, Ana Sofia P. S.\*; Enghoff, Henrik

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**Organic carbon content as substantial factor affecting diversity and vertical distribution of Collembola on forested scree slopes.**

Rendoš, Michal \*<sup>1</sup>; Raschmanová, Natália <sup>1</sup>; Miklisová, Dana <sup>2</sup>; Mock, Andrej<sup>1</sup>; Luptáčík, Peter<sup>1</sup>; Kováč, Lubomír<sup>1</sup>

<sup>1</sup>Institute of Biology and Ecology, Faculty of Science, Pavol Jozef Šafárik University, Košice, Slovakia

<sup>2</sup>Institute of Parasitology, Slovak Academy of Sciences, Košice, Slovakia

**Physiochemical differences in water sources within De Leon Springs, Florida, and their potential effect on cave biota.**

Sawicki, Thomas R.\*<sup>1</sup>; Stine, Michael<sup>2</sup>; Long, Richard A.<sup>3</sup>

<sup>1</sup>Department of Biological Sciences, Florida A & M University, Tallahassee Florida, United States

<sup>2</sup>Department of Mathematics, Physics, and Biological Sciences, North Florida Community College, Madison, Florida, United States

<sup>3</sup>Department of Biological Sciences, Florida A & M University, Tallahassee Florida, United States

**Molecular and morphological analysis of *Stygobromus sp.* near San Marcos, Texas.**

Schwartz, Benjamin<sup>1,2</sup>; Nice, Christopher<sup>1</sup>; Jenson, Aubri\*<sup>1</sup>

<sup>1</sup>Department of Biology, Texas State University, San Marcos, Texas, United States

<sup>2</sup>Edwards Aquifer Research and Data Center, San Marcos, Texas, United States

**The effects of well type and quality on sampling of stygofaunal communities.**Siemensmeyer, Tobias<sup>\*1,2</sup>; Schwenk, Klaus<sup>2</sup>; Hahn, Hans Jürgen<sup>1</sup><sup>1</sup>Institute for Groundwater Ecology IGE GmbH, University of Koblenz Landau, Fortstr. 7, 76829 Landau, Rheinland-Pfalz, Germany<sup>2</sup>Institute for Environmental Sciences, University of Koblenz Landau, Fortstr. 7, 76829 Landau, Rheinland-Pfalz, Germany**Building a constituency for karst conservation.**Simon, Scott<sup>\*</sup>; Slay, Michael E.

Arkansas Field Office, The Nature Conservancy, 601 North University Avenue, Little Rock, Arkansas, United States

**Troglophobic fauna sampling methods in canga formations, Minas Gerais State, Brazil.**Soares, Gustavo<sup>\*</sup>; Andrade, Renata; Perroni, Gustavo  
Instituto do Carste, Belo Horizonte, Minas Gerais, Brazil**Updated records of troglomorphic palpigrales in Brazil.**Souza, Maysa Fernanda Villela Rezende<sup>\*</sup>; Ferreira, Rodrigo Lopes  
Study Center on Subterranean Biology, Biology Department, Federal University of Lavras, Lavras, Minas Gerais, Brazil**Global warming – where are the refugia for cold-stenothermous stygofauna?**Spengler, Cornelia; Hahn, Hans Jürgen<sup>\*</sup>

University of Koblenz Landau, Institute for Environmental Sciences, Fortstr. 7, 76829 Landau, Rheinland-Pfalz, Germany

**Species delimitation and phylogeography of *Hesperocheernes* (Pseudoscorpiones: Chernetidae) from karst regions of the southeastern United States.**Stephen, Charles Donald Robert<sup>\*1</sup>; Niemiller, Matthew Lance<sup>2</sup>; Bond, Jason Edward<sup>1</sup><sup>1</sup>Department of Biological Sciences, Auburn University, Auburn, Alabama, United States<sup>2</sup>Illinois Natural History Survey, Prairie Research Institute, University of Illinois Urbana-Champaign, Champaign, Illinois, United States

**Documenting Missouri cave biology – from Ruth Hoppin to Missouri Cave Database.**

Sutton, Michael\*<sup>1</sup>; House, Scott<sup>2</sup>

<sup>1</sup>Cave Research Foundation, 5544 CR204, Annapolis, Missouri 63620, United States

<sup>2</sup>Cave Research Foundation, 1606 Luce Street, Cape Girardeau Missouri 63701, United States

**Integrative taxonomy of cryptic subterranean Amphipods (Niphargidae: *Niphargus*) from Dinaric Karst.**

Švara, Vid\*<sup>1</sup>; Delić, Teo<sup>1</sup>; Coleman, Charles Oliver<sup>2</sup>; Fišer, Cene<sup>1</sup>

<sup>1</sup>Department of Biology, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia

<sup>2</sup>Museum für Naturkunde, Leibniz Institute for Evolution and Biodiversity Science, Berlin, Germany

**Cave-dwelling terrestrial isopods (Crustacea, Oniscidea) from Southeast Asia: a review.**

Taiti, Stefano\*<sup>1</sup>; Cardoso, Giovanna Monticelli<sup>1,2</sup>

<sup>1</sup>Istituto per lo Studio degli Ecosistemi, Consiglio Nazionale delle Ricerche, Florence, Italy

<sup>2</sup>Instituto de Bociências, Laboratório de Carcinologia, Departamento de Zoologia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

**Current status and habitat use of the Foushee cavesnail, *Ammicola cora* (Hydrobiidae) in Foushee Cave, Independence County, Arkansas.**

Throneberry, Jason\*<sup>1</sup>; Slay, Michael E.<sup>2</sup>; Taylor, Stephen J.<sup>3</sup>

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**Diversity and distribution of cavernicolous ground beetles (Insecta: Coleoptera: Carabidae) in China.**

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<sup>1</sup>Department of Entomology, College of Agriculture, South China Agricultural University, 483, Wushanlu, Guangzhou, 510642, China.

<sup>2</sup>Zoologische Staatssammlung - Münchhausenstraße 21, 81247 Munich, Germany.

**Crossing to the dark side: the South Central Texas *Eurycea* clade as a novel subterranean model system for the study of evolutionary developmental biology.**

Tovar, Ruben U.\*<sup>1</sup>; García, Dana M.<sup>2</sup>

<sup>1</sup>Department of Biological Science, The University of Tulsa, Tulsa, Oklahoma, United States

<sup>2</sup>Department of Biology, Texas State University, San Marcos, Texas, United States

**The origin of niphargids revisited and tested at the continental scale.**

Trontelj, Peter\*; Moškrič, Ajda; Verovnik, Rudi; Fišer, Cene

Department of Biology, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia

**StygoTracing - a biological tracing method for underground waters.**

van den Berg-Stein, Susanne<sup>1</sup>; Schwenk, Klaus<sup>2</sup>; Hahn, Hans Jürgen<sup>1</sup>

<sup>1</sup>Institute for Groundwater Ecology IGE GmbH, University of Koblenz Landau, Fortstr. 7, 76829 Landau, Rheinland-Pfalz, Germany

<sup>2</sup>Institute for Environmental Sciences, University of Koblenz Landau, Fortstr. 7, 76829 Landau, Rheinland-Pfalz, Germany,

**Geomicrobiology study in Heshang Cave, central China.**

Wang, Hongmei\*; Yun, Yuan; Man, Baiying; Zhou, Jianping

State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Wuhan, 430074, P R China

**Managing the spread of *Pseudogymnoascus destructans* and conserving bats threatened by White-nose Syndrome in North America.**

Coleman, Jeremy T. H.<sup>1</sup>; Reichard, Jonathan D.<sup>1</sup>; Geboy, Richard<sup>2</sup>; Kocer, Christina<sup>1</sup>; Watson, Cyndee<sup>3\*</sup>

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<sup>2</sup>U.S. Fish and Wildlife Service, Bloomington, Indiana, United States

<sup>3</sup>U.S. Fish and Wildlife Service, Austin, Texas, United States

**How the Endangered Species Act protects subterranean fauna in central Texas.**

Watson, Cyndee A.

United States Fish and Wildlife Service, Austin Ecological Services Office, Austin, Texas, United States

**The effect of selection on the phenotype of response to light in subterranean, epigeal, and interstitial Crangonyctidae.**

Worsham, McLean<sup>\*</sup>; Nair, Parvathi<sup>1</sup>; Nowlin, Weston<sup>1</sup>; Gibson, Randy<sup>2</sup>; Schwartz, Benjamin<sup>1</sup>

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<sup>2</sup>U. S. Fish and Wildlife Service, San Marcos Aquatic Resources Center, 500 East McCarty Lane, San Marcos, Texas 78666, United States

**Adaptation through changes of behavioral and morphological traits in Mexican Cavefish.**

Yoshizawa, Masato<sup>\*</sup>; Settle, Alexander<sup>1</sup>; Macaspac, Christian<sup>1</sup>; Fernandes, Vania<sup>1</sup>; Yoshida, Mina<sup>1</sup>; Keene, Alex<sup>2</sup>

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**The neglected subterranean biodiversity hotspot under threat: can we protect the aquatic interstitial fauna of the Sava River in the Balkans (Europe)?**

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