

Canyons & Caves

A Newsletter from the Resource Management Offices
Carlsbad Caverns National Park

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Edited by Dale L. Pate

Special Thanks to Paula Bauer, Bill Bentley, Kelly Thomas

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Look for Issues of *Canyons & Caves* at the following websites: <http://www.caver.net/> Once there, go to the Caves & Canyons icon. Bill Bentley has placed all issues on his personal website. <http://www.nps.gov/cave/> Kelly Thomas is in the process of placing these newsletters on the park website.

RESOURCE NEWS

MINERAL WITHDRAWAL PROPOSALS – In order to better protect caves in the Guadalupe Mountains, the Bureau of Land Management is proposing to withdraw 8,950 acres north of the park from future leasing for mineral or oil and gas development. At the same time, the U.S. Forest Service is proposing to withdraw from the future leasing of 27,299 acres from between Carlsbad Caverns National Park and Guadalupe Mountains National Park from the same type of activities, mineral extraction and oil and gas leasing. The two agencies held an open house meeting in the town of Carlsbad on December 7 to inform interested parties of the proposals and to solicit comments. An Environmental Assessment is being prepared for each agency's proposal.

PREDESIGN PLAN FOR CARLSBAD CAVERN AREA – The draft Environmental Assessment (EA) for this plan has moved closer to its release to the public. To help complete the EA, plant and archeological surveys were recently done for the area surrounding Carlsbad Cavern. A likely release date for the Draft EA will be February 2000.

14TH NATIONAL CAVE AND KARST MANAGEMENT SYMPOSIUM - On October 19-22, 1999, Chattanooga, Tennessee was the location for the 14th National Cave and Karst Management Symposium. Hosted by the Southeastern Cave Conservancy, Inc., the Symposium's theme was "Living with Caves and Karst". This well attended

symposium drew cave and karst managers, researchers, and cavers from all over the United States including Alaska and international guests from as far away as Australia. With many talks focused on water resources issues, history, education, GIS, Cave and Karst Management and research, this year's symposium was a great success. Keynote and banquet speakers were Ronal Kerbo, NPS National Cave Coordinator; George Veni, a prominent cave and karst consultant; and Michael Ray Taylor, author of *Cave Passages* and *Dark Life*.

SAR TRAINING – Our annual 3-day Vertical Rescue Techniques Training Class was held December 1-3 this year and was a great success. The first day of training was in a classroom setting (the fire cache training room) where the participants practiced knot tying, anchors, packaging the patient, and other aspects of vertical rescue in a controlled environment. The second day found us on a small vertical cliff practicing the art of raising and lowering a litter. The third day, in order to practice a cave-simulated rescue in a cave, participants rigged a vertical drop in Wen Cave, one of the recreational permit caves in the park. This gave the participants real-life cave rescue practice and also helped in preparing our pre-rescue plan for the cave.



With Laura Denny as the litter attendant and Jason Richards at the edge to help maneuver the litter, Garnet Goodrich (as patient) is successfully raised up the 60-foot deep pit in Wen Cave. (NPS Photo by Dale Pate)

Thanks to everyone who was able to participate: Stan Allison as the leader, Jason Richards, Tom Bemis, Laura Denny, Pat Donahue, Chris Burns, Dale Pate, Susan Herpin, Patrick Brady, Miho Horokoshi, and Garnet Goodrich. Thanks to all the supervisors for allowing these employees to attend.

NATIVE AMERICAN AWARENESS DAY – A celebration of our Native American heritage was held on November 6, 1999 at the Visitor Center. Presentations, story-telling and a dance performance by the Southwestern Indian Polytechnic Institute highlighted this day. Thanks to Jeff Sena and Lola Henio for their efforts in making this a successful celebration.

THANKS to all staff members and volunteers that performed conservation and restoration activities in the caves of the park during 1999. Your efforts are appreciated.

CCGMA ONLINE BOOKSTORE - The Carlsbad Cavern Guadalupe Mountains Association is now offering books and other educational materials at their website: www.ccgma.org Check it out!

WELCOME to Susan Herpin and Miho Horikoshi who are volunteering in the Cave Resources Office.

PLANTS OUTSIDE MY WINDOW

by Gary Vequist

In order to make reasonable decisions during the planning process for the Pre-design Plan for the developed area near Carlsbad Cavern, a survey was needed to identify any rare or endangered plants that may exist in the area. In December, Yvonne Chauvin and Amanda Kennedy, from the New Mexico Natural Heritage Program performed this survey. Although they didn't locate any rare species they did compile a list of common plants within a easy walk of the visitor center or housing area. I spent half a day with them learning botany, a major undertaking for an **OLD** wildlife biologist.

The most common species encountered within the developed area's south slopes were:

Curlyleaf muhly	<i>Muhlenbergia setifolia</i>
Pinchot's juniper	<i>Juniperus pinchotii</i>
Sotol	<i>Dasyllirion leiophyllum</i>
Lechuguilla	<i>Agave lechuguilla</i>
Mariola	<i>Parthenium incanum</i>
Skeletonleaf goldeneye	<i>Viguiera stenoloba</i>
Feather plume	<i>Dalea formosa</i>
Algerita	<i>Mahonia trifoliata</i>
Silver dalea	<i>Dalea bicolor var. argyrea</i>
Englemann's pricklypear	<i>Opuntia engelmannii</i>
Purple-fruited pricklypear	<i>Opuntia phaeacantha</i>

Some additional common plant species within the developed area on the north slopes were Wright's beebush (*Aloysia wrightii*), catclaw mimosa (*Mimosa aculeaticarpa var. biuncifera*) and catclaw acacia (*Acacia greggii*). Within the drainage are found nice stands of hackberry (*Celtis laevigata var. reticulata*), Mexican buckeye (*Unghadia*

speciosa) and western soapberry (*Sapindus saponaria*).

In the near future, the park will be working with the New Mexico Natural Heritage Program to prepare a vegetation map for the entire park. The data gathered from this two-year long project will be placed into a GIS format for use during the 21st century for various resource management activities.

CARLSBAD CAVERN RESURVEY 1999 UPDATE

by Jason M. Richards

The last year of the millennium was indeed a good year for Carlsbad Cavern. At the beginning of 1999, the resurveyed length of Carlsbad Cavern was 26.75 miles (43.05 kilometers) of mapped passage. During the year, several dedicated survey groups added 1.36 miles (2.19 kilometers) of mapped passage making a total survey length of 28.11 miles (45.24 kilometers). The areas being resurveyed in 1999 were: F-Fissure in the New Section, Troll Town in Left Hand Tunnel, Central Boneyard off Lower Cave, Mable's Room off Lower Cave and Middle Earth in the Big Room.

Dan Montoya, Deb Rivera and Jennie McDonough, all from Albuquerque, have been working in the F-Fissure for the past three years. The crew of the F-Fissure added 1,267 feet of resurveyed length.

Paul Burger, the karst hydrologist for the park, was assisted by a number of cavers in the surveying of the Troll Town section of Left Hand Tunnel. Paul's teams added 898 feet of resurvey.

Joe Sumbera and "Team Troglo Brau" from San Marcos, Texas worked in two sections of Lower Cave and started the Lake of the Clouds resurvey. Joe and his crew added 1,162 feet of resurvey.

Expedition members of the Cave Research Foundation worked in various locations in Lower Cave adding 2,534 feet of resurveyed passage.

Kathy and Dale Lankford from Idaho and Kelly Holladay from Hobbs, New Mexico started the resurvey of the Middle Earth section of the Big Room. Kathy's team has completed the Nether World section of Middle Earth and their total for the year was 1,320 feet of resurveyed passage.

Pat Kambesis along with Mike Lace continued her excellent sketching of the Big Room. Pat has spent numerous nights over the past few years using the park's laser distance meter and a compass to create the most detailed sketch ever made of this area of the cave.

Each of the above teams plan to continue their survey projects in 2000. The Remarkable Crack section of the cave will be added to the resurvey schedule starting in February 2000. Erik Niemeyer, a computer specialist with the National Park Service in Santa Fe, will take the lead in this project.

The resurvey of Carlsbad Cavern has made a great deal of progress in the past few years. It will be interesting to see the progression and growth of Carlsbad Cavern in the next century.

CACTUS MORPHOMETRICS MADE EASY (WELL, EASIER...)

by Renée Beymer and Diane Dobos-Bubno

It seemed easy. All that our federal neighbors and we wanted was a study to give us good characteristics for identifying our federally listed cactus – Lee pincushion – in field situations. But, as often happens with plant taxonomy, we got more than we bargained for.

Taxonomy is the study of the classification of plants and animals based on naturally related groups. Morphometrics is the measuring of physical characteristics. Sometimes when a scientist describes a new species, the characteristics that differentiate it from other related species are not well defined. Such was the case with CCNP's federally Threatened Lee pincushion cactus. Over the years, park Resource Management staffers have had a difficult time identifying some populations and individual cacti. This problem was compounded on neighboring U.S. Forest Service and Bureau of Land Management lands. Many cacti that were found appeared to be of this species, but they looked just a little different. Since there were no other cacti identified for this area with similar characteristics, they have always been identified as Lee pincushion.

Proper identification of this species is important when we perform surveys and go through the compliance process. A better idea of what characteristics were the best to use in the field was needed. So three years ago, the Surface staff set out to get funding for a study. The Native Plant Initiative through the National Fish and Wildlife Foundation, awarded the study with a maximum of \$10,000 to be matched with \$13,000 in donations or in-kind services. Approximately \$11,500 of the needed \$13,000 match came from funds *and pro bono* services through Carlsbad Caverns/Guadalupe Mountains Association and volunteer botanists. With the grant, we contracted Dr. Marc Baker of Southwest Botanical Research to provide a detailed study of the characteristics that differentiate the pincushion cacti in this area. Dr. Baker was chosen on the strength of both his study proposal and his previous experience with the cactus family.



Lee Pincushion Cactus

(NPS Photo by Diane Dobos-Bubno)

Dr. Baker, a botanist, completed the study this year, along with Dr. Robert Johnson, an Arizona State University entomologist with a statistical background who has published other statistical works on rare cacti. It has been submitted to the *Journal of Systematic Botany* to be

reviewed and published. (In botany, 'systematics' is an experimental approach to taxonomy.) The study is titled: "Morphometric analysis of *Escobaria sneedii* var. *sneedii*, *E. sneedii* var. *leei*, and *E. guadalupensis* (Cactaceae)" by Marc Baker and Robert A. Johnson. Don't be confused by the Latin name *Escobaria*. It is another name for some of the *Coryphantha*, the name we've usually used. The study contains some very fancy statistical analyses. Below, we have tried to condense and translate the results – and management implications – into plain English for the benefit of the park staff.

Baker and Johnson studied a series of physical characteristics of the Lee pincushion cactus and two other closely related, nearby cacti: Sneed pincushion and Guadalupe pincushion. They measured and statistically compared averages of the number of immature stems, diameter of mature stems, number of radial spines, and length of the innermost central spine (the side and central spines in each cluster of spines – the "pincushion"). They used these features not only to give us better ways to identify these species in the field, but also to determine if the various populations were all properly identified.

Baker and Johnson's study has confirmed that:

- ◆ Lee pincushion is restricted to the Guadalupe Mountains as an isolated population in eastern New Mexico, and does occur in CAVE.
- ◆ Guadalupe pincushion is restricted to the Guadalupe Mountains in Texas (mostly in Guadalupe Mountains NP), and does not occur in CAVE.
- ◆ Sneed pincushion does not occur in either CAVE or GUMO, but is known only from some individuals in the Guadalupe Mountains (on adjacent federal lands) and populations in the Franklin Mountains of NM and TX.
- ◆ CAVE also has some populations that, though they look similar to Lee and Sneed pincushions, may differ genetically with the potential of being a separate species.

For field identification purposes, they determined that Lee pincushion has the largest number of immature stems, the smallest stem diameter, smallest inner central spine length, and highest number of radial spines of the three. Lee is similar to Sneed in that both tend to bear numerous immature stems and have stems less than 30 mm in diameter. For reference, 30 mm is about 1¼ inches. However, Lee has more than 40 radial spines while Sneed has fewer than 40, and the innermost central spine length in Lee is less than 5 mm and greater than 5 mm for Sneed.

In contrast, the Guadalupe pincushion has few immature stems, mature stems greater than 35 mm in diameter, innermost central spine length nearly 10 mm, and radial spines fewer than 35 in number.

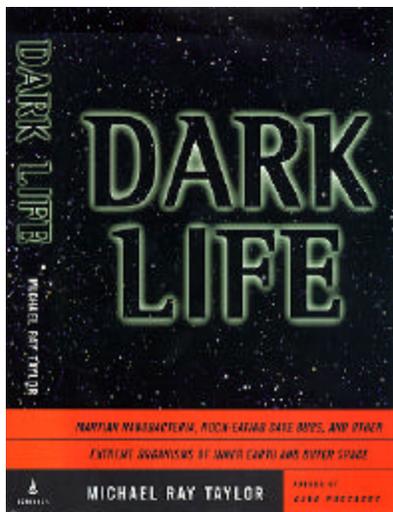
Baker and Johnson advise us though, that because these values represent averages and not absolutes, further identification of populations should be done using the average measurement of several individuals in a particular population.

Now that we have good differentiating characteristics, it seems that every time we need to identify populations of our federally listed cacti, we're going to be in

the field with our botanical magnifying lenses (called hand lenses) and millimeter measuring sticks – counting and measuring tiny cactus spines... Somebody pass the microscope!

DARK LIFE BY MICHAEL RAY TAYLOR

Reviewed by Dale Pate



Dark Life by Michael Ray Taylor is a book about microbes and some of the fascinating scientists who are changing the way we think concerning this unseen world of life. Part of Taylor's story weaves around Larry Mallory, Diana Northup and Penny Boston and their search for microbial life in Lechuguilla Cave, Mammoth Cave, caves in Hawaii and Cueva de Villa Luz in Tabasco, Mexico. Though certainly not the whole story, the research in Lechuguilla Cave is put into perspective concerning research on microbial communities in other parts of the globe as well as the debate over microbial life that may have originated on Mars.

In *Dark Life* Taylor has created a readable, easy to understand story out of a very complex and arguable subject. He examines, of course, some of the work that has been ongoing in Lechuguilla Cave, but moves on to describe numerous other discoveries and studies. Taylor describes the discovery Anne Taunton and the NASA team from the Johnson Space Center made after closely examining a Martian meteorite found in the Antarctic. He follows James Cowen's study of a huge plume of microbial mats that are erupted from an undersea volcano located 100 miles off the coast of Oregon. Taylor also describes his own work with Steve Rudd, a resource manager from Hot Springs National Park and some of the microbial life flowing out of the hot springs at the park. Taylor examines some of the most controversial work when he discusses Bob Folk's discovery of "nanobacteria". Nanobacteria appear to be microbes far smaller than any known bacteria and are related to the discoveries from Mars.

I found Taylor's *Dark Life* entertaining, adventurous and fascinating. Mankind is only now beginning to seriously look at the world of the microbe. What is found there will change how we think about life, the world and the universe we live in. Taylor's book is a good introduction to this subject and well worth reading.

Dark Life was published by Scribner out of New York during 1999. It retails for \$23.00 and can be obtained from the Carlsbad Caverns Guadalupe Mountains Association (CCGMA) or from most book vendors.

COMMON GRAY FOX (*Urocyon cinereoargenteus*) by Ken Geluso

Over a period of 22 years, I observed 65 gray foxes during my studies at the park. Most sightings of this canid occurred at night along Walnut Canyon, but I also saw them during daylight hours at Oak Springs and Bat Cave Draw. These diurnal sightings and others along Walnut Canyon occurred on the afternoons of 24 March, 22 April, 23 May, 15 August and 1 September. Gray foxes are most commonly observed in mid-spring. Thus far, I am unaware of any records of this species from habitats on the seabed.



A Gray Fox makes a meal of juniper berries. (Photo © Dale L. Pate)

This article was borrowed from a report by Kenneth Geluso to the National Park Service in 1993 titled "Mammals of Carlsbad Caverns National Park: An Annotated Checklist".

KEEPING A FIELD JOURNAL by David Roemer

Good field notes are a vital aspect of being an excellent naturalist. Good field notes are also exceedingly rare in today's fast-paced world where even the natural history observations of park resource management specialists are often rushed in deference to some other urgent task (!). A quick perusal of my own field notebooks over the

past few years tells the tale all too clearly – scribbled shorthand that is marginally decipherable to myself, and which would provide a frustrating experience at best to other future readers. If one is serious about making detailed natural history observations, learning as much as you can from them, and passing on that knowledge to others, then a good-faith effort is going to have to be made towards keeping a field journal.

In an attempt to improve upon my field skills, I sought out a little book with a big title: The Naturalist's Field Journal: A Manual of Instruction Based on a System Established by Joseph Grinnell (Buteo Books 1986). The book is by Steven Herman, a professor at The Evergreen State College in Washington. The book describes the discipline of keeping a daily field journal from scribbled field notes that otherwise would waste away in desk drawers and soon be forgotten. Within the pages of the field journal are recorded every aspect of the landscape that can be gleaned by the careful observer – the location or route traveled, weather conditions, habitat, plant phenology, dominant flora, animal behavior, lists and numbers of species seen, etc. The content is limited only by the abilities (and perhaps the patience) of the observer. In this way, the journal is more than just a book for the archives, but “a workbook in which observational skills are repeatedly and continuously tested and sharpened.”

Much of the book's pages are devoted to describing the rules of “the system.” First and foremost, the journal must be written in during the afternoon or evening on which the observations are made. Herman even shouts in capital letters “NO JOURNAL THIS DAY – NO SLEEP THIS NIGHT!” Furthermore, the system is exacting when it comes to the nuts and bolts of actually doing the writing. It tells you what paper to use, what pen and ink, where to write the date, and how to write it. One of the goals of keeping a field journal is to produce a consistent organized body of material that may be evaluated objectively by others. Thus there are 94 pages of rules and examples on the format and style of your journal.

Overwhelming? Well... yes. But it contains tons of really stellar advice that makes reading this book pleasurable. For example, I have yet to come across any other natural history field guide or textbook that addresses the following subject (which seems especially pertinent for biologists):

“It is a fact of contemporary life that some persons have fallen into the habit of consuming alcoholic beverages as they relax in the afternoon or evening. As a simple matter of physiological and biochemical observation, not moral guidance, be cautioned that alcohol taken in excess (a relative term) will adversely affect your ability to transcribe notes and compose journal material.”

Fortunately, the book also contains much to inspire the budding naturalist. Such inspiration is apparently needed, as the author suffers no illusions as to the amount of work and discipline that is required to neatly transcribe each day's observations “on one side of the paper only” every single night. Among the passages that best provide justification (and inspiration) for undertaking such an endeavor, is this quote from Elliot Coues' 1874 work, Field Ornithology:

“Now you know these things, but very likely no one else does; and you know them at the time, but you will not recollect a tithe of them in a few weeks or months, to say nothing of years... Write down everything while it is fresh in your mind; write it out in full – time so spent now will be time saved in the end, when you offer your researches to the discriminating public. Don't be satisfied with a dry-as-dust item; clothe a skeleton fact, and breathe life into it with thoughts that glow; let the paper smell of the woods. There's a pulse in a new fact; catch the rhythm before it dies.”

The book treats its subject exhaustively, and sets a high, if somewhat daunting, standard for biologists. In many ways the system described is “old school” since the modern biologist, equipped with global positioning units, data loggers, laptop computers, and other technological gadgets, may question the necessity of writing everything down in pen and ink. Since reading it I have been gathering the necessary materials for my journal and soon hope to develop the discipline of writing in it regularly. I've cheerfully ordered a copy for the park library in the hopes that some of you will find it enjoyable. If by chance anyone thinks that they would like to attempt “the system”, then give me a call and perhaps we can start a support group!

Figure 1 - These examples are far from perfect, but they will hopefully show improvement with practice.

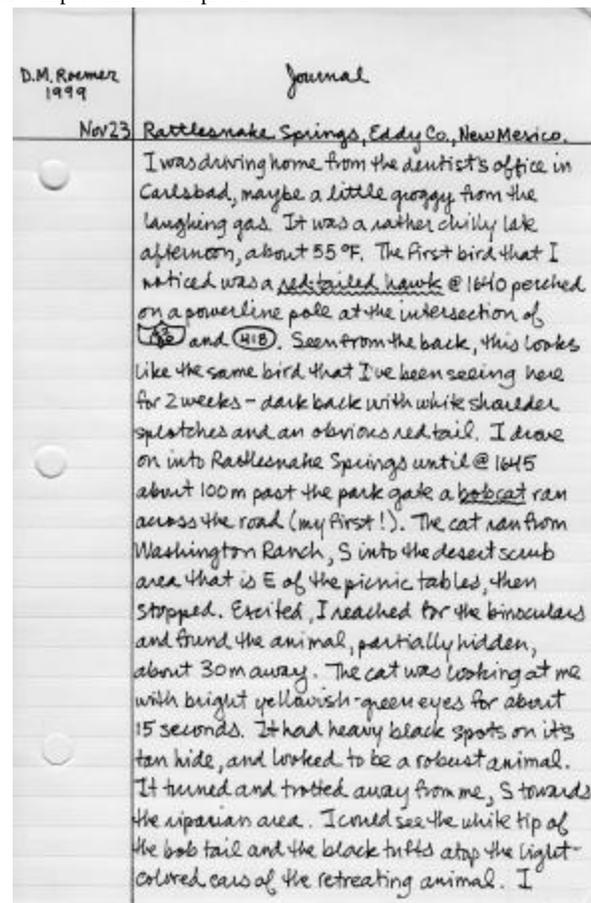
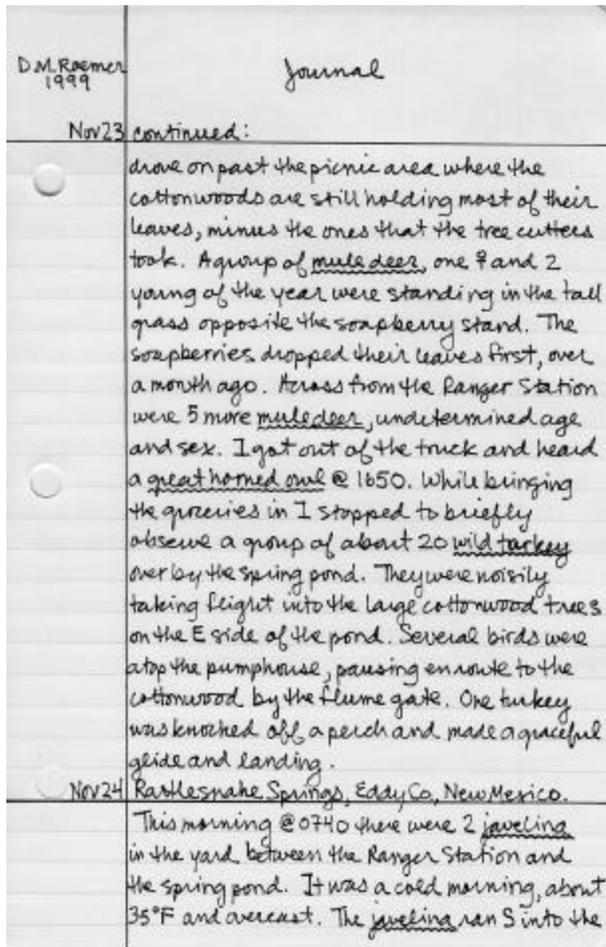


Figure 2 - The journal becomes more valuable with time, serving as a reference for future naturalists.



RECENT LECHUGUILLA HAPPENINGS by Stan Allison

On August 1-7, Sid Perou and Martin Beldersen filmed footage in Lechuguilla Cave for an upcoming NOVA Public TV special. This special called "Window into Darkness". At this time there is no set date for the showing of this documentary. The focus of the filming in Lechuguilla was the ongoing microbiology research being done in Lechuguilla by Dr. Penny Boston and Diana Northup. The formal title of their study is "Geomicrobiological investigations of a Cave Deep Substrate Environment. This is a study to investigate the possibility that the corrosion residues in Lechuguilla and Spider Caves are produced through the actions of microorganisms. The filming went well and impact to the cave was minimized.

A Lechuguilla Exploration and Research Network (LEARN) exploration expedition to the cave occurred September 11-19. Two teams spent the week doing further exploration in the Zanzibar Area discovered off of the far end of the Western Borehole in August. No major discoveries were made in this area, although a less delicate route was discovered to enter the delicate Nativity Chamber. One team surveyed in the Far East and another in the Southwest with no major new finds reported. The total

survey for this expedition was 5,499 feet with an additional 1,037 feet of resurvey.

In early October a management trip was made by the Cave Resources Office to make a management decision concerning exploration in the Nativity Chamber. Due to the delicate nature of the room involving vulnerable aragonite and flowstone, and stalactites a decision was made to hold off on exploration in the Nativity Chamber in the hopes that a bypass might be found to circumvent this pristine and delicate room.

In light of this decision, the October 23-30 LEARN exploration expedition made a concerted effort to explore and survey in the Keel Haul area, hoping to find a bypass to the Nativity Chamber. Over 3,000 feet of cave was surveyed in a new area below Keel Haul called Lost Cargo. Lost Cargo consists of solutionally enlarged breakdown fissures and in some places contains aragonite and corrosion residues. One of the two teams surveying in the area reported that "...there appears to be extensive amounts of passage in and under the Keel Haul area in general". Both teams surveying in the area felt that the surface had just been scratched. "It is entirely possible that one or more of these leads will push under the wall from Keel Haul and provide new discoveries." One team did mainly mop-up survey in the Southwest while another team did climbing leads in the Far East. The Far East team found an area with Gypsum hairs that were up to five feet long and left an area with unchecked fissure leads and airflow. Total survey for this trip was 4,540 feet. Lechuguilla is currently surveyed to a length of 105.79 miles.

Linda Doran led a dual, geological-inventory and water-sampling trip into the cave on November 10-13. The recently discovered Zanzibar area as well as the Clam Bake area near the FUBAR Survey was inventoried. The Zanzibar area was found to have extensive aragonite and corrosion residue deposits. The Clam Bake has numerous fossils with crinoids and algal leaves being the most extensive. A Bellerophonitid Snail was found as well as two different types of Pelecypods (bivalves) along with brachiopods, gastropods, nautiloids, horn corals and sponges. Of note is the exceptional diversity of fossils in this area which are remarkably well-preserved with delicate internal structures still intact.

Jake Turin led the water collecting part of the trip for his study titled "Tracer Tomography in Unsaturated Fractured Rock". Jake is using Lechuguilla Cave as a natural laboratory to better understand the flow of water through the unsaturated zone. The unsaturated zone is the layers of rock between the surface and the permanent water table where water gradually makes its way down through fractures and solutional features (caves) to finally arrive at the water table. Jake's study is to determine the age of the water in pools in Lechuguilla to understand better how long it takes for water to travel through the unsaturated zone. The methodology for this study includes taking water samples from pools in Lechuguilla and examining them for radionuclides that would have been produced during atmospheric nuclear tests such as the Trinity Site in New Mexico. Measuring these radionuclides in the water will determine how long it takes for the water to flow through this unsaturated zone.

During November and December there have been two week-long restoration trips in Lechuguilla sponsored by LEARN as well as a restoration trip led by Jim and Val Werker. The LEARN trips focused on restoration in Ghost Town, Ghostbusters Hall, Nirvana, Underground Atlanta, Ultra Primo and Deep Secrets. The Werkers restored sediment-stained flowstone in Pellucidar, which is the site of the first subaqueous helictites found in the cave.



Steve Keselik cleans a mud-stained area in Underground Atlanta.
(Photo © Marty Brown)

This has been a busy year for Lechuguilla Cave. Expeditions and trips will diminish during the first part of the year 2000 because of the entrance culvert replacement project.

WHITE-ANKLED MOUSE *(Peromyscus pectoralis)* by Ken Geluso

White-ankled mice in New Mexico are known only from the Guadalupe Mountains and adjacent areas. Most specimens from the state are from Carlsbad Caverns National Park. I found the white-ankled mouse to be the most abundant and widespread species of *Peromyscus* in the park, occurring in nearly every habitat of the reef and in all

seabed habitats along the base of the escarpment. The altitudinal range of white-ankled mice in the park extends from 3,700 to 6,390 feet in elevation.



White-Ankled Mouse (Photo by Ken Geluso)

The white-ankled mouse was very common on the reef, and it was the only species of *Peromyscus* captured along the entire face of the escarpment, on floors of Walnut and Slaughter Canyons and in the juniper penneplains. Similarly, white-ankled mice were abundant and the sole inhabitants of rock outcroppings, cliffs, rocky slopes, and gullies of canyonsides below 5,720 feet. In rock outcrops and gullies above 5,740 feet, white-ankled mice were relatively uncommon and none were captured in cliffs at these higher elevations. White-ankled and brush mice inhabited the grassy, oak summits between 5,640 to 5,860 feet and both species were uncommon. The white-ankled mouse was absent from the highest summits of the reef which were inhabited solely by brush mice. White-ankled mice were the only species of *Peromyscus* at water holes at high elevations (5,960 feet).

Compared to the reef, white-ankled mice were relatively uncommon in the flatlands of the seabed. The main exceptions were the rocky arroyos that cut through the lowlands and the boulder terrain of Slaughter Canyon Draw. Nevertheless, some white-ankled mice were captured in some areas of desert scrub, the grasslands, alluvial fans and juniper plains. None were taken at Rattlesnake Springs.

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