ABSTRACT: SEASONAL VARIATION OF STABLE CARBON ISOTOPES IN CENTRAL MISSOURI CAVE WATERS

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Analysis of stable isotopes and major ions in cave waters in Central Missouri was performed to identify processes that may affect the use of stable carbon isotopes in speleothems as a paleoclimate proxy. Preliminary analysis discovered significant seasonal variation of carbon-13 $\delta^{13}C_{DIC}$ in cave streams, rimstone pools, and drip water. Variation in the amplitude of $\delta^{13}C_{DIC}$ appears to be constrained by the number of cave entrances and cave entrance proximity. Seasonal variations in carbonate growth of speleothems coupled with changes in cave entrance geometry could have significant impacts on interpretations of stable isotope signatures found in speleothems and resulting paleoclimate models.

ABSTRACT: A DECADE OF PALEOCLIMATOLOGICAL STUDIES IN CREVICE CAVE, MISSOURI

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Crevice Cave in Perry County, Missouri is a world-class site for paleoclimatological studies. The cave contains a wide assortment of speleothems, many broken by natural processes, which are useful in reconstructing past variations in temperature, vegetation, seasonality, and flooding. The time frame of possible inquiry extends back from present for nearly 400,000 years, with resolution varying from centuries to seasons depending on the proxy and technique being utilized. The chronology of the speleothem record is established by high-precision U/Th dating. Highlights of the paleoclimatic record in Crevice Cave include:

- The first explicit demonstration of replication of stable isotope profiles among multiple speleothems.
- An outstanding carbon isotope history during past interglacial/glacial cycles that shows the response of mid-continental vegetation to changes in global climate.

- Detailed oxygen isotope variations during the last glacial period that can be rigorously compared to ice core records from Greenland.
- Development of a new proxy for flooding, obtained from sediment laminae preserved in stalagmites.

ABSTRACT: SPELEOGENOMICS: A PROPOSAL

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The many ways in which cryptobiotic (*sensu* Peck 1990) species have adapted to become light-deprived biota of crevices, caverns, caves and karst arguably count as prime manifestations of the body-plan-molding-power of the evolutionary process. Troglobitic species represent the extreme end of multiple independent solutions to conquering adaptive challenges, such as readjusting water-content regulation to constant humidity and enhancing the sensitivity of tactile and olfactory senses for successful search of food and prey. Much attention has been paid to such species by comparative morphology and physiology. These disciplines recently have been complemented with comparative developmental genetics. Seminal studies in the Mexican cavefish *Astyanax* revealed a surprising trade-off in the development of sensory over visual primordia (Yamamoto et al. 2003). The recent analysis of the genome of the cryptobiotic red flour beetle, *Tribolium castaneum*, unraveled an unexpectedly drastic reduction of visual receptor genes correlated with massive expansion of genes encoding olfactory and gustatory receptors (Consortium). These findings expose dramatic gene regulatory and genomic consequences that can come along with cryptobiotic adaption.

How general is genomic trade-off between visual and olfactory genes in cryptozoic species? Which changes in the genetic control of development are responsible for the often-observed reduction or loss of visual organs? These questions can now be comprehensively addressed by comparative genome sequencing. As sequencing technology continues to become increasingly more affordable, the thesis is posed that the time has come to study cryptobiotic organisms by comparative genomics. Advancing the resulting field of "speleogenomics" would critically depend on the expertise of the speleological community. Understanding the uniqueness of troglobite genomes in turn is likely to stimulate ecological research and to enhance public understanding for conservation efforts.

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ABSTRACT: KARST COLLAPSE IN MISSOURI: GEOLOGY AND RISK ASSESSMENT

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Over 170 karst collapses were documented by the Missouri Department of Natural Resources between 1970 and 2007. A significant number of the collapses occurred in populated areas and several resulted in loss of property. Historically, several sewage lagoons have failed by karst collapse resulting in significant groundwater contamination. The Missouri Department of Natural Resources evaluates karst collapse potential based on a combination of eight factors. Geospatial analysis and geologic investigations of collapse settings in Missouri indicate the current evaluation technique is only marginally adequate and is most applicable in the Salem Plateau province. A new evaluation technique has been developed based on geologic setting in combination with other factors and is the basis for new collapse potential maps.

ABSTRACT: RECENT ADVANCES IN BAT GATES

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Recent changes to bat-friendly, low-airflow-loss cave gates have made them easier to build, more secure, and have enabled the construction of gates in locations once considered ungateable.

ABSTRACT: FECAL BACTERIAL CONTAMINATION OF A KARST WATERSHED IN CENTRAL MISSOURI

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The Bonne Femme watershed of Boone County, Missouri, has a varied surface geology that includes karst topography with losing streams that are an especially vulnerable setting for groundwater contamination. The study objective was to compare fecal contamination and detection of specific, pathogenic, water-borne bacteria within the major subwatersheds, and relate this contamination to land use and hydrology. Ten subwatersheds were sampled weekly, for one month per quarter-calendar year since 2003 for fecal coliforms, *E. coli*, enterohemorrhagic *E. coli* O157:H7, *Salmonella*, and *Shigella*. Fecal coliform and *E. coli* enumerations were done by the membrane filtration techniques, and pathogen-specific analyses were performed through culture enrichment of water samples followed by DNA extraction of bacterial growth and PCR using pathogen-specific primers. Under low-flow conditions, fecal coliforms and *E. Coli* levels were typically less than 1000 cfu/100 mL, but many sites exceeded state and federal whole body contact limits in the second and third quarters of the year. Under high flow conditions, most sites exceed 10,000 cfu/100 mL, and whole body contact limits were always exceeded. *Salmonella* and *Shigella* were detected in at least two streams in each quarter of 2005 and 2006; *E. coli* O157:H7 was detected in at least one stream each quarter since second quarter 2005. In general, fecal bacterial contamination was significantly correlated to stream discharge and time of year, but it was not significantly correlated to land cover or to physico-chemical properties of the stream water within the subwatersheds. Site-specific causes explained the observed levels at the three sites with the highest fecal bacterial contamination.

ABSTRACT: WHAT, IF ANYTHING, IS A CAVE?

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A point of great sensitivity and often controversy among cavers is the dissemination of cave entrance locations. When a caver asks "Where is the cave?" they generally mean "Where is the cave entrance?" This shorthand expression can lead to serious miscommunication and friction between cavers and land managers.

Land managers or agency personnel who have responsibility for cave resources and protection will often ask cavers for cave locations. The land managers need to know primarily where the appropriate management unit is located, which almost always is a much larger area than an entrance. Everyone tends to use the word cave, but almost no one actually is referring to a cave as such. Good relations and trust among cavers and government and nongovernmental organizations can be much better fostered with the use of more precise language and using the sharing of less sensitive management unit information, such as recharge areas, as a starting point for building trust.

ABSTRACT: MANAGING PALEONTOLOGICAL RESOURCES IN CAVES

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Caves typically contain a wealth of paleontological resources that hold important clues to past climates and ecosystems. These resources range from invertebrate and vertebrate remains to animal trackways, and from dung deposits to speleothems. Unfortunately these irreplaceable resources often go unrecognized and thus management protocols are generally lacking. The first step in managing such cave resources is assessment and inventory. This involves a survey to recognize and identify these resources, a photographic record of each site, and a map with accompanying notes that pinpoint and discuss the localities. The second step is sampling and advanced assessment of known sites. This is a continuation of the first step but requires a more advanced research component to establish the overall significance of the localities. This research often includes sampling, salvage of fossil remains, and follow-up laboratory work. The third and final step in the management process is monitoring and protecting the known localities. To better demonstrate the significance of paleontological resources in caves, and the importance of their management, we provide examples from Powder Mill Creek Cave, a well-known system managed by the Missouri Department of Conservation.

ABSTRACT: "CAVES: LIFE BENEATH THE FOREST"

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While caves prove to be fascinating for the brave of heart, the harsh conditions in them can make their recesses difficult and uncomfortable for many people to explore. As a result, it is unlikely that significant numbers of our public will ever have a chance to see the remarkable adaptations that life has made to survive in this inhospitable environment. This education initiative is geared at educating and engaging children, as well as adults, about the intriguing life forms that exist in the remarkable karst topography that stretches across the United Stated.

But, how do you get the public excited about the array of bizarre creatures living in caves, especially millipedes, spiders, and isopods? The Hoosier National Forest, Indiana Karst Conservancy and National Speleological Society sponsored a cave biology documentary/webumentary produced by Ravenswood Media of Chicago, Illinois, "Caves: Life Beneath the Forest." The goal of this program is to emphasize the importance of cave conservation by giving the general public a chance to see creatures that they will likely never encounter on their own. By engaging the public, the sponsors hope to instill in them an appreciation for caves and cave species.

To help get the word out, showings of the film are given across the country, and it is being worked into various education and outreach programs such as Project Underground (next page). A special showing of this video was presented during the poster session at this Symposium.

For more information on the production, including various clips and availability, see http://www.caves.org

ABSTRACT: KARST AND CAVE STEWARDSHIP: AN EXPLORATION OF CURRENT AND FUTURE EDUCATIONAL AND RESEARCH NEEDS

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Karst is a landscape characterized by disappearing streams, sinkholes, and subsurface drainage, often in the form of caves; although, not all caves are found in karst environments. Once a rural environment, it has increasingly become

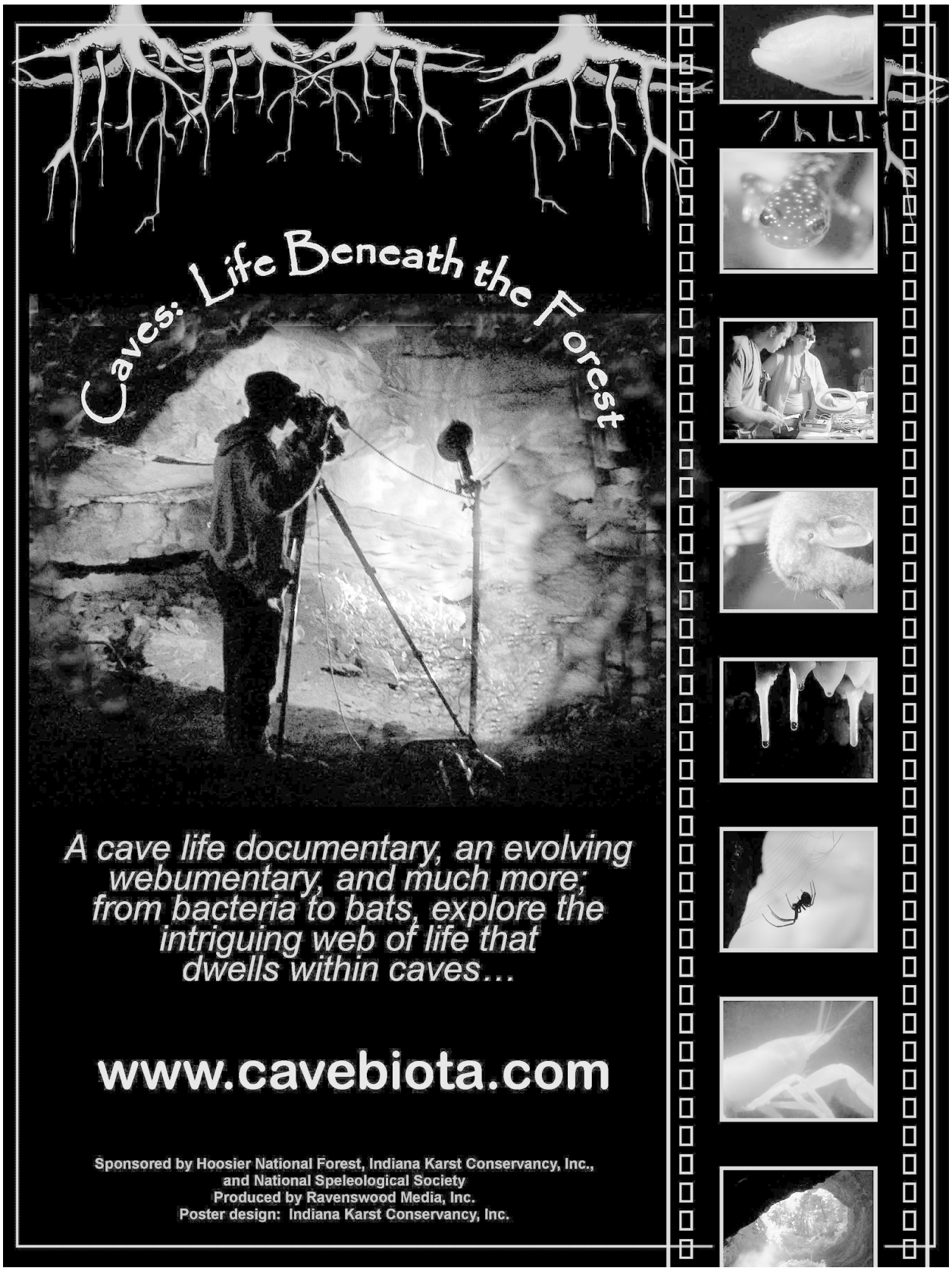

Figure 1 *Poster for "Caves: Life Beneath the Forest."*

associated with suburban and urban needs and environments. Throughout the world, karst and cave concerns include water access, pollution transport, tourism, and research, yet few land managers and policy makers understand what karst is. Worldwide, karst and cave education is extremely limited, and only two universities have established well-developed cave and karst programs. The lack of understanding about karst and caves stewardship results in lack of understanding of educational needs and even research funding. Karst and cave stewardship requires a multi-disciplinary approach as well as local, national, and international cooperation.

ABSTRACT: THE POTENTIAL EXTENT OF THE JEWEL CAVE SYSTEM

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With over 217 km (135 mi.) mapped, Jewel Cave is currently the second longest cave in the world. Research has shown a direct relationship between airflow at the entrance and the prevailing atmospheric pressure. Herb Conn used this barometric airflow to estimate a total minimum volume of 113 million m^3 (4 billion $ft.^3$), or 6,400 km (4,000 mi.) of average-sized cave, only 3–4% of which is presently documented.

This study estimates the extent of still-undiscovered portions of the cave system based on the following existing information: 1) thickness and distribution of the Madison limestone, 2) potentiometric surface of the Madison aquifer, 3) location and extent of potential geological obstacles, 4) the three-dimensional distribution of Wind Cave and Jewel Cave within the host rock, and 5) the "cave density" at Wind Cave and Jewel Cave.

The resulting geospatial model delineates the maximum geographic extents of the two caves. Most of Jewel Cave's volume extends toward Wind Cave, and vice versa. The overall cave-to-limestone ratio is well within the range of known "cave density" values for each cave. These data support the possibility that the two volumes could be part of a single large cave system, but a physical air trace is needed to prove an air connection.

Outlining the potential extent of the proposed Wind/Jewel cave system is a valuable tool for resource protection. It strengthens the rationale for adaptive surface use, pursuit of land purchases and exchanges and good-neighbor relationships.