PHOLEOS

JOURNAL OF THE WITTENBERG UNIVERSITY SPELEOLOGICAL SOCIETY

Volume 11 (1)

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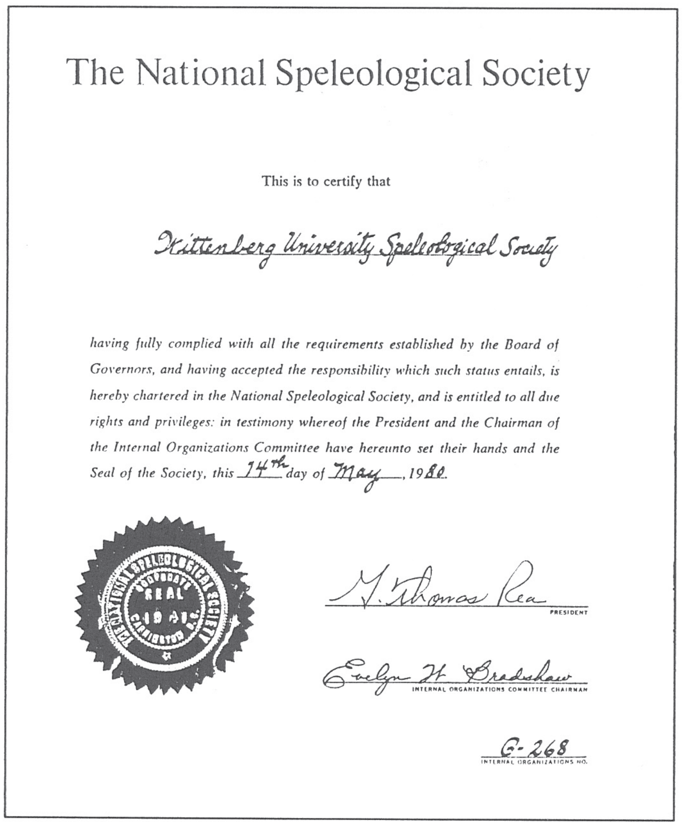
The Wittenberg University Speleological Society

The Wittenberg University Speleological Society is a chartered internal organization of the National Speleological Society, Inc. The Grotto received its charter May 1980 and is dedicated to the advancement of speleology, to cave conservation and preservation, and to the safety of all persons entering the spelean domain.


The National Speleological Society

This is to certify that

Wittenberg University Speleological Society

having fully complied with all the requirements established by the Board of Governors, and having accepted the responsibility which such status entails, is hereby chartered in the National Speleological Society, and is entitled to all due rights and privileges: in testimony whereof the President and the Chairman of the Internal Organizations Committee have hereunto set their hands and the Seal of the Society, this 14th day of May, 1980.

G. Thomas Rea
PRESIDENT

Evelyn H. Bradshaw
INTERNAL ORGANIZATIONS COMMITTEE CHAIRMAN

G-268
INTERNAL ORGANIZATIONS NO.

Front Cover Photo: Junction of Guano Canyon and passage leading to the Meat Grinder in Saltpetre-Moon Cave System, Carter County, Kentucky, by Horton H. Hobbs III

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GROTTO OFFICERS 1989-90

GROTTO ADDRESS: c/o Horton H. Hobbs III, Department of Biology, P. O. Box 720, Wittenberg University, Springfield, Ohio, USA 45501-0720, Tel. (513) 327-6484
SUBSCRIPTION RATE: 1 Volume - $5.00 (2 issues), Single issue $3.00. Send to Grotto address.
EXCHANGES: Exchanges with other grottoes and caving groups are encouraged. Please mail to Grotto address.
MEETINGS: Wednesday evening, 7:00 p.m., Room 206, Science Building, Wittenberg University, Springfield, Ohio.

Editor's Note

In this issue, one of the two main articles is by Cathy Pederson, a Wittenberg senior and biology major. Her extensive study on Bat Cave is both interesting and informative and is published in full along with all the data and charts from her research. The second main article, a chronology of Carter County, Kentucky, is an extensive year by year account of all historical events pertaining to the Carter Caves. This issue also contains other interesting communications including an article review about Texan show caves, an article review about a newly discovered cave in Arabia, a republished essay about cave explorers locating possibly several new species, and a personal account of a first surveying adventure.

Work has already begun for the next *Pholeos*. Four members from this grotto are venturing to Costa Rica this winter on an NSS expedition and are promising to report in full all the exciting details. The survey of a cave in Boone National Forest in Kentucky is already underway, and a detailed study of man's impact on caves including everything from the pollution caused by trash to the effects of dams is also in progress. The reference in the last issue (June 1990) about a complete report on a new Ohio cave has been postponed until a later issue. We apologize for any inconvenience this causes.

For a number of years the members of W.U.S.S. have talked about *Pholeos* as being more than a "newsletter" and with this issue we make the transition to "Journal." The following remarks by Dr. Hobbs should help justify this change.

J.T.

As we begin a second decade of publishing *Pholeos*, we look back at the 19 issues that have appeared somewhat regularly since March 1981 and tabulate a total of 115 cave maps and 130 articles published, excluding editorials. Reviews, cave description, poems, essays, short fictional stories, and articles treating a variety of topics pertaining to karst have appeared, including a diversity of areas in the United States, the Bahama Islands, Bermuda, and Kenya, Africa. We even wrote the bill and were instrumental in passing an Ohio Cave Protection Law; also *Pholeos* has received three awards from the National Speleological Society. To the 56 authors who have contributed and to all those 200 plus members who surveyed, photographed, hiked, crawled, climbed, rappelled, froze, sweated, etc., we THANK YOU!!

We are attempting to locate all of the "caving club alums" and hope that you will let us know where you are and what you are doing. If you see, correspond with, or talk to any of the former "Wusses," urge them to contact us. If you would like to find out what the current members of W.U.S.S. are doing, subscribe to *Pholeos*. We hope to hear from you and, better yet, come back to Wittenberg for a visit—we might even drag you underground!!

H^3

A Comparative Study of Drift in a Kentucky Cave and Surface Stream

by
Cathy Pederson

ABSTRACT

This investigation provides information on several aspects of the drift of benthic macroinvertebrates in a cave and surface stream in Carter County, Kentucky. Biological and physicochemical data were gathered at three hour intervals for twenty-four hours on seven occasions during the summer of 1990. Drift, primarily of the amphipod *Gammarus minus*, was found to be a common phenomenon in both the cave and surface stream cave effluent, representing only the second study to demonstrate the process occurring in any cave ecosystem. Although drift was demonstrated, no physicochemical parameters were shown to influence drift significantly within the cave. No peak times were found for cave drift but a significantly higher number of macroinvertebrates drifted in the surface stream with the maximum number of organisms moving during the early evening.

INTRODUCTION

Invertebrate drift refers to the advertent or inadvertent detachment of benthic organisms from the streambed and their movement with the current in a freshwater stream. Needham (1928) discovered the drift of benthic invertebrates when he set nets in a stream to study the downstream movement of terrestrial insects in the current. Muller (1954) found that invertebrate drift was not a stream phenomenon that resulted only from stream flooding but instead, it was a normal and continuous event in a stream (Dendy 1944). Waters (1965) divided drift into three categories: 1) catastrophic drift, the drift detrimental to the organism's population which occurs during or after flooding; 2) constant drift, the accidental drift of benthic organisms transpiring continually which has little or no effect on stream population; and 3) behavioral drift, the purposeful detachment of benthic organisms from the substrate influenced by some physical, chemical, or biological factor in the water.

Several parameters have been found to influence drift, such as benthos density (Waters, 1965; Diamond, 1967), light intensity (Elliott, 1965; Holt and Waters, 1967; Chaston, 1969), water temperature (Waters, 1968; Wojtalik and Waters, 1970), the effect of stream flow on drift (Anderson and Lehmkuhl, 1968; Minshall and Winger, 1968; Gallepp, 1977), and the relationship between organism development and drift (Muller 1966). In addition, a pattern of diurnal periodicity has been found for drift (Tanaka, 1960; Waters, 1962; Muller, 1966) and the organisms are more active at night, thus increasing drift rates during the hours of darkness (Harker, 1953; Madsen, 1966). The diel and seasonal variability of the external environment were found to alter the numbers of organisms in the drift (Hynes 1970).

A considerable amount of work has been devoted to drift in surface streams and springs, but little has been done in regard to subterranean drift. Waters (1981) studied drift in the mouth of a cave and found that virtually no organisms drift out of the cave environment. Death (1988, 1989) found that drift does occur in a limestone cave in Cave Stream, in the foothills of Craigeburn Range, Canterbury, and the benthos density inside the cave was found to be smaller than that discovered in the connected surface stream. A cave is one of the least variable environments found in the world and its only major natural disturbance is flooding (Hawes 1939). Hence, a cave would not give many cues for benthic organisms to drift. This study focused mainly on the population of *Gammarus minus* that inhabited the stream both inside and outside of Bat cave in Carter County, Kentucky.

This investigation seeks to confirm that there is drift inside the predictable environment of a cave while also comparing the cave stream drift to that occurring in a surface stream. This study was designed to look for some possible causes of drift within a cave, but a comprehensive investigation of the initiation of drift was not intended. Instead, analyses were made to determine whether drift is a phenomenon found within the boundaries of a cave and measurements were taken to consider density-independent factors that might be correlated with stream drift. During the last set of measurements, the density of the population in the stream was evaluated at each of the three stations.

DESCRIPTION OF STUDY SITE

The stream studied originates as a spring in Bat Cave, Carter Caves State Resort Park, Carter County, Kentucky and was investigated at three sampling stations. Two sites were located within the limestone cave (see Figure 1) and a third site was situated approximately 100 m downstream from the entrance. The cave is 3.7 kilometers in length and is developed in St. Louis and St. Genevieve limestones (Hobbs, 1989). At the lower historic entrance, the floor is irregular and covered with large breakdown blocks. Entering the cave further, the floor is packed clay, sand, and gravel. Station 1 is located at a riffle approximately 200 m upstream from the main entrance of the cave; pools lie approximately 25 m upstream and directly below this site (Figure 1). Station 2, also in a riffle, is 350 m upstream from the entrance. This site is forerun by a very shallow, wide area of the stream which narrows at the location of the nets and is directly succeeded by a large pool. The substrate of the stream as it runs through the cave is primarily small stones and gravel. The surface stream, Cave Run, with a bedrock and gravel substrate, flows through a deciduous forest and is shaded heavily by vegetation. A long pool precedes Station 3 and a small pool follows the locality. As the summer progressed, the stream volume decreased until a 40 m section below the entrance became dry. Although the water flowed below the ground, the stream was not truly connected for organism movement between the sites within the cave and the surface stream.

METHODS AND MATERIALS

Drift sampling was conducted on seven occasions between 29 June and 18 August 1990. Each data set covered a 24 hour time span with data being taken at each of the three stations at three hour intervals. Two drift nets were placed at each of the three sites early in the summer, but as the season progressed the stream volume decreased, thus only one net was required at each station. The drift nets were cone shaped and constructed of 363 mm Nitex. The nets were positioned so that the majority of the water in the stream flowed through them. The invertebrates captured were placed in 70% ethanol for counting and identification early in the summer, but after the third data set specimens were counted and no longer collected except for small numbers which were used for population analyses of invertebrates in the stream.

At each of the three hour net inspections, the following data were taken: air and water temperature, relative humidity, pH, specific conductance, water velocity, and the dissolved oxygen content in the water. Twice during the 24 hour period water samples were obtained to ascertain the concentration of iron, sulfur, nitrogen, and phosphorous in the water. Following the last data set, a Surber sampler was used to measure the density of the organisms at each of the three stations.

A variety of statistical tests were conducted on the data sets using Stat 11, a computer program for simple statistics. When analyzing data that involved only one parameter, such as the pH of the water, and making a comparison between the three sites, an independent sample t-test was used. This particular test was chosen because the measurements were taken repeatedly in the same position at each of the three sites. Analysis of Variance (ANOVA) was used to determine the differences over time in a particular analysis at one site, such as the number of organisms at Bat Cave (Station 2) over the 24 hour period. ANOVA required the use of repeated measures because the data for the test in question were from all of the seven sets for each individual site. The third test employed was the Pearson r correlation coefficient. This test was used to determine whether or not a correlation existed between any two parameters such as the oxygen content and the numbers of organisms drifting. Graphics were generated using TWIN® graphics software.

RESULTS

This study found that the cave environment exhibited very little fluctuation in any of the physicochemical parameters that were measured. Tables 1-7 and Figures 2-10 display physicochemical and biological data. Air temperatures were relatively constant and did not vary significantly over time (F <.05 ANOVA) nor were they statistically different between the two sites in the cave (t <.05 independent sample t-test). Accordingly, the water temperature did not vary significantly over time (F <.05 ANOVA) nor was there a significant difference between the two cave stations (t <.05 independent sample t-test). The velocity of the water inside the cave also showed no significant differences over time (F <.05 ANOVA) nor between stations (t <.05 independent sample t-test). The oxygen content in the cave stream was not significantly different between the two hypogean stations (t <.05 independent sample t-test) and over the 24 hour time period (F <.05 ANOVA). The pH of the water also failed to show a significant statistical difference over time (F <.05 ANOVA) or between the sites (t <.05 independent sample t-test). There was no statistical difference between the sites (t <.05 independent sample t-test) nor over time for specific conductance (F <.05 ANOVA). Seemingly, there are very few fluctuations in the physical and chemical aspects of the cave. No peak times were found for organisms drifting at either site in the cave.

Correlations were made between the various physical and chemical parameters in the cave and the numbers of organisms drifting. The drift rates and the pH were not found to be statistically significantly correlated (r <.05 Pearson r). Likewise, organism drift failed to be correlated with velocity (r < .05 Pearson r) and specific conductance (r <.05 Pearson r). The amount of organism drift, however, was found to have a significant negative correlation with the oxygen content in the water, both at Station 1 (r >.05 Pearson r) and at Station 2 (r >.01 Pearson r).

The amphipod, *Gammarus minus*, was found to drift both inside and outside the cave. The amphipods in the cave were larger and tended to be much lighter in color than those found in the surface stream. The amphipods were abundant in the drift during the early part of the investigation and tended to decrease in numbers as the summer continued. In August, a change was noticed in the organisms. Many were much smaller than previously noted and darker in color. Also, exuviae were found in the drift nets in early August. Apparently, reproduction and molting were occurring. Differences such as these were difficult to detect in the surface stream as the organisms were of such small size. The population density was also measured at each of the three sites at the conclusion of the study. At Station 1 inside the cave, the population density was found to be 1216.3 organisms per m^2, at Station 2 the density was 10.8, and at Station 3 the population density was found to be 592.0 amphipods per m^2.

The trends in the drift found in the surface stream, Station 3, corresponded with previous studies that discovered some patterns in regard to stream drift. There were peak times for organism drift in the surface stream (F>.01 ANOVA), with more drift occurring during hours of darkness, especially at dusk. There were no times when the velocity or oxygen levels were significantly higher or lower at Station 3 (F<.05 ANOVA). As would be expected, peak times were discovered for air temperature (F>.01 ANOVA) and water temperature (F>.01 ANOVA).

Data were analyzed to determine whether or not correlations could be made between various parameters measured and organisms drifting in the stream. The drift rate did not have a significant correlation with the pH in the surface stream (r <.05 Pearson r). In addition, neither the velocity (r <.05 Pearson r) nor the conductivity of the stream (r <.05 Pearson r) had any significant correlation with the number of organisms in the drift. As was found in the cave, there was a significant correlation found between the oxygen content of the water at Station 3 and the number of organisms drifting (r >.05 Pearson r), but no peak oxygen level found in the surface stream (F<.05 ANOVA). The drift also failed to correlate with the water temperature at Station 3 (r <.05 Pearson r).

The comparison of the cave and the surface stream lead to some conclusive results. There were many differences found between the cave environment and the surface. There was a significant difference in velocity between the cave stream and the surface stream (t >.05 independent sample t-test) with the velocity higher in the cave than at the surface stream site. A significant difference was also discovered between the cave and the stream in the number of organisms drifting (t >.01 independent sample t-test) with more organisms drifting in the surface than in the cave stream. A significant difference in the pH factor between the cave and the stream (t >.05 independent sample t-test) was observed. Oxygen content also proved to have a significant difference between the cave and the surface stream (t >.01 independent sample t-test), with the oxygen being higher in the cave than in the surface stream. There were significant differences between the cave and the stream in air temperatures (t >.05 independent sample t-test) and water temperatures (t >.01 independent sample t-test).

DISCUSSION

This study offers many opportunities for future investigations of stream drift within a cave. First, drift of benthic macroinvertebrates does occur in the Bat Cave stream. This study supplies further documentation that the cave environment is relatively constant with only slight physical and chemical changes. Third, this investigation appends and supports the work that has been done in a cave environment and the discovery of drift in a cave.

This investigation's initial goal was to discover whether or not stream drift occurs in Bat Cave, Carter County, Kentucky. The numbers of organisms this study found drifting in the cave imply the common nature of drift in this cave stream. Since this study was not designed specifically to determine which parameter(s) influences the downstream displacement of organisms, only speculations may be considered. The population density was not continually monitored in the stream throughout the course of the study, and density-dependent factors in the benthic communities may be the cause of the drift inside the cave habitat, as has been found in surface stream communities (Waters, 1965; Diamond, 1967). None of the parameters measured in this study provided any obvious connection with the numbers of organisms drifting. Even the oxygen content of the water, which was statistically correlated with drift, does not show a relationship when the mean values of the two parameters were plotted on a line graph. Because this investigation was not designed to determine the triggering agents of the drift, the only conclusion that may be drawn is that the oxygen content and organism drift are correlated but not necessarily in a cause-effect manner. Slight fluctuations in some of the cave data occurred according to the time of day and others varied according to the particular day and external weather conditions.

The cave environment has been demonstrated to be relatively unchanging with the measurements of air temperature, water temperature, relative humidity, pH, oxygen content, specific conductance, and velocity of the water. These measurements all affirm that the cave is predictable and in many ways a much less variable environment than the surface stream.

Measurement of drift in the surface and the cave stream allowed for comparison of the patterns and trends of benthic macroinvertebrate movement in each environment. The surface stream had definite peaks in numbers of organisms drifting. These patterns seemed to follow the light intensity of the stream, as many studies have previously demonstrated (Elliott, 1965; Holt and Waters,1967; Chaston, 1969). There was no peak time for the drift in the cave stream. Some variables, of course, are not present in a cave that have been found to influence the drift of the surface stream, such as light intensity and variations in water temperature. There were also no peak times for any of the physical or chemical fluctuations that were observed in the cave.

When comparing the amount of drift inside and outside the cave, significantly more organisms drifted on the surface than were found in the cave stream. Since the density of the benthos was not continually measured, it is difficult to determine if the difference comes from a smaller cave population or if the cave populations do not drift as often as those outside do. Considerably more research needs to be conducted on this issue to determine if the drift of cave stream macroinvertebrates is the result of density-dependent or density-independent factors.

ACKNOWLEDGMENTS

I would like to give special thanks to the Faculty Research Fund Board and Wittenberg University for giving me an opportunity to conduct this work through their program of summer grants for students. I would also like to thank Carter Caves State Resort Park, especially John Tierney and Sam Plummer, for their support of the work and allowing me access to the cave. Appreciation is extended to Dr. Josephine F. Wilson for her aid with the statistical analyses of data and to Dr. Horton H. Hobbs III for suggesting this study and for his overall assistance. I would also like to give a special thank you to my field assistants, Pam Schuetze, and my parents, Carol and Lowell Pederson.

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Table 1
Biological and Physicochemical Data
29-30 June 1990

	Air temp. °C	H_2O temp. °C	Rel. Hum. %	Velocity m/sec	pH	Oxygen mg/l	Total # of Drift Organisms
Time:2230							
STA 1	10	9	98.1	.01	7.65	-	305
STA 2	12	8	97.9	.02	7.65	-	5
STA 3	14	11	87.3	.00	7.60	-	35
Time:0130							
STA 1	9	9	94.6	.02	7.55	7.7	465
STA 2	10	8	100	.01	7.55	7.8	0
STA 3	14	12	85.5	.00	7.65	7.7	32
Time:0430							
STA 1	9	13	88.3	.00	7.70	7.7	96
STA 2	13	10	96.7	.04	7.50	7.7	22
Time:0730							
STA 1	9	9	98.2	.01	7.40	7.7	138
STA 2	10.5	9	100	.02	7.50	7.7	5
STA 3	14	11	96.7	.01	7.45	7.6	31
Time:1030							
STA 1	9	9	100	.02	7.40	7.7	51
STA 3	14	12	98.4	.03	7.40	7.7	28
Time:1330							
STA 1	9	9	93.0	.02	7.40	7.7	26
STA 2	10	9	93.1	.01	7.05	7.8	21
STA 3	18	13	93.2	.02	7.35	7.7	2
Time:1630							
STA 1	10	9	100	.06	7.25	7.75	15
STA 3	-	-	-	-	-	-	-

Table 2
Biological and Physicochemical Data
9-10 July 1990

	Air temp. °C	H_2O temp. °C	Rel. Hum. %	Velocity m/sec	pH	Total # of Drift
Time:1800						
STA 1	10	10	92.5	.412	7.35	12
STA 3	16	13	97.8	.115	7.15	3
Time:2100						
STA 1	12	9	94.9	.321	7.40	11
STA 3	17	13.5	94.3	.074	7.15	7
Time:2400						
STA 1	14	9.5	96.6	.474	7.35	9
STA 3	14	11.5	85.0	.109	7.15	36
Time:0300						
STA 1	11	9	93.0	.424	7.35	2
STA 3	15	11	97.1	.111	7.15	21
Time:0600						
STA 1	10	10	91.8	.309	7.00	14
STA 3	13	11	96.7	.134	7.25	4
Time:0900						
STA 1	11	9.5	100.0	.342	7.15	20
STA 3	17	12	96.9	.064	7.05	3
Time:1200						
STA 1	10	10	98.2	.315	7.35	3
STA 3	19	13	98.5	.058	7.15	2
Time:1500						
STA 1	11	10	88.5	.236	7.45	7
STA 3	17	13.5	84.7	.092	7.09	2

Table 3
Biological and Physicochemical Data
11-12 July 1990

	Air temp. 'C	H_2O temp. 'C	Rel. Hum. %	Velocity m/sec	pH	Total # of Drift
Time:1800						
STA 1	10	10	98.2	.250	7.25	6
STA 3	19	-	100.0	.158	7.15	21
Time:2100	-	-	-	-	-	-
Time:2400						
STA 1	12	10	96.6	.429	6.70	22
STA 3	15	11	100.0	.331	6.30	55
Time:0300						
STA 1	11	10	81.8	.403	6.70	26
STA 3	14	10.5	84.7	.304	6.80	22
Time:0600						
STA 1	10	10	96.5	.575	7.05	9
STA 3	13	10	95.2	.312	6.85	3
Time:0900						
STA 1	12	10	100.0	.312	6.95	16
STA 3	15	10	96.9	.270	6.75	3
Time:1200						
STA 1	10	10	80.6	.291	6.60	1
STA 3	14	11	95.5	.274	6.75	0
Time:1500	-	-	-	-	-	-

Table 4
Biological and Physicochemical Data
27-28 July 1990

	Air temp. 'C	H_2O temp. 'C	Rel. Hum. %	Velocity m/sec	pH	Oxygen mg/l	Con.	Total # of Drift Organisms
Time:2100								
STA 1	13	9	93.2	.01	6.85	8.4	267	41+1S
STA 3	14	12	95.4	.03	6.50	8.6	133	15
Time:2400								
STA 1	11	9	86.9	.07	7.20	8.9	259	0
STA 2	12	10	87.1	.13	7.15	9.0	250	12
STA 3	14	11	98.4	.03	6.30	7.0	250	88
Time:0300								
STA 1	10	9	100.0	.03	7.15	8.6	260	6
STA 3	13	12	100.0	.03	7.10	7.7	252	91
Time:0600								
STA 1	10	9	96.6	.04	7.10	9.5	258	3
STA 2	10	10	100.0	.03	7.15	7.8	266	32
STA 3	12	11	96.6	.005	7.05	7.7	128	14+1S
Time:0900								
STA 1	9	9	98.2	.08	7.25	8.8	262	1
STA 3	13	11	96.7	.02	6.75	7.2	258	5
Time:1200								
STA 1	10	9	93.3	.13	6.85	8.6	268	2+3S
STA 2	10	9	100.0	.04	6.85	9.0	132	11
STA 3	17	13	95.5	.01	6.55	8.0	140	9
Time:1500								
STA 1	10	9	100.0	.10	6.45	8.5	262	4
STA 3	16	13	92.4	.13	6.75	7.8	148	5
Time:1800								
STA 1	11	9	100.0	.15	7.25	9.3	272	1+2S
STA 2	10	9	98.2	.10	7.05	8.4	158	6
STA 3	15	13	96.9	.03	7.15	7.0	138	31

Table 5
Biological and Physicochemical Data
3-4 August 1990

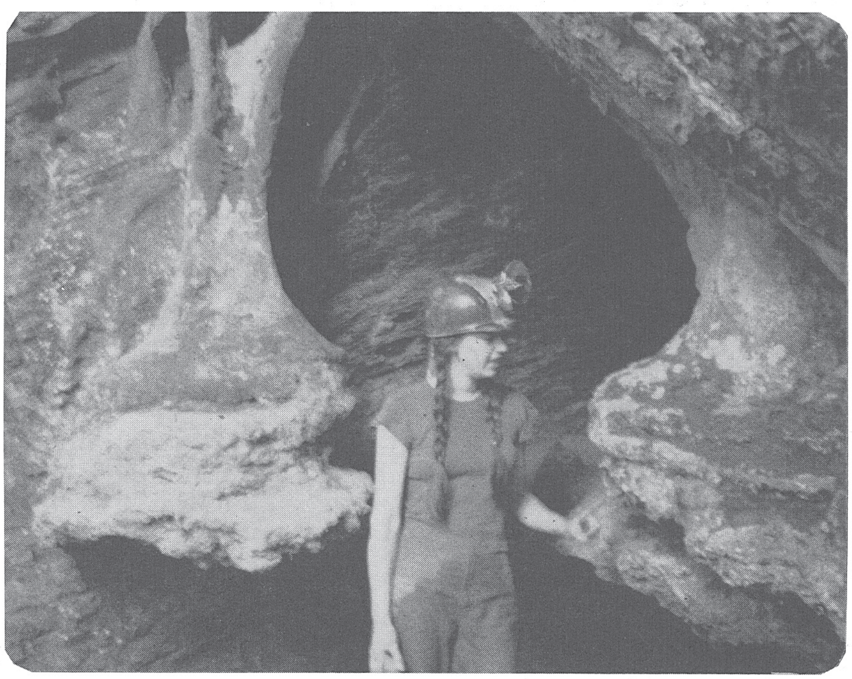
	Air temp. 'C	H_2O temp. 'C	Rel. Hum. %	Velocity m/sec	pH	Oxygen mg/l	Con.	Total # of Drift Organisms
Time:2100								
STA 1	9	9	96.4	.03	7.40	9.5		135
14								
STA 3	15	13	98.4	.06	7.25	7.0	20	35
Time:2400								
STA 1	11	9	98.2	.03	7.25	8.8	280	2
STA 3	13	13	98.4	.01	7.25	6.8	48	25
Time:0300								
STA 1	10	9	100.0	.01	7.25	7.9	135	11
STA 3	13	13	98.4	.03	7.15	6.4	15	70
Time:0600								
STA 1	10	9	96.4	.04	7.25	8.8	138	11
STA 3	13	13	98.3	.03	7.05	6.8	8	27
Time:0900								
STA 1	9	9	96.4	.01	7.45	8.3	265	10
STA 3	14	13	98.4	.06	7.25	7.8	135	8
Time:1200								
STA 1	10	9	100.0	.03	7.20	8.6	135	7
STA 3	10	14	98.4	.02	7.15	8.2	10	0
Time:1500								
STA 1	10	9	100.0	.03	7.15	8.3	270	3
STA 3	17	14	97.0	.01	7.10	7.9	25	3
Time:1800								
STA 1	10	9	93.2	.05	7.15	8.0	132	7
STA 3	16	14	98.4	.02	7.15	7.9	138	39

Table 6
Biological and Physicochemical Data
7-8 August 1990

	Air temp. °C	H_2O temp. °C	Velocity m/sec	pH	Oxygen mg/l	Con.	Total # of Drift Organisms
Time:1600							
STA 1	11	9.5	-	7.25	10.2	287	3+2S
STA 2	11	10.0	-	7.25	10.6	283	3
STA 3	15	12.5	-	6.70	10.4	282	6
Time:1900							
STA 1	11	9.5	-	-	9.3	289	3
STA 2	11	9.9	-	-	8.6	291	4+1M
STA 3	13	12.3	-	-	9.4	281	6
Time:2200							
STA 1	11	9.9	-	-	9.8	287	0
STA 2	11	9.9	-	-	9.5	291	1+1M+1S
STA 3	12.9	11.0	-	-	9.3	278	14+1P
Time:0100							
STA 1	11	9.9	.18	-	10.0	289	7
STA 2	11	11.0	.14	-	9.5	296	2+2S
STA 3	11	10.1	.18	-	9.2	273	17
Time:0400							
STA 1	10.1	9.9	.17	-	10.2	289	2+1S
STA 2	10.1	10.1	.17	-	9.6	293	5
STA 3	9.8	10.1	.12	-	9.2	270	9
Time:0700							
STA 1	11	9.5	.13	-	9.7	288	2
STA 2	10.9	9.8	.18	-	9.7	290	0
STA 3	11	9.9	.10	-	9.0	269	2
Time:1000							
STA 1	10.9	9.9	.12	-	9.3	291	4
STA 2	11	9.9	.16	-	9.6	298	0
STA 3	14	12	.13	-	9.5	279	5
Time:1300							
STA 1	10.9	9.9	.13	-	9.8	290	1
STA 2	10.9	9.9	.11	-	9.7	297	2+4S
STA 3	16.1	12.7	.34	-	10.6	280	13

Table 7
Biological and Physicochemical Data
17-18 August 1990

	Air temp. °C	H_2O temp. °C	Velocity m/sec	pH	Oxygen mg/l	Total # of Drift
Time:2100						
STA 1	11	9	.05	9.0	290	3
STA 3	15	14	.02	8.4	290	7
Time:2400						
STA 1	9	9	.06	10.6	305	3
STA 2	11	9	.12	9.2	310	3
STA 3	13	13.5	.04	8.4	285	1
Time:0300						
STA 1	9.5	9	.08	9.8	220	7
STA 3	13	13	.03	7.2	270	4
Time:0600						
STA 1	10	9	.04	10.4	300	4
STA 2	10	9	.07	10.0	300	6
STA 3	13	13	.02	7.2	275	0
Time:0900						
STA 1	9	9	.09	10.2	300	7
STA 3	14	13	.02	7.4	280	10
Time:1200						
STA 1	9	9	.07	10.0	295	8
STA 2	10.5	9	.07	10.2	310	7
STA 3	16	15.5	.02	8.0	285	10
Time:1500						
STA 1	10.5	10.5	.16	10.8	300	7
STA 3	17	17	.02	8.0	290	1
Time:1800						
STA 1	10	10	.10	10.8	380	2
STA 2	10.5	10.5	.38	10.2	308	7
STA 3	-	-	-	-	-	-



Cavelets (or solution cavities), Snyders Landing, MD. Photo by Warren Luther

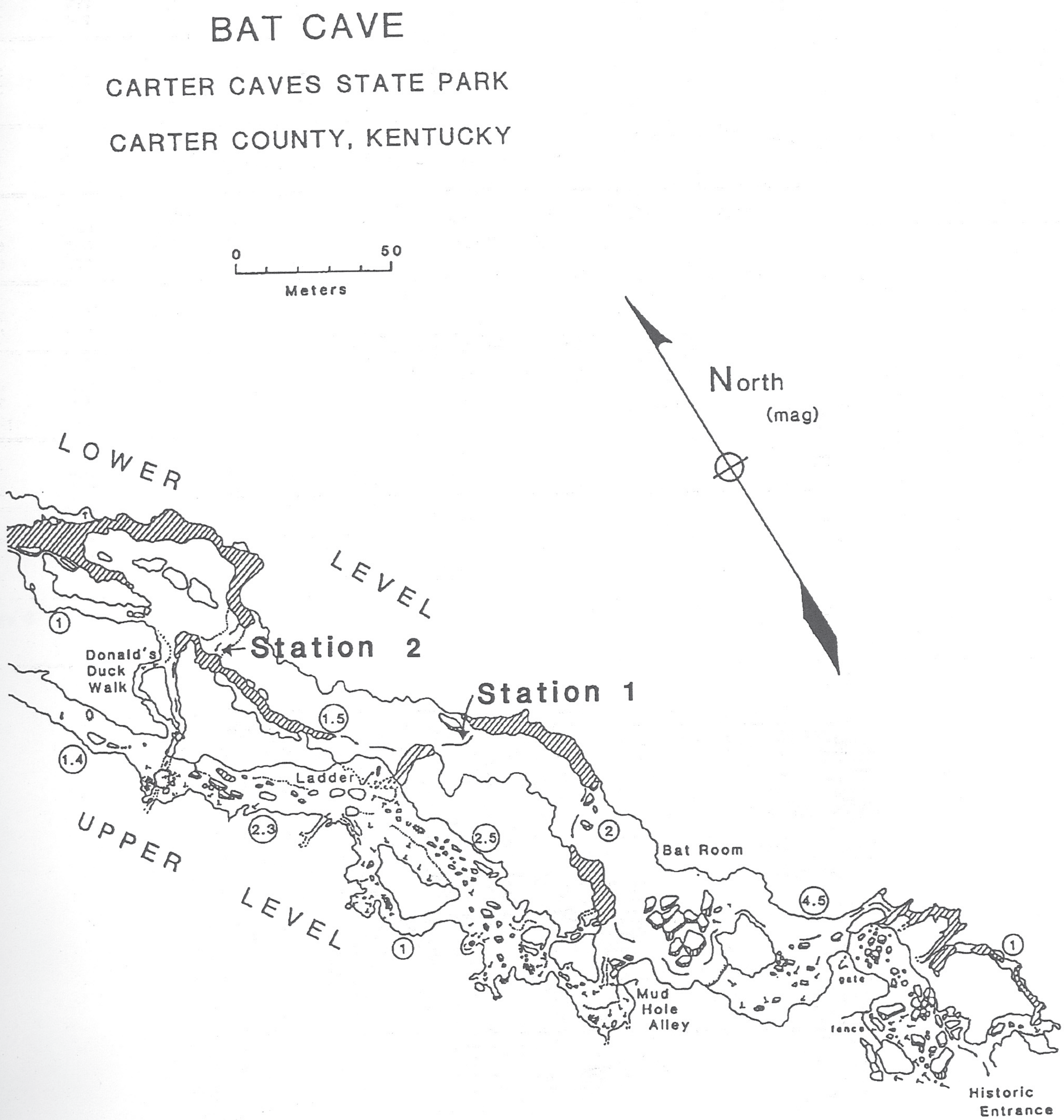
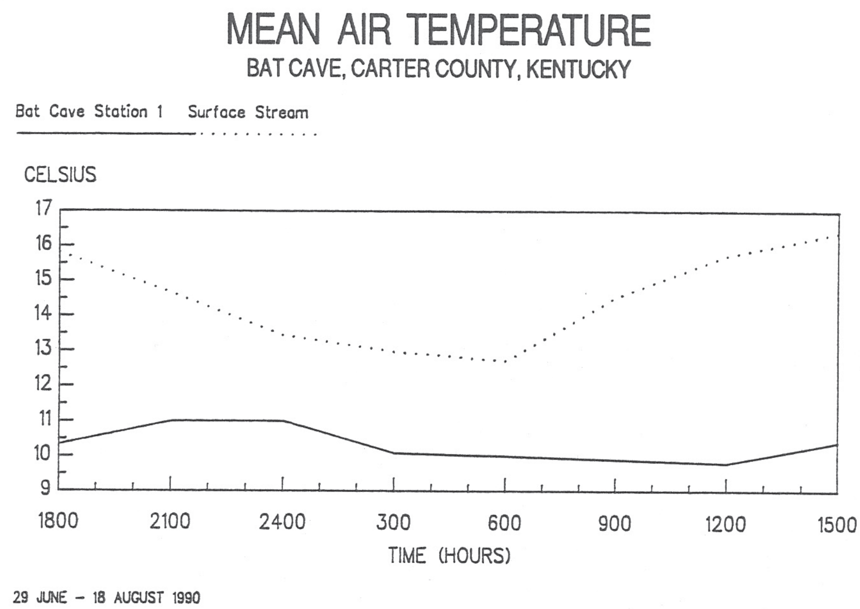


Figure 1. — *Southeastern portion of Bat Cave, showing locations of sampling area (after Hobbs 1989).*



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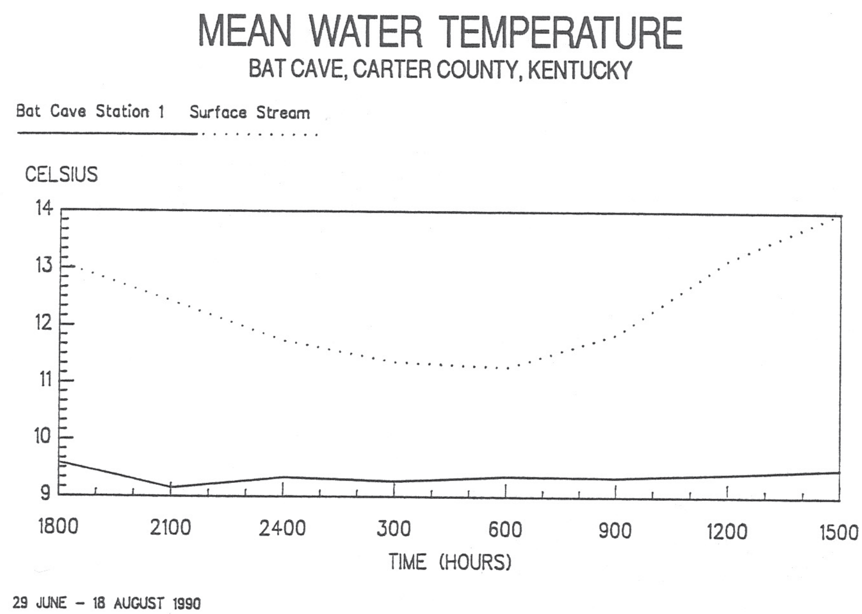

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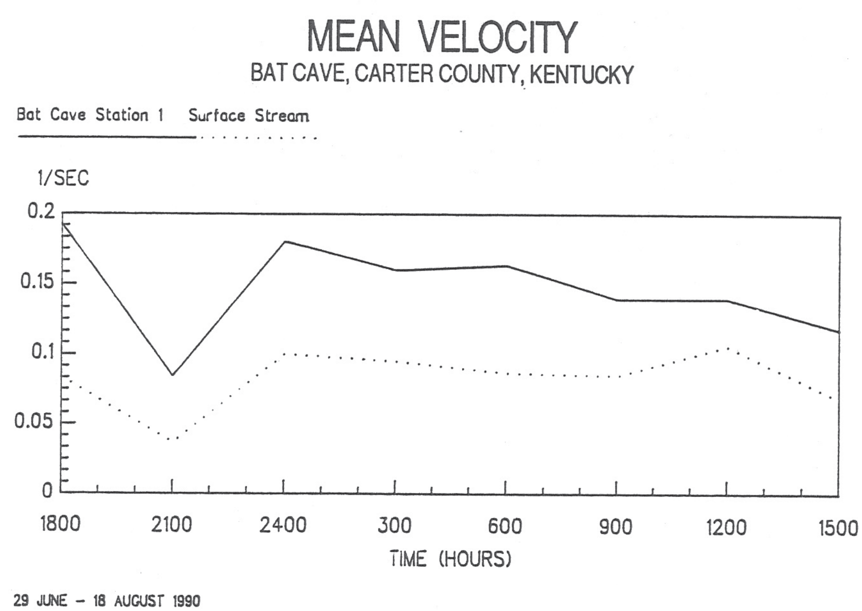

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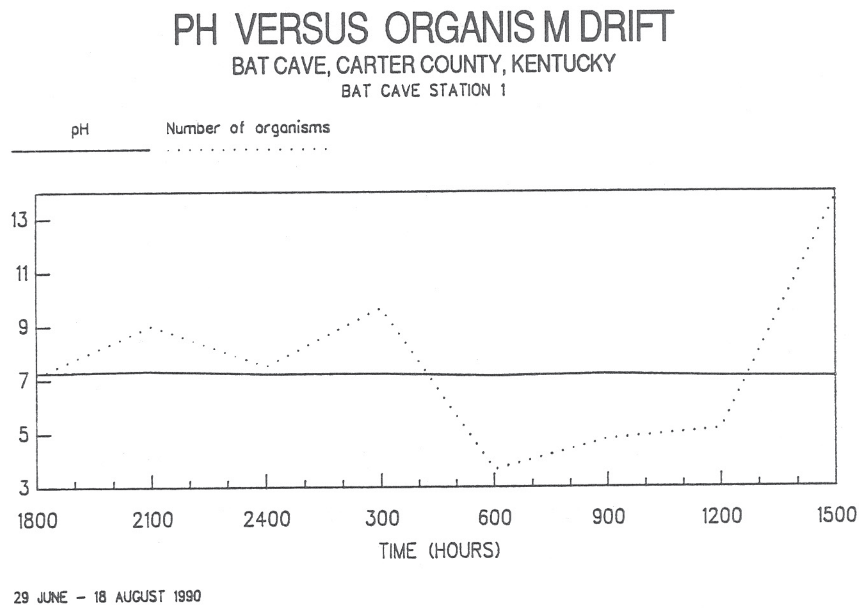

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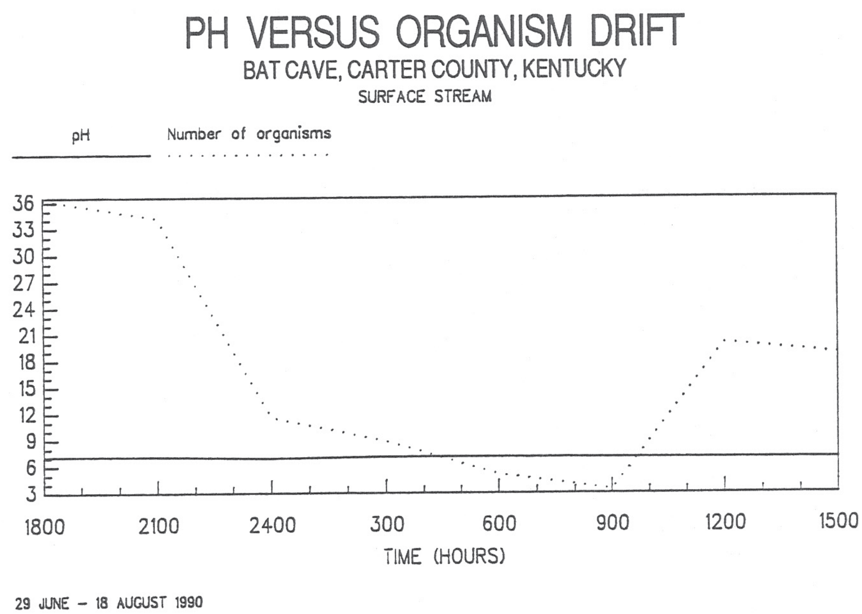

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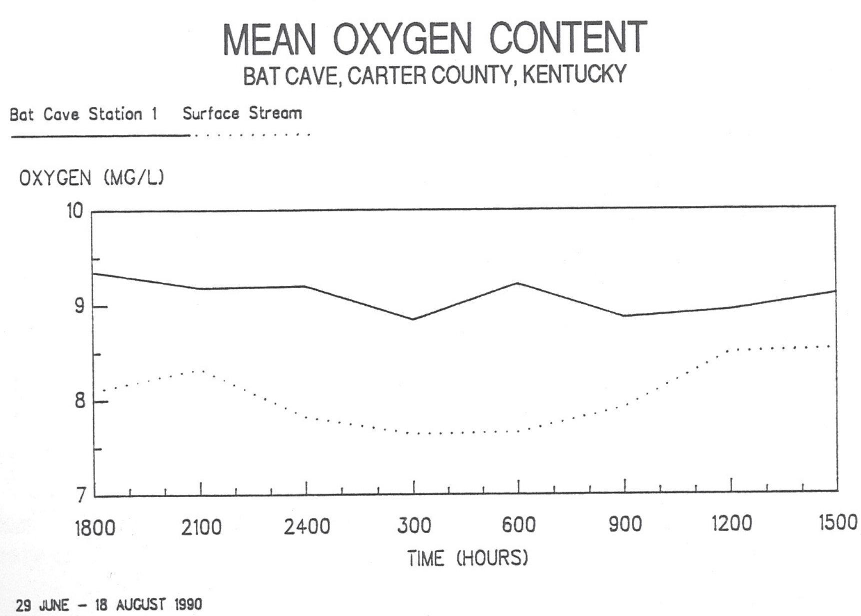
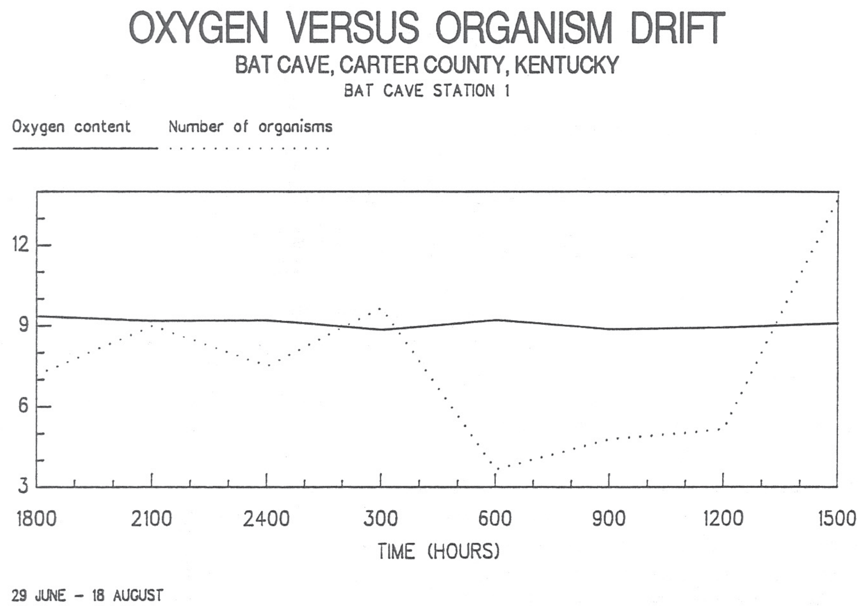


Figure 7.

Figure 8.



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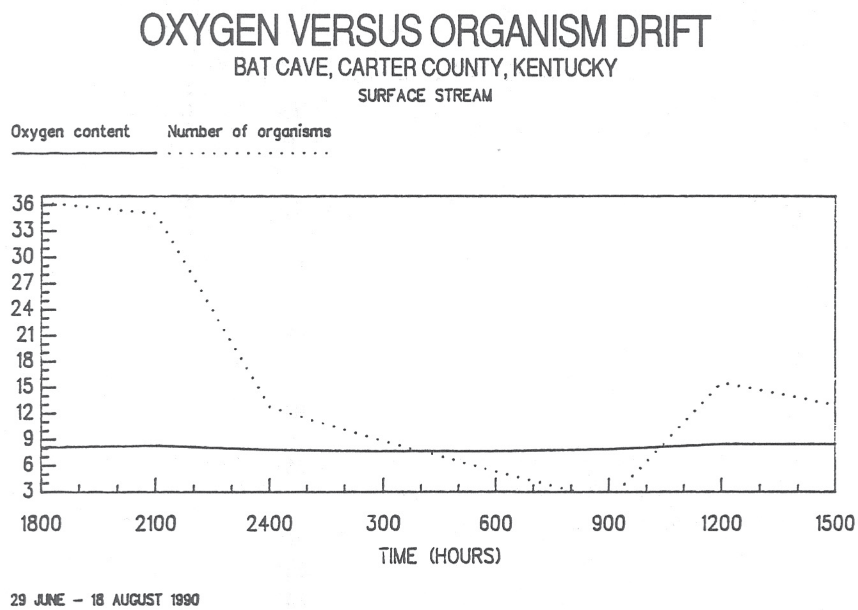
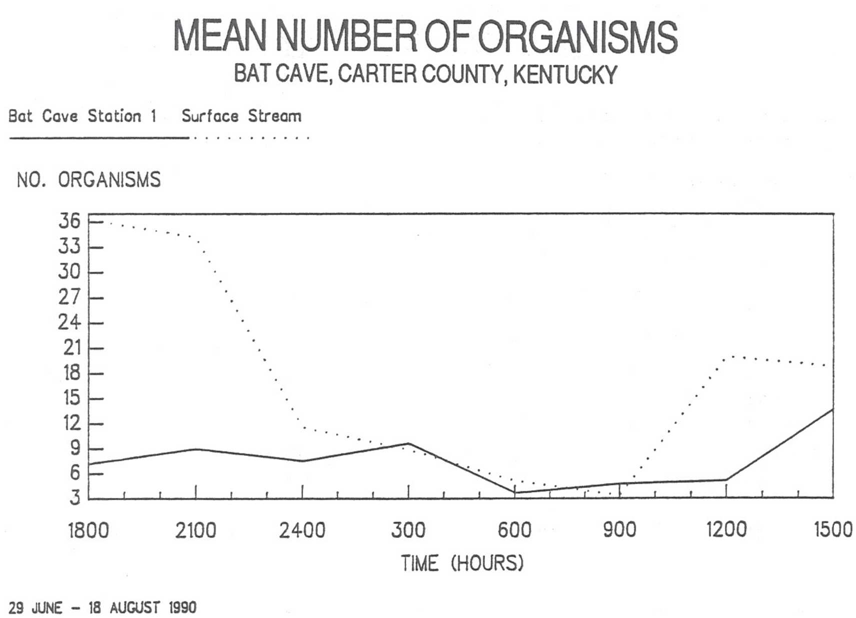


Figure 10.



Carter Caves Chronology of Historic Events Carter County, Kentucky

by
Angelo I. George
NSS 7149 RE,FE

Carter Caves is the second oldest commercial cave park in Kentucky. The caves were opened to the public about 1849. This is approximately the same time period that Wyandotte Cave, Indiana opened its doors in 1850. Carter Caves is located in far northeastern Kentucky. Its isolated position rendered visitation difficult from population centers in Kentucky. More easy access was overland through Ohio to Portsmouth. By taking a ferry across the Ohio River and then overland on horse back, the cave could be reached in about a day. In the early days of commercialization, most visitors came from Portsmouth, Ironton, and Cincinnati.

Many stories and traditions have been told about the caves of Carter Caves State Park. These stories represent a cross section of cave guide patter within the time frame of individual visitation to the caves. The validity of the stories rests with the cave guides and the resulting embellishments are due to the reporters' enthusiasm. Some of the stories were created by the management to supply a history where none existed. The chronology will help in placing these stories in context with actual historic events at the caves.

1783 Alleged Simon Kenton signature in Saltpetre Cave. Use of block lettering in carbide renders this signature as suspect of a hoax.

1795 Large land grants belonging to Richard Graham (80,406 1/4 acres) and William Grayson (Kemper and Bolt, n.d.). The mouth of Cave Branch was a common boundary station.

1803 Formation of Greenup County from Mason County.

1810 Federal Census for Greenup County records 7,970 pounds of saltpeter and 1,070 pounds of gunpowder were manufactured in the county (Coxe, 1814: 125, 127).

War of 1812 Cave mined for saltpeter. Wolfford (1985: 12-13) said the saltpeter was transported by sleds along an improved road next to Tygarts Creek to Van Bibber's ferry on the Ohio River. Wolfford (1985: 13) said John Swingle lived at the caves. His friends were John Alexander and James Ward the salt maker.

Mid 1814-mid 1816 Colonel John Plummer and two young men were on a hunting expedition and made their way down Tygarts Creek to the saltpeter caves, one of which would later be known as Swingle's Cave. During their stay, they supplied meat to the saltpeter mining operation for almost 2 years (George and Plummer, 1987: 5).

December 24, 1814 Treaty of Ghent, end of the War of 1812.

January 8, 1815 Final battle of New Orleans.

February 15, 1815 Congress ratified Treaty of Ghent.

1837 Formation of Carter County from Greenup and Lawrence counties.

Circa 1849 Start of commercial tourist history of Carter Caves (Greiner,1869).

Pre-1856 John Maylan of Philadelphia owned 26,500 acres of land containing the Carter Caves. It is not known if Maylan purchased this land from Richard Graham or William Grayson or other intermediary land owners (Plymale, n.d.:1).

Pre-April 1856 John Maylan dies.

April 22, 1856 Sale of 1045 acres of John Maylan's land to John T. Ratcliff for $680.47. Grayson Courthouse, Deed Book 7:444-46, recorded December 7, 1868 (Plymale, n.d.:1).

Pre-September 18, 1856 The Rev. Dr. Burr and company from Portsmouth, Ohio, visit Carter Caves in August (?). Bat Cave, Natural Bridge, Saltpetre Cave and Laurel Cave were explored. A log cabin with accommodations was in operation near the north entrance to Bat Cave. A half grown boy was the guide. They used torches for lights. The vats in Saltpetre Cave still had their wood construction in a good state of preservation. Burr renames Bat Cave to "Crystal Brook Cave." He thought the cave deserved a better and more fitting name than just Bat Cave. First published use of the name Swingles Cave (Burr, 1856: 1).

1860-1864 Civil War. Cave probably closed because of lack of patronage. Fashionable Kentucky spas also closed their doors (Coleman,1942:21). Although more northern caves, such as Wyandotte Cave, remained open during the war years. (Plymale, n.d.). According to Plymale (stat: 2), "Taylor Warnock said that his father, William Howe Warnock told him about the powder that was made in Saltpetre Cave during the Civil War." This is unsubstantiated and undocumented tradition. There is no primary documentation for any saltpeter mining in Kentucky for the period of the Civil War.

November 17, 1868 John T. Ratcliff, Samuel and Nancy Ratcliff (father and mother of John T.) sell 640 acres for $10,000 to William Howe Warnock and Thomas Dugan. Grayson Courthouse, Deed Book C, p. 217 (Plymale, n.d.: 1). Ratcliff retains mineral interest (Kemper and Bolt, n.d.). Anonymous (1984a: 1) says

Mr. Ratcliff sold this property to his brother-in-law, Thomas Dugan and William H. Warnock (Plymale, n.d.: 1).

Pre-February 9, 1869 Midwinter visit by Theodore S. Greiner to Carter Caves. Mentions Cave Branch, Bat Cave, Laurel Cave, X-Cave and Natural Bridge (Greiner, 1869). The log cabin described by Burr is now called a hotel.

July 17, 1869 R. R. Peebles, Jr. visits cave. George Wolfford located an article in the Portsmouth Times for 1869 that described Peebles visit in company with thirty other people (Anonymous 1969).

Pre-1874 Cave once the rendezvous for counterfeiters (Collins and Collins, 1874: 123).

1881 William Howe Warnock dies (Plymale, n.d.: 1).

1883 Executors ordered to sell at public auction the Warnock estate (Plymale, n.d.: 1).

January 14, 1884 Samuel Price Warnock and Taylor Warnock (brothers) purchase at auction the land for $3500 (Plymale, n.d.: 1).

1886 Taylor Warnock, wife and 5 children move to property; conduct tours through Saltpetre, X-Cave, Bat and Laurel caves. Their light sources were homemade candles and kerosene lanterns. Constructed bridge to X-Cave and built ladder to upper level in Laurel Cave (Plymale, n.d.: 1).

Winter 1888 The daughter of Taylor Warnock, Myrtle Bell, went to Saltpetre Cave to get a bucket of potatoes. While in the potato room passage, "something went past her so fast, that it put her candle out, and she had to get out without a light. She never knew what did it, but her parents thought it might have been a bear going in for its winter sleep" (Plymale, n.d.: 2).

1888 Land auction sale of 1884, confirmed and recorded in Grayson Courthouse, Deed Book C.D. 1: 50 (Plymale, n.d.: 1).

1889 John T. Ratcliff purchased 30 acres from Taylor and Catherine Warnock. This property contained Laurel Cave. The Warnock's retained "exclusive use of and right of way to all caves and natural wells" (Plymale, n.d.: 1).

October 17, 1890 Taylor Warnock and wife, Catherine Agnes (Morton) Warnock sell property for $15,000 to Samuel B. Timmons. Note that $10,000 of the base amount was a property exchange for a hotel in Portsmouth, Ohio (Plymale, n.d.: 1).

1895 Samuel B. Thomas purchased the Laurel Cave and 30 acres of land from Ratcliff (Plymale, n.d.: 1). It is unclear at this point, did Thomas also purchase the rest of the Carter Caves area?

1902 Samuel B. Thomas owned Carter Caves until his death. He built trails in Saltpetre Cave and X-Cave. Commercial tours only during spring, summer and fall months. Cave area managed by Jessie Timmons.

March 19, 1902 Plans made to make the Carter Caves property into a vast park. This consisted of fencing in the property, clearing out underbrush, and the construction of new buildings (Anonymous, 1902: A3).

1902 Samuel B. Thomas dies.

1924 Heirs sell Carter Caves and 1000 acres to John F. Lewis for $45,000 (Kemper and Bolt, n.d.). Lewis forms a company and develops the caves for tourist trade. Original plan called for logging the property (Anonymous, 1984a: 1). Several references describe a puncheon broad axed floor made of poplar planks in Saltpetre Cave. The floor may not be saltpeter related. Floor construction may point to the 1902 or 1924 trail improvement in the cave.

January 24, 1924 John F. Lewis and nine joint venturers form the Carter Caves Company. The cave has become an important tourist attraction since this date (Plymale, n.d.: 1).

May 9, 1924 Dr. Willard R. Jillson returns to recently formed Kentucky State Parks Department in Frankfort, Kentucky. He conducted an investigation of Carter Caves for possible inclusion as a State Park.

January 26, 1924 First reference to the story about John Swift and his silver mine. Swift supposed to have hidden his silver in Saltpetre. Indian grave opened in the cave. Bones and relics exhumed (Anonymous, 1924).

September 7, 1929 Governors Day. Over 500 people attend Carter Caves. Plans made to make Carter Caves and Cascade Caves into a State Park (Anonymous, 1929). New state road under construction from the Midland Trail to Carter Caves.

1930 Mrs. James Darnell recites tradition of first jury trial in this section of Kentucky. The trial took place in Bat Cave (Darnell, 1930: 42). Cave Branch was called Little Caney and before that it was called Swingle's Branch.

March 2, 1930 Open Indian grave touted to the public as belonging to a mummified Indian Princess (Anonymous, 1930).

February 1931 Start of folklore connected with Simon Kenton's signature in Saltpetre Cave (Keith, 1931: 24, 47-48). The Saltpetre Cave contains the fable of the Indian brave, Huraken and his Cherokee lover, princess Manuita. She was buried in a cave where Huraken could watch over her. He was suspected of murder, tried, and sentenced to death. He escaped. Later gave himself up and requested one last visit to the grave of Manuita. That was granted; he entered the cave, and was never seen again. The story has a surprising amount of detail and imaging which gives a romantic view of Indian culture typical of the 1920's and 1930's cinema. The love story has strong overtones to Romeo and Juliet by Shakespeare. Start of folklore about the counterfeiting Swingle. In A Carter County Legend, the story is repeated that Saltpetre Cave or Swindell (sic.) Cave, contains a lost silver mine and that Swindell was one of the counterfeiters (Anonymous, n.d., in stat. 7).

1933 Saltpetre and X-Cave are electrically lighted (Anon., 1984a: 1).

1937 John F. Lewis dies.

1945 Commercial cave operation in financial difficulty and the caves and property are put up for sale (Anony mous, 1984a: 1).

1945-1946 Private fund raising effort to purchase land for the State of Kentucky (Plymale, n.d.: 1; and Anonymous, 1984a: 1).

July 31, 1946 Property sold to the State of Kentucky (Grayson Courthouse, Deed Book 72: 209-11; Kem per and Bolt, n.d.). Ercell Bush in charge of concessions on a percentage basis (Kemper and Bolt, n.d.).

1949 State takes over property. New construction consisted of kitchen and dining room, 5 cabins, group camp, rest rooms, picnic area, service buildings and superintendent's house. Frank Owens of Olive Hill was the first superintendent and lead guided tours through the caves (Kemper and Bolt, n.d.).

April 7, 1953 William E. Davies collects soil samples from Saltpetre Cave for a nitrate and sediment study (Davies, 1953: 6).

1954 Construction of 40 acre Smokey Hollow Lake (Kemper and Bolt, n.d.).

June 26, 1954 Smokey Hollow Lake opened to the public (Kemper and Bolt, n.d.).

February 1955 Ralph Brewer is superintendent. There is an announcement for the construction of a new dining room (Kemper and Bolt, n.d.).

Summer 1961 Construction of a new lodge (Kemper and Bolt, n.d)

August 25, 1962 New 28 room lodge opened to the public with a 200 seat dining room (Kemper and Bolt, n.d.).

April 1966 Nine hole golf course opened to the public (Kemper and Bolt, n.d.).

November 1968 Prior to this, the State Park was closed for the winter (Kemper and Bolt, n.d.).

1970 Boy Scout discovers connection into Saltpetre Cave from Moon Cave.

1971 Guide patter touts Simon Kenton signature as authentic. And saltpeter manufactured into gunpowder, was shipped down river and used in the Battle of New Orleans during the War of 1812. Saltpetre Cave was also called Swingleton Cave or Swingler's Cave. Guides tell the story of the counterfeiters use of the entrance room; and the old Indian grave (Anonymous 1971).

1971 Robert McDowell collects the guide story about a counterfeiter named Sprinkle. Sprinkle is supposed to have manufactured silver dollars with more silver in it than the U.S. Treasury coinage. Coin dealers have never encountered any of the Sprinkle dollars (McDowell, 1971: 82). This is a variation on a theme connected with John Swift's silver mine legend.

March 20, 1971 Joe Creason (1971) adds to the Manuita tradition from his conversations with the guides at the cave. The Indian princess haunts the Saltpetre Cave where she was buried 200 years ago. She retreated to the cave and died of a broken heart because her lover was killed in battle. She was buried in the cave by her people. Her open grave is shown to tourists today. And her ghost is supposed to reappear in the early spring.

May 9, 1980 Price of a ticket to visit Saltpetre, X-Cave is \$1.50 adult, \$0.75 children. Each trip takes 45 minutes.

1984 Story that Simon Kenton was in charge of the 1812 saltpeter mining in Saltpetre Cave; and that Swingle had run the saltpetre operation in the early 1800s (Anonymous, 1984b: 2).

1987 The Indian Princess story was told during my visit to the cave. But the grave is supposed to have been where University of Kentucky archaeologist unearthed a skeleton and took it back for study many years ago.

ACKNOWLEDGMENTS

Sincere appreciation is extended to Mr. John Tierney of Carter Caves State Park for sharing access to his files on the history of Carter Caves. Mr. Bryan Bain was instrumental in clarifying some references connected with Carter Caves. Dr. Horton H. Hobbs III, provided several early key references to the Carter Caves. The Louisville Free Public Library was instrumental in securing microfilm of early newspaper references on the caves. Mrs. Diana Emerson George provided field support and offered many suggestions during the writing of the manuscript.

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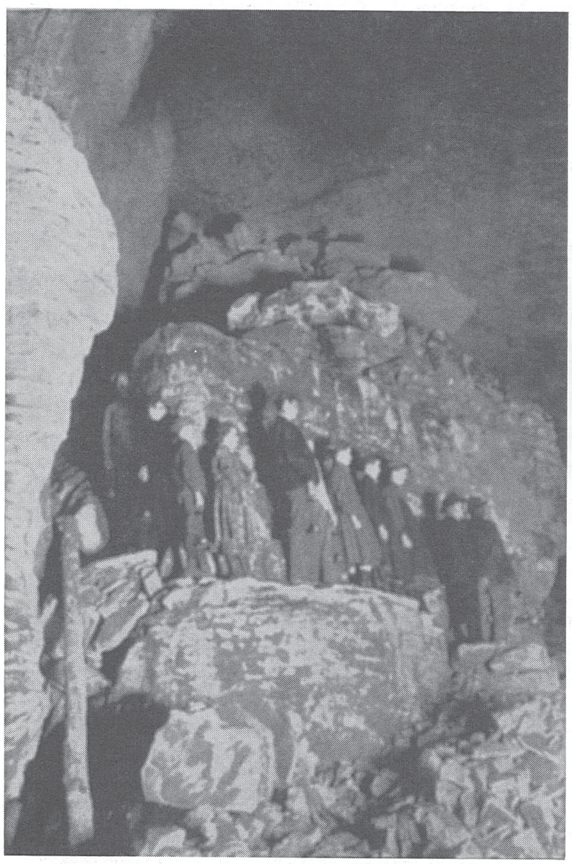

Exit of Corkscrew into Main Cave, Mammoth Cave, KY.

Wishing Well, Perry Cave, Put-in-Bay, OH

Review of "Meeting Place of the Spirits"

by
Phil Mumford

Davison, Don, Jr. 1990. Meeting Place of the Spirits. Aramco World 41(5):16-23

In a desolate mountainous region of northeastern Oman lies the second largest cave chamber in the world. Majlis al-Jinn, The Meeting Place of the Spirits is immense with dimensions of 340 meters long by 228 meters wide with a ceiling height of 120 meters. The chamber is large enough to contain a dozen Boeing 727's parked wingtip to wingtip with a volume that could encompass the entire New Orlean's Superdome.

The cave was discovered by hydrogeologist Don Davidson Jr. as the result of groundwater studies conducted by the Karst Research Program of Oman's Public Authority for Water Resources. The first indications of a cave were revealed through examination of aerial photographs of the Bani Jabir mountains located in the Sharqiyah Region of the northwestern Oman. These photographs were being examined for swallow holes, places where past or present streams disappeared into the ground. Several swallow holes were indicated as well as two very small black dots at the northern edge of the plateau.

Ground survey of the area occurred in June 1983. The two small dots on the photo turned out to be pit entrances to Majlis al-Jinn. First Drop entrance, as it came to be called, was found to be 118 meters deep. About 100 meters away from First Drop, the second entrance pit, The Asterisk measures 140 meters deep.

The author first descended into Majlis al-Jinn on June 23, 1983. The five minute drop ended on top of a debris cone created by the breakdown of the First Drop entrance. At the bottom of the block-debris cone was a large silt and clay plain. It had many stream channels and was occasionally punctuated by an embedded rock or cave formation that had fallen from the ceiling far above. The plain was the drying bed of a shallow lake supplied by infrequent rainfall on the surface. The sediment settles out as the water gradually recedes through the mud. The lowest part of the lake remains wet for many weeks in the cool still air of the cave. The cave contains some evidence of flowstone draperies on its north wall with thousands of cave pearls in a shallow dry area along the edge of the dry lake bed.

The cave was formed in the limestone of the Dammam Formation, laid down in a warm shallow sea 40 to 50 million years ago during the Middle Eocene epoch. Compressional forces, associated with the continental drift, folded, faulted, fractured, and gradually lifted the bedrock above sea level, allowing the chamber's formations to begin. The climate of Oman has repeatedly alternated between wet and dry periods called pluvials. Most cave formation has occurred during these periods. The development of Majlis al-Jinn was controlled by the location of the faults and fractures. Groundwater drained along these faults and fractured during the wet periods. The shape and stability of the large dome shaped chamber resulted from compressional forces on the fractured limestone blocks. The fallen blocks that obstructed the original lower exits from the chamber giving rise to the lake bed. The original floor depth beneath the dry lake bed is unknown.

In May 1985, Majlis al-Jinn became known as the second largest cave chamber in the world following the completion of a mapping survey conducted by Don Davidson and his wife, Cheryl Jones, The chamber has a floor area of 58,000 square meters and a volume over four million cubic meters. There are only three free fall entrances to the cave; First Drop, The Asterisk, and Cheryl's Drop, a small, narrow opening at 158 meters, which is the longest free fall drop in Arabia.

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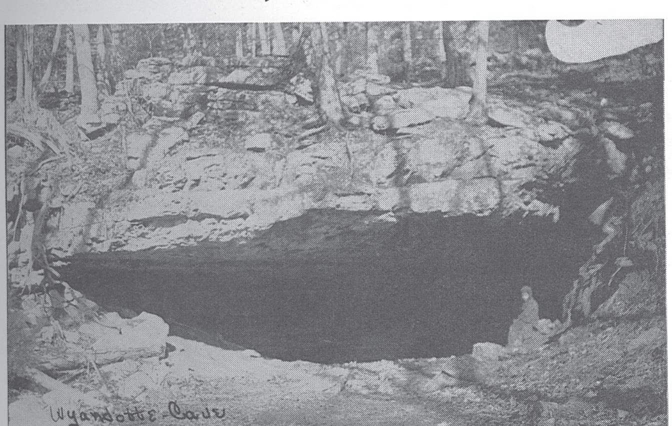
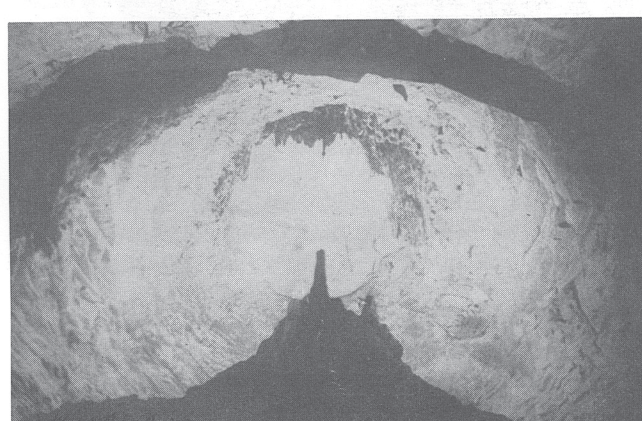


Wyandotte Cave, IN



Wyandotte Cave, IN

Southern Caves Revisited

by
Timothy L. Lewis

"Show Caves of Texas," by Cheryl Laird in Texas (Houston Chronicle Magazine) August 26, 1990, pp. 10-16.

The last issue of *Pholeos* (June 1990) included a review of Lechuguilla Cave in Carlsbad Caverns National Park, New Mexico. That Cave, newly discovered in 1986, featured many distinctions including the longest gypsum speleothem known, and the honor of being the deepest cave in the United States. Its pristine condition and fragile formations create a yearning to go to Carlsbad and see its caves.

Unfortunately "The Show Caves of Texas" will not instill any such yearnings in even the least experienced caver. Unlike most of Texas' 2500 caves, the show caves featured here are no longer wild. They have been tamed by lights, walkways (one is even wheelchair accessible), hand rails, and a cable car. However, for a public otherwise ignorant of caves, this article and the caves it details might help Texans to realize the treasures beneath their feet.

Seven caves are described by Laird. The Caverns of Sonora is described as, "the most beautiful cave in Texas." The Cave Without a Name reportedly features the best tour, with "guides as intriguing as the cave." Inner Space Cavern features brilliant colors and two light and sound shows. Discovered during road construction in 1963, it was quickly exploited as a show cave because of its proximity to I-35. Natural Bridge Caverns, the "biggest cave in Texas", is advertised on numerous billboards, features huge tour groups (over 50 tourists each), and a 22-foot orange dinosaur named Grendel. Longhorn Cavern is 98 percent dormant, and is promoted as a hands-on cave. Cascade Caverns includes a concession to wildlife: a dark tunnel where albino cave salamanders reside. Wonder Cave is a dry cave, the result of shifting rocks. Because it lacks speleothems, the cave features other "attractions" such as an anti-gravity house and a near-by petting zoo.

Any of these caves can be visited for under 10 dollars, with discounts for children. Each features a guide and "improvements." Don't bother with the carbide, these are all electric caves. Like the sacrificial touchstone on most of these caves, these grottos do serve to relieve pressure on wild caves from the merely curious. To a public which might not otherwise visit the subterranean world, the show caves do hold their share of wonder without sacrificing too much southern comfort.

New Insect Found, Cave Explorers Say

Associated Press
Spokesman-Review, 20 Oct. 1990, Moscow, Idaho

Jerome, Idaho — Twin Falls-area cave explorers have located five cave creatures that may constitute new entries on the list of known species.

A group of six spelunkers stumbled upon the bugs during a recent outing. The spelunkers are part of a group called Magic Valley Grotto that is exploring and surveying lava caves in cooperation with the Bureau of Land Management.

The cave creatures have been catalogued by BLM. But a new species must be confirmed by an entomologist experienced in cave invertebrates, said Dennis Fielding, a BLM entomologist.

For verification of a potential new species, larvae would have to be found and raised in a controlled environment, Fielding said.

The spelunkers' specimens will be sent to the Department of Interior, then to an entomologist, who will either identify the creatures or verify they have not been found elsewhere.

There are only five entomologists in the world qualified to indentify cave adapted insects, and the closest one lives in Canada, said David Johns, director of the exploration group.

The five have spent their entire lives in total darkness inside the cave. As a result, they have neither eyes nor optic nerves, but have longer antennae then most insects, Johns said.

Johns declined to give the cave's location. He said it has a 60-foot vertical drop at the entrance, which makes it very dangerous for anyone other than experienced cave explorers to enter.

One of the albino creatures discovered resembles a silk worm: It spun an intricate web, crawled back along each span of the web to check each crossing point, then retracted to half its body length in the web, Johns said.

Then the worm quickly shot its needle-like mouth into the prey and sucked out the body fluids, Johns said.

The group of adults — Dave LaSalle, Chuck Carter, Vernon Ray, William Ancheta, Paula Purletti with the BLM and Johns — also found an albino fly, a specimen resembling a centipede, another that looks like a cricket and several unusual looking gnats.

Blind Harvest spiders were also found in the cave. These spiders are extremely rare; they are known to inhabit only three caves in the world, Johns noted.

To Survey or Not to Survey

by
Tom Stitzel

There it was! In the darkness, just beyond the dim camp light, its oval, fluorescent-green eyes peered at me. They taunted me. They whispered laughingly, "Catch me if you can!" The phantom culprit. The mysterious bandit. The thief!

It was October 13, 1990. It was a cool, overcast Saturday morning that promised no delight in any other outdoor activity except one, caving, or so I believed. I was on my way to Red River Gorge, Kentucky, where I would assist my brother, Bill Stitzel, in surveying a cave. Bill, a member of the Wittenberg University Speleological Society, invited me along to help out. This was going to be my second experience in a cave, and I knew I would love it! My first trip to Sloans Valley Cave, Kentucky proved to be an exhilarating time. It was basically a walk-through cave that presented many fascinating sights. Little did I know that it was no training for what I would be forced to endure at the Gorge.

The first offense, albeit only a slight discomfort, was the three mile hike to the actual sight with a pack strapped to my back. (It must have weighed two hundred pounds, although Bill still contends it was far less than that!) I was willing to overlook this when, upon my arrival at the cave, I stood in awe of the entrance, whose jaws opened into a whale-sized yawn. This pleased me to no end. We stepped inside. This was to be our camp sight. I accepted this fact with my usual grace. (Easy enough since its wide mouth afforded me ample room in the event of the need for a fast escape!) We first made a pot of coffee and lazily drank a couple of cups. I thought this was very civilized. I now realize that it had been a nasty trick to lull me into a false sense of security. However, after the coffee break, I found myself foolishly looking forward to the adventure as I eagerly put on my caving gear. (Part of the fun is dressing the part, isn't it?) Bill gave me a couple of surveying tools, which seemed harmless enough at the time. I was equipped with a compass (to do back shots, whatever that meant) and a measuring tape. I soon discovered that these innocent looking devices would turn out to be the lethal weapons that would be used against me. (If you can't trust your own brother, who can you trust?) We were now dressed, geared and ready to go, and we were off. I felt quixotic. Descending deep into the blackness with nothing but measly little light attached to the hard hat on my head, I became a man with a mission. Under that helmet should have been my thinking cap, which I carelessly left behind when I arose early that morning. (A sad, sad lesson.)

Crawl! Webster defines it as: "1. to move on hands and knees or by drawing the body along the ground; 2. to advance slowly or feebly: 3. to be or feel overrun by creeping things." I would say all of those definitions are true, but let me add one thing: crawl is hell! Dragging my body feebly along the ground and crawling through water, I tried not to think of the many unimaginable creeping things overrunning my body. I crawled through mud and I know that I crawled through bat do-do, but Bill emphatically denied that. (Of course, now I know that he would lie to me!) I was tortured, humiliated, angry, and on the verge of strangling him with the damn measuring tape! I came close a couple of times before I thought twice. He was, after all, my only way out of this hell hole. (The final degradation) So I suffered, but not in quiet! (Ha!) Bill said that I whined, moaned, and groaned so much that he thought I was having a conversation with someone. (I suppose he thought that was funny!) I won't go into any details because they're actually too painful to remember. It will suffice to say that when, after four hours, we emerged from the bowels of the earth I collapsed. (A snivelling, broken man.)

I may have been broken, but at least I was safe. Or so I dared to think. A new nightmare was about to begin. I was so shattered I didn't even have the strength to remove my caving gear. I just sat there in full regalia, smoking one cigarette after another while Bill prepared coffee for us. I considered refusing any coffee out of principle, but I was desperate! I needed it to calm my nerves. So, I humbled myself further and drank several cups. As I drank and smoked, Bill began complaining that something was missing. It was a little blue bag. ("Serves him right!," I thought.) In spite of his alarm, I calmly reassured him that he had simply misplaced it and that it would show up. I felt pretty smug alright and continued to feel that way all through dinner, coffee, and dessert. But, it wasn't long until I noticed something very important of mine missing also. My virgin wool stocking cap was not where I had left it. I'd always worn it to keep my head heated and the cold off my bald spot. Now, I became alarmed too. I needed my cap! The heat from the day's work was gone, and it was becoming quite cold. It wasn't until Bill discovered that his seat pad was missing that we began a search. (I guess his delicate butt was more important than my vulnerable bald spot.) Off we went to search the borders of the camp site, which was now shadowed by the lamp light. Daylight had abandoned us long ago. A short way away, in the area where we had laid our sleeping bags, was a large pile of rocks. Our search took us into that area. Peeking out from under the rocks was Bill's seat pad.

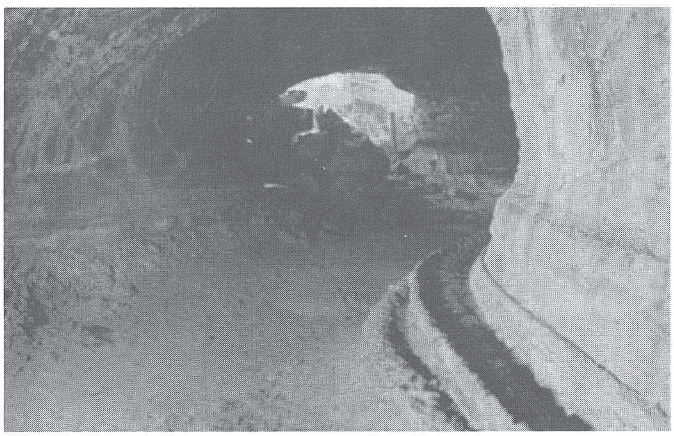
"Aha!" he said, "Pack rats", he added. (A little too casually if you ask me.) Bill continued, "Strange, they've never bothered us before." (Lucky me! The one time I decide to come along, they decide to attack!) It was then that I began seeing the eyes of darkness. They were everywhere. (I'm sure that I was seeing them a couple of times.) They were awful: menacing and malevolent. It was with great bravado with which I continued the search for my stocking cap. (Good things come to those who persevere.) In the blackness, just a few feet from the head of my sleeping bag, my beloved cap lay, abandoned and abused. I quickly picked it up and scrambled back to the light of the camp. "Ha!" I jeered into the darkness, "He who laughs last." All was well until I prepared to crawl (Oh, how I hated that word) into my sleeping bag. Then I realized that I was lying right next to the very pile of rocks where those villainous creatures had hidden. They were probably there now, watching me, laughing at me, and just waiting for me to fall asleep. I laid awake. To further my humiliation, I was being persecuted by pack rats. I pulled the sleeping bag up tight around my neck and then gave a final tug on the stocking cap, now safely warming my head. Shortly thereafter, fear gave way to exhaustion and I fell asleep.

As my mind was surfacing to consciousness, I grabbed my head with confusion and fear. "How could this be," my mind screamed! Here in the pitch black of a cave, I was in a fight for what? My life? No. My hat. Someone. Something. A rat! A pack rat trying to steal the hat right off my head! I held on for dear life and possibly limb as it tugged and pulled ferociously. "WHOOOOAAAAAAAAA!!" I screamed as I sat upright. I frantically searched around for the flashlight that I had left conveniently beside me. There! Finally I found it. I flicked it on, half-turned, and threw the flashlight beam in the area behind me. I expected to see it there, bearing its fangs and ready to pounce on my hat. But, there was nothing there. There was no sign of a rat, just the lifeless cave ground and wall. I waited, but nothing appeared. My panic began to abate, and suddenly I started to laugh. A rat had just tried to steal the cap right off my head. (The nerve!) I had been in a battle with a rat for my cap, and I had won. I laughed. It was suddenly all very funny to me. I turned off the flashlight and put it down before lying down again. I pulled the sleeping bag up around my neck. (This time to keep out the cold.) Reaching up to my head I gave my cap a triumphant tug down over my ears. Mentally, I dared that rat to try again.

I had one more battle that night with that rat. Yes, I awoke later to find that bugger pulling away on my cap again. Holding onto my cap, I challenged it in the darkness, "You can't have my cap!" The tension on the cap then released. I smiled, turned over, and went back to sleep.

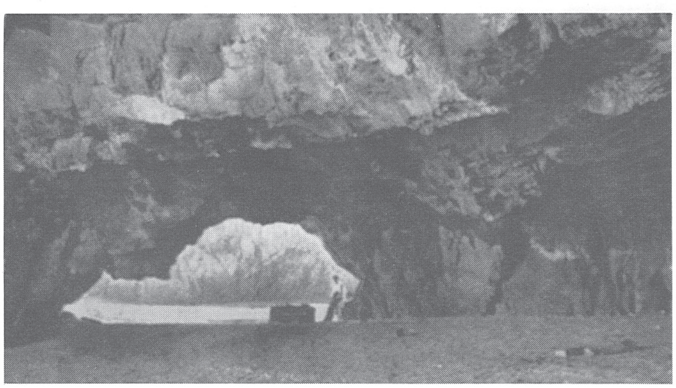
The next day's survey was rather much like the first. Although I whined, moaned, groaned and had been stiff, sore, and bruised for days afterwards, the memory of my surveying trip makes me smile today. But that rat! Now that makes me laugh!

From Our Archives, *Cont.*

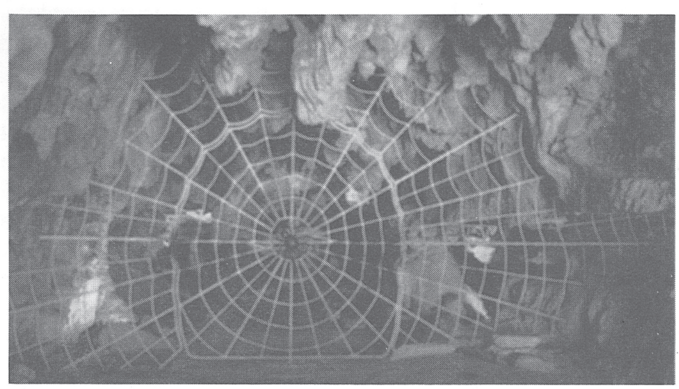


Valentine Cave, Lava Beds National Monument, CA

Kings Canyon National Park, CA



Tres Bocas Cave, Santa Cruz Island, CA



Crystal Cave, Sequoia National Park, CA